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TECHNICAL AND ECONOMIC CHARACTERISTICS OF FURANS AS MOTOR FUELS

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Abstract:

Biofuels are considered to be fuels of the future. According to scientists, it is necessary to look for new ways of obtaining energy, because the amount of natural deposits is decreasing. Biofuels are a type of renewable energy source. The use of biofuels to power motor vehicles is associated with various difficulties. Currently, the use of biofuels is mainly based on the use as an admixture to conventional fuels. Biofuels made from biomass that is not derived from food products are second generation biofuels. An example of such biofuels are furan fuels, which are produced from lignocellulosic biomass. Furans as fuels to power vehicle engines have great potential, however, their use is associated with certain restrictions.

Keywords:
biofuels, furan fuels, biomass

Introduction

The current propaganda imposed by global decision-makers to protect the environment through the use of renewable energy sources is conducive to the development of the use of bio chemicals for industrial purposes. Due to the European Union law in force in force in force regulations regarding the use of the amount of biofuels in the economy, research on the second generation of biofuels has begun. These biofuels also include furan fuels, which can be obtained from lignocellulosic biomass. Furan fuel production is based on a number of physical, chemical and biological processes. Mass production of furan fuels requires appropriate technology and facilities in the form of the possibility of obtaining raw materials for production at the lowest possible costs. Unless lignocellulosic biomass is directly used for human consumption, its resources appear to be quite substantial. Unfortunately, when furan compounds are obtained from biomass, it is necessary to properly process it in order to obtain an appropriate semi-finished product from which the highest furan fuel production efficiency can be obtained.

Characteristics of furans

Furans are biofuels that can be made from lignocellulosic biomass, which is one of the most efficient and economical types of renewable energy source [1]. Lignocellulosic biomass contains cellulose, hemicellulose and lignin. Depending on the product from which it is obtained, the content of individual ingredients varies. For corn on the cob, the content of cellulose, hemicellulose and lignin is 42, 35 and 15% respectively. Lignocellulose biomass contains 40 to 45% oxygen and 35 to 50% carbon in the dry matter of the product [2].

In order to obtain liquid fuel from biomass, it is necessary to produce bio-oil in the pyrolysis process or perform the gasification process and obtain synthesis gas, or to hydrolyze biomass to produce sugars. Most often, a third method is used for this purpose, which is based on the hydrolysis of cellulose in the lignocellulosic material to fermentable sugars, followed by fermentation of the sugars produced to obtain final products. Unfortunately, due to the fact that lignocellulose consists in addition to cellulose of hemicellulose and lignin, it is necessary to properly prepare the biomass for the hydrolysis process. Preparation of lignocellulosic biomass for biofuel production processes is based on physical, physico-chemical, chemical and biological treatment. There are many methods in the categories given that are used for the pretreatment of lignocellulosic biomass. Unfortunately, there is no single optimal method. The fundamental problems developed over the years include pre-treatment methods should be cost technology and the implementation of the process of preparation, yield and energy balance [1, 2].

Furans have gained in popularity in recent years, are considered to be fuels of the future, which may become an alternative or even competition for petroleum fuels [3]. Increased interest in furans and its derivatives results to some extent from the development of the world economy, but also involves the search for new alternative types of energy. Biofuels made from furans can be classified as second generation biofuels because they are produced from lignocellulosic biomass, i.e. products not used for human consumption. Furans as fuels or fuel admixture in the form of biocomponents can generally improve the boiling point, they dissolve in water to a lesser extent, and in addition they can be obtained from more energy during combustion compared to first generation biofuels [4]. Additionally, it was found that admixtures of furan fuels can be modifiers of combustion of traditional fuels by increasing engine efficiency and reducing exhaust emissions [5].

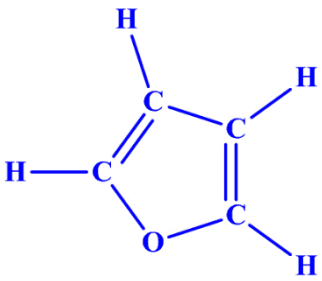

Fig. 1. Chemical structure of furan
Source: [3]

Furans consist of four carbon atoms and one oxygen atom (Fig. 1). The furan nucleus is highly reactive. Furan fuels are obtained from platform chemicals such as furfuran (FFR - Fig. 2a) and 5-hydroxymethylfurfural (HMF - Fig. 2b) [3, 5, 6]. Furfuran is produced by acid-catalyzed conversion of xylose, while HMF is formed as a result of glucose dehydration [6].

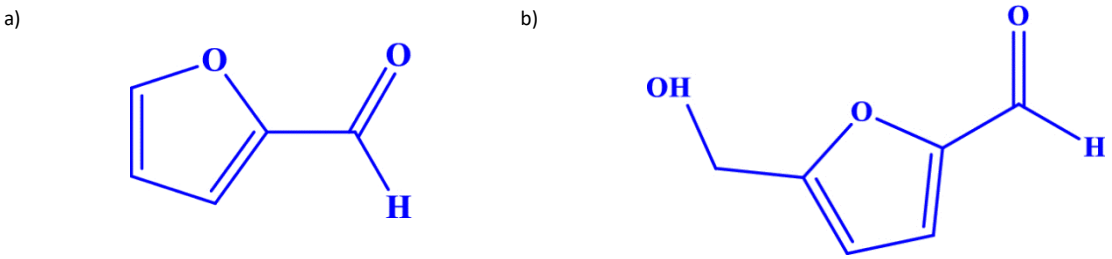

Fig. 2. Chemical structure of FFR (a) and HMF (b)
Source: [3]

The production of furans and their derivatives is based on a number of chemical changes that do not always allow the achievement of the expected effect in the form of the production of appropriate quality furan fuel.

Acquiring furan fuels

The use of furans as fuels involves the need to produce alcohol, which can then be used as an independent fuel or as an admixture to conventional fuels. Preparation furfuranowego alcohol (FA) with furfuran is based on carrying out catalytic reduction or hydrogenation furfuran. The catalytic reduction of furfural to FA is shown in Fig. 3, in this reaction the catalyst is copper chromite [7]. It is estimated that 70% of furfural produced is allocated to FA production [14].

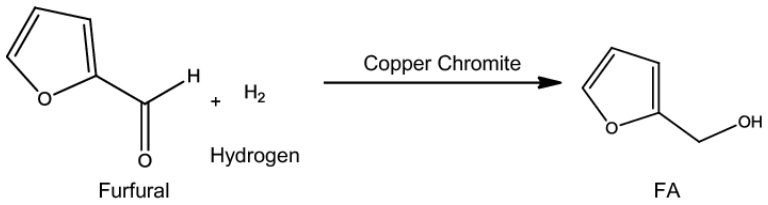

Fig. 3. Catalytic reaction of FFR to FA
Source: [7]

Currently, furans are gaining popularity, unfortunately mainly in terms of research and hypotheses for their practical use as fuels to power engines of internal combustion vehicles. One of the most popular furan fuels are 2-methylfuran (MF) and 2.5 dimethylfuran (DMF).

Tab. 1. Comparison of DMF, MF and motor gasoline (BS) parameters

No.	Parameter	DMF	MF	BS
1.	Boiling point [°C]	94	65	30…210
2.	Research octane number	101	103	98
3.	Motor octane number	88	86	88
4.	Water solubility [mg/dm^3]	1460	3410	-
5.	Calorific value [MJ/dm^3]	30.1	27.6	ok. 33.0

Source: own study based on [17, 18]

The data presented in Tab. 1 show some parameters of DMF, FM and petrol (BS) allowing their comparison. As you can see, furan fuels have a calorific value similar to BS, especially in the case of DMF. According to the authors [17], they have low water solubility, where this argument can be applied mainly to DMF. As for the research octane number and motor octane number, the values are very similar to BS, and slightly higher in the case of DMF. However, when it comes to boiling point, only DMF is suitable for possible mixing with petroleum fuels, e.g. motor gasoline. It can be seen from the table that DMF has better properties than MF compared to motor gasoline.

MF is a flammable liquid that is difficult to dissolve in water. It can be obtained by synthesis reaction as a result of hydrogenation of furfural, using intermediates, i.e. catalysts. Various catalysts have been used over the years and variable effects have been achieved. The production of MF is based on the hydrogenation of furfuran as vapor to MF at the appropriate pressure and temperature. The resulting efficiency varied in the range of 75 to 85%, and in some cases has been asserted to 90% [7, 8, 9]. However, these were tests on a laboratory scale, where costs are not included and the tests themselves are performed on a small scale. A lot during the production of MF depends on the conditions that in most tests were variable, but also on the catalyst selected for the reaction.

DMF is a colorless liquid that, like MF, does not dissolve in water. The chemical compound has comparable properties to gasoline and much better than bioethanol. In addition, it has anti-knock and anti-friction properties. The DMF production process is based on two stages. The first stage is obtaining HMF from biomass by using the appropriate solvent depending on the type of biomass. At a later stage, it is necessary to separate the crude HMF from the solvent. The purified HMF is then subjected to a hydrogenation reaction with a suitable catalyst. This type of method gives a yield of 49 to 79% [10, 11]. Another way to produce DMF is to heat the HMF produced in the presence of formic and sulfuric acid, where the yield is 95% [12].

One of the most important problems in the production of fuels from furans is the lack of accurate economic data. Most researchers focus on creating new furan fuel production methods, apply variable conditions, use different reactions with different catalysts, but do not base their final research results on economic rationality. Each method used for the production of MF and DMF has its advantages and disadvantages, unfortunately, production costs are not mentioned as disadvantages or advantages.

Economic and technical aspects of furan fuel production

The production of furfuran from lignocellulosic biomass is practically based on the use of similar methods and technologies from the beginning of the researchers' interest in this subject. Although new technologies for producing furan fuels are emerging, they often prove to be slightly more efficient than previous methods, and in addition the costs they generate make production even less profitable. In the production of furan fuels, attention should be paid to such aspects as [12, 14-16]:

- cost of biomass preparation (pre-treatment);
- type, quantity and price of the catalyst used for the reaction;
- method of separating products from waste;
- efficiency of the process to obtain the finished product;
- energy balance;

- the cost of purchasing technological equipment;
- time after which the return of investment will take place.

The production of furfuran from lignocellulose is generally based on carrying out an appropriate chemical reaction and then purification of the resulting product to the final expected product. Work on furfuran production should start with designing the entire process and performing tests based on choosing the right solvent. Selection of a suitable solvent is very important, since if it is mismatched, the biomass is not properly distributed, and then there will be less efficient manufacturing process. Unfortunately, most solvents show high toxicity and ecotoxicity, which results in the abandonment of a more efficient solvent in favor of a less effective, but also less harmful to the environment [12]. In the studies described in [12] a technical and economic analysis was carried out of furfuran production from lignocellulosic biomass. Furfural was obtained in a hybrid extraction/distillation process. The appropriate solvent was selected from the group of 10 most popular, in terms of selectivity, decomposition balance, easy regeneration and economic viability based on the procedure developed in previous studies [13]. The furfural purification process was assumed at the level of 50 tons per year. An economic assessment of the process was made to determine the total investment cost, total annual operation costs, total annual costs and total annual carbon dioxide emission. In addition, the chemical engineering index, column diameters and trays of the extraction/distillation processes as well as the necessary elements and assemblies for the production of furfuran from lignocellulose were included. Finally, three solvents (toluene, benzene and butyl chloride) were selected and the appropriate parameters were determined for them. Choosing benzene as the solvent have the best results in terms of total investment costs, total annual operation costs and total annual carbon dioxide emissions. Unfortunately, due to environmental protection and harmfulness of benzene, butyl chloride was chosen, which was not as effective as benzene, but met the appropriate conditions despite the fact that it is also highly toxic and ecotoxic. In addition, studies [13] compared a hybrid extraction/distillation process with a traditional one, using methanol as a solvent, where it is not treated as a by-product. The results were better for carrying out the butyl chloride process. Savings in total annual costs of 19.2% were recorded compared to the traditional distillation process. Interestingly, a reduction of over 50% in carbon footprint was also achieved for the hybrid process.

Another work [15] shows the production of maleic anhydride from furfural in oxidation processes in the water and gas phases. It has been shown that the current development of water catalysts is below the expected level and the huge amounts of water needed for purification significantly impede the process. In addition, it was found that high production costs were achieved. In the case of gaseous oxidation, the obtained result on sales of maleic anhydride is comparable to current production technology. It has been shown that in the aspect of these studies it is necessary to reduce the price of furfuran, which in turn will reduce costs and give greater efficiency in the production of maleic anhydride.

In another article [16] a technical and economic analysis was made of the creation of a biorefinery based on the production of HMF and DMF from fructose. The considerations were based on the production of HMF from fructose in a two-phase reactor with a water catalyst and a solvent in the form of butanol, which is characterized by low boiling point, and the production of

DMF from HMF using a copper catalyst. It was determined that the most important factor affecting HMF production efficiency is the extraction of HMF into the organic phase from the aqueous phase. According to the authors, another important parameter is the price of the input, i.e. in this case fructose, which can be replaced with cellulose, which can reduce the cost of purchasing raw material. An important aspect here is the cost of purchasing equipment and assemblies for the construction of a refinery and the sale of residues from the HMF production process, which can reduce the total investment costs. In the case of DMF production, the largest costs fall on the total cost of installations at the refinery. In this system, the catalyst accounts for 1/3 of the total installation costs. The total investment costs are high and the resulting product compared to motor gasoline is not competitive in terms of price per dm3. The cost analysis shows that the largest share is attributable to the raw material fructose and subsequent recovery of raw materials, i.e. fructose and butanol. The analysis shows that the profitability of HMF production is associated with obtaining raw materials at low prices, as in the case of DMF, where it is also necessary to use other, cheaper catalysts. The authors notoriously emphasize the need to create new technologies both in the process of producing HMF and DMF, as well as obtaining appropriate raw materials for production.

The cited publications show that it is possible to produce furan fuels, but in most cases the costs incurred for the investment only offset the revenues from the sale of the finished product. It can be said that in this matter a lot of research is needed to determine the optimal method of creating furan fuels, but this is a very complicated process, because in the development of furan fuel production technology one encounters many variables.

Conclusions

1. Most authors of publications in their considerations emphasize the advantages of furan fuels as an example of second generation biofuels compared to conventional fuels. show the obvious advantages of these biofuels. This fascination probably results from the promotion, especially in Europe, but also on other continents, of the need to use renewable energy sources, supporting this argument by the need to protect the environment by eliminating carbon dioxide from the atmosphere.
2. Research in most cases is based on the performance of laboratory tests in the selection of the appropriate furan fuel production technology and the use of the most effective catalysts and solvents.
3. Furan fuels are able to replace petroleum fuels to some extent, however, only methods of obtaining and processing them are known at this stage, unfortunately there is no patented optimal production technology supported by thorough and precise technical and economic analysis.
4. Although research on the use as motor fuels furans last several decades, their greatest use and application in the automotive industry is estimated at 50 years of the twenty-first century, which is similar to the time when it is expected the total use of crude oil.

5. There is practically a small chance that furan fuels as an example of second generation biofuels will replace conventional fuels, but they are certainly a favorable alternative and competition for first generation biofuels.

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CHANGES IN THE LIMITATION PERIOD IN CIVIL PROCEEDINGS

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Abstract:

The statue of limitations is an institution which constitutes a kind of temporary limitation of creditors' possibilities to pursue their claims. The regulations governing this issue changed significantly in 2018. The Legislator's assumption was to shorten limitation periods in such a way as to enable creditors to effectively pursue their claims, while considering the development of technology, which allowed to take steps to secure them much more quickly. Despite the fact that the limitation period for claims against consumers has been shortened, by far the most controversial is the change of verification whether the limitation period has expired. However, due to a great number of changes introduced - the Legislator's actions need to be assessed by analysing all the amended articles of the Civil Code.

Keywords:
limitation period, civil proceedings

Introduction

As it was rightly pointed out by A. Szpunar: "Limitation does not belong to the legal institutions which are clear and easy to be presented" [1]. Obviously, it may be stated that limitation is classified in the category of remissions, i.e. a particular type of legal events which are connected with the legal consequences in the form of weakening the law, mainly with the lapse of time specified in the regulations and other premises indicated therein. [2] In the Act of 23 April 1964. [3] - the institution of limitation is regulated in the Civil Code, Book 1, Title 6 i.e. in Articles 117 to 125. Despite more than 50 years of operation of the afore-mentioned legal act, the location of provisions relating to the subject of limitation has remained unchanged. Although, the content of the provisions governing this issue has changed frequently, the main reasons for legislative changes have been mentioned most frequently, i.e: "the need to ensure the stability of law and security, the need to protect the current situation, elimination of uncertainty and tensions in legal relationships, persuading entitled persons to purse their claims on time and removal of difficulties that arise when

a court deals with a case that happened many years ago" [4]. This argument - despite more than half a century of applicable provisions regulating the issue of limitation - remained unchanged.

Shortening limitation periods

The amendment to the Civil Code of 13 April 2018 [4] was intended to shorten the basic limitation periods, so that the current general limitation period indicated in Article 118 of the Civil Code was limited to 6 years (previously it was 10 years). In the event of other claims, i.e. concerning periodical benefits and those related to conducting a business activity, the limitation period has not changed and still remains 3 years. The amendment to the wording of Article 118 of the Civil Code has only seemingly limited itself to shortening the limitation periods to 6 years. The second sentence of this regulation clearly indicates that "the end of the limitation period falls on the last day of a calendar year, unless the limitation period is shorter than two years" [4], so in practice, the liabilities with a due date falling in the same calendar year on 1 January and 31 December will have the same limitation period, although in the case of liabilities with a due date falling on 1 January the creditor will have one year more to protect his claims. According to the Drafter indicated in the explanatory memorandum to the bill, the application of this solution was aimed at facilitating the determination, by both creditors and debtors, of the date after which a given obligation would become statue-barred by law. Unfortunately, this solution, due to the afore-mentioned disproportion in time which allows creditors to pursue their claims effectively in practice, may turn out to be very problematic, especially in the case of people who have problems with the timely payment of liabilities at the beginning of the calendar year.

Taking into account the actions taken by the Legislator aimed at increasing consumer protection, and aiming, above all, at enabling over-indebted persons to undergo social rehabilitation (e.g. through the process of amendment which has been going on for several years, resulting in a significant liberalisation of regulations enabling the declaration of civil bankruptcy), the addition in Article 117 of the Civil Code of Civil Law of the requirement according to which: „§ 2^1. "After the expiry of the limitation period, no claim against the consumer may be pursed." [4]. The amendment in this field, which has been in force since 9 July 2018, is a special rule in relation to the general rules on limitation periods. According to the Drafter's assumption, this change was aimed at "tightening the statute of limitations of claims due to entrepreneurs against consumers by tying, with the expiry of limitation period, - by virtue of law - the effect in the form of inability to satisfy the claim effectively" [5]. However, similarly to the change related to shortening of the limitation period, the applicable solution, since the entry into force of the amendment, should be considered as imprecise.

The consideration of the statute of limitations by the court

The current solution resulting from Article 117 § 2 of the Civil Code remained unchanged in case if the debtor is not a consumer. According to this regulation, "the statutory effect of the statute of limitations is that, after the expiry of the statute of limitations, the party against whom a claim is pursed, has the right to refuse satisfaction of the claim, i.e. the so-called peremptory charge.

The exercise of this right means that the claim may not be enforced. This effect occurs when the objection of limitation is raised effectively (after the expiry of the limitation period) - not when the limitation period expires itself. A claim against which the statute of limitations has been successfully raised does not expire, but turns into the so-called incomplete (natural) obligation which is characterised by the inability to enforce it.

Consequently, if the debtor does not raise an objection of limitation, the court cannot take into account the statute of limitations - for the reason that the expiry of the statute of limitations does not deprive the creditor of the right to enforce the claim. The creditor loses this right only when the debtor raises a peremptory charge. The raising of such a charge, i.e. the exercise by the debtor of his right to refuse satisfaction of the claim, obliges the court to dismiss the complaint involving a time-barred claim. The reason for the debtor's failure to exercise his right is irrelevant. The decision in this respect shall be left solely to the debtor, who has the right to invoke or waive the statute of limitations after the expiry of the limitation period. [5] Due to the use, by the so-called mass creditors, of the possibility to bring an action at law in electronic writ-of-payment proceedings, some debtors became aware of the claim filed by the creditor only after receipt of the payment order or - if the creditor indicates in the claim the invalid address of the debtor's residence - after the court enforcement officer took action following the creditor's submission of an application for the commencement of enforcement proceeding. As a result, the debtor was responsible for raising an objection within the prescribed period of time, although, as it has been already mentioned, the debtor was not always aware of the payment order issued. This solution was sometimes very problematic, as in difficult cases, the alleged debtor's referral of the objection to the court against the payment order was made after the court enforcement officer's deduction from the bank account and coincided with the issuance by the court enforcement officer carrying out enforcement proceedings under the said order - the decision on termination of enforcement proceedings in connection with the full repayment of the debt. Therefore, the Drafter proposed changes according to which "in the case of claims due against a consumer at the time of expiration of the statute of limitations, the claim was transformed into an incomplete (natural) obligation, and thus an inability to execute it compulsorily arises" [5]. This solution was expected to bring a double benefit. On the one hand, the conversion of a claim into a natural obligation without the debtor's necessity to raise an objection increased the consumer protection, and on the other hand, it aimed at mobilising the creditor to take steps to secure his claim. When analysing this argument, it can be observed that the consumer did not always have the necessary knowledge to assess correctly whether the obligation under the legislation in force at that time could be considered to be time-barred. At the same time, it should not be forgotten that although in practice it would be sufficient for the debtor to raise an objection to the statute of limitations and the creditor, knowing that he was justified, usually withdrew the claim, the requirements related to the necessity to submit an objection on the appropriate form sometimes prevented the consumer from defending himself effectively. In particular, creditors, being aware of the easily accessible solution to increase the chances of the debtor's improper objection, filed claims on official forms.

"For this reason, it is justified to introduce the solution proposed in the draft limiting the importance of the parties' intent in shaping legal relations in the consumer trade. The solution

included in the proposed Article 117 § 2^1 of the Civil Code will therefore determine that the statutory effect of the expiry of the statute of limitations of a claim against a consumer will be to transform this claim into a natural obligation. From that moment on, by virtue of law, there will be an inability to enforce the claim, i.e. the inability to pursue the claim before the court.
It should also be pointed out that the court's application of the said standard of substantive law (contained in the proposed Article 117 § 2^1 of the Civil Code) cannot be equated with the court's "ex officio" initiation of evidentiary proceedings in a civil procedure (which, as a rule, is of an adversarial nature and is based on the equality of the parties) [5].

Limitation and reasons of equity

This - as can be initially recognised - very pro-consumer action of the Legislator, after analysing other changes resulting from the amendment, may in time prove to be a much more unfavourable solution for the indebted. With the solution in force until 9 July 2018, the court discontinued the pending proceedings after the debtor's effective lodging of an objection. The applicable amendments, since 9 July 2018, provide for circumstances in which the court will be able to issue a payment order despite the expiry of the statute of limitations against the consumer.
In accordance with the content of Article 117^1 of the Civil Code: „§ 1. In exceptional cases, the court may, after considering the interests of the parties, disregard the expiry of the limitation period for a claim against the consumer, if equity reasons so require.
§ 2. When exercising the right referred to in § 1, the court should consider in particular:
1) the length of the limitation period;
2) the length of the period between the expiry of the limitation period and the time when the claim is pursed.
3) the nature of the circumstances which caused the entitled person not to pursue the claim, including the impact of the obligor's behaviour on the delay in the assertion of a claim." [6].

The introduction of the above-mentioned solution is a specific way to alleviate the rigour resulting from the earlier article. "The necessity of considering the interests of both parties is intended to provide protection for each party, however taking into account their individual situation. That is why, the court should determine the personal and financial situation of the parties, as well as their education, profession and type of activity (cf. P. Machnikowski (in:) E. Gniewek, P. Machnikowski, Comment 2013., art. 3571, no. 29). The interests of both parties should be balanced within the limits deserving protection while maintaining an appropriate relationship between them; the petitioner's legitimate interest can and should be taken into account, but only to the limits of a collision with the defendant's deserving protection (cf. judgment SA in Poznań of 1 July 2010, I ACa 499/10, LEX No 756613). [5] As a result, this solution increases the scope of the court's duties, as apart from the need to verify "ex officio" whether the obligation is not time-barred, it will be obliged to consider moral reasons and determine whether in a given case, despite the statute of limitations, it would be justified to issue a payment order taking into account the reasons of equity. In this respect, the court's discretionary nature could limit the court's application of the premise of the principles of social coexistence, although it is not possible to fully identify these two concepts. In particular, in the event of the applicable regulation, the positions concerning the

method of assessment of the circumstances should be standardized in order to meet the Drafter's assumptions, according to which the use of this possibility by the court should be an exception and not constitute a rule.

In addition - due to the changes introduced- the possibility to file a claim for payment in electronic writ-of-payment proceedings has been significantly reduced. Currently, pursuant to Article 505^{29a} of the Code of Civil Procedure, claims which became due within 3 years before the date of bringing an action at low, may be enforced in this way. This solution is intended to reduce the risk associated with issuing payment orders in cases where the limitation period has expired. Unfortunately, the introduction of the above-mentioned limitation will force creditors to file claims in standard writ-of-payment proceedings, which will impose an additional burden on courts and will significantly increase the time for issuing payment orders. As a consequence, this change may lead creditors to file payment claims before the expiry of 3 years - in order to be able to obtain a payment order issued in electronic writ-of-payment proceedings, and thus significantly shorten the period during which the debtor can take action to resolve the dispute out of court and voluntarily repay the debt, e.g. in installments agreed with the creditor.

Limitation of liability as income on the debtor's side

When considering the amendments in force since 9 July 2018, it is also necessary to analyse the examination by a court "ex officio" of whether the creditor's claim is time-barred or brings benefits to the consumers. It should not be forgotten that a debt redeemed - and, as a rule, it is a liability which is time-barred - pursuant to Art. 20 of the Personal Income Tax Act [7] constitutes income on the debtor's side and at the same time, pursuant to Art. 42a of the afore-mentioned Act, an obligation arises on the creditor's side, according to which the creditor is obliged to prepare and provide the debtor and the Tax Office competent according to the debtor's place of residence with PIT-8C information.

This position was confirmed in many individual interpretations, among others by the "Director of the Tax Chamber in Bydgoszcz in an individual interpretation of 8 October 2010. (ref. ITPB2/415-653/10/MM) [8], Director of the Tax Chamber in Łódź in an individual interpretation of 15 August 2013. (ref. IPTPB1/415-173/12-9/13-S/KSU) [9], Director of the Tax Chamber in Katowice in an individual interpretation of 14 March 2012. (ref. IBPBII/1/415-1030/11/BJ) [10] and the Director of the Tax Chamber in Poznań in an individual interpretation of 13 November 2009. (ref. ILPB1/415-899/09-2/TW)" [11, 12].

It should be taken into account that unrecoverability of debts is understood mainly as the inability to satisfy the creditor from the debtor's assets, despite the fact that the debtor exhausted the possibilities provided by law to secure his claim. Therefore, it should be assumed that if a claim is time-barred, it cannot be considered as a tax-deductible cost for the creditor. Moreover, it should be highlighted that its cancellation will not result in tax benefits for the creditor, but only in the income of the debtor to whom the debt is redeemed. [13] As a result, despite the fact that the debtor will benefit from the cancellation of the statute of limitations by the court, the consumer will have to take into account the need to pay the relevant tax. [14] In exceptional cases, the need to apply the above-mentioned interpretation of tax regulations may consequently, instead of significantly

improving the situation of the debtor - if it did not have the means to pay the required tax - only reduce the amount of the debt and change the creditor to the Tax Office.

Conclusion

Considering the presented analysis of the most important changes to the statute of limitations in force since 9 July 2018, it should be noticed that the Legislator's actions were intended to shorten the time of legal uncertainty existing between a creditor who does not undertake actions aimed at defending his claims and a debtor who, in some cases, did not know about unpaid liabilities. Although the control of the expiry of the limitation period is still carried out by the court, the introduction of the current solutions is undoubtedly part of the changes related to specific consumer protection. However, it will only become clear over time to assess whether the transfer of the obligation to verify the existence of the statute of limitations in each case to the court, together with the granting of discretionary powers to assess whether this circumstance should be taken into account or whether a payment order should nevertheless be issued, has brought the intended results.

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REBELION. PHILOSPOHY OF LIFE OR HASHTAG

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Abstract:

For centuries, philosophers have been discussing the concept of an ideal state in which it will be possible to reconcile two attitudes individual, directed towards personal development and a community attitude in which individuals are subordinated to the principles of social coexistence. From antiquity, up to the 20th century, various ideas of social order were created, from the most gentle forms to radical ones, on the basis of which attempts were made to create the perfect social and political structure. All forms of rebellion were opposed because they introduced chaos that was not conducive to the harmonious development of structures. On the other hand, rebellion and contestation introduced the dynamics necessary for transformation and growth. This paper focuses on the problem of rebellion as a philosophy of life or media image appeared in the era of social media together with the appearance of the prosumer.

Keywords:
rebellion, anarchy, social media, a rebellious man, prosumer

Introduction

The phenomenon of rebellion and the character of a rebel can be found in literature, film and pop culture models of the 20th century, although the prototype appeared much earlier. The phenomenon of popularization of this phenomenon was influenced by a number of factors: from the evolution of popular culture through moral and economic changes, and as a result the creation of extra - system spaces in which subcultures could arise and exist. The concept of subculture in the general sense can be understood as groups, bringing together individuals who, functioning in certain socio - economic relations, try to be independent of them. An important feature of these groups is the belief in the malfunctioning of the dominant systems in force for the rest of society. The protest takes many forms: from protest songs as a manifestation of views in textual and musical form, through artistic practices beyond the rigid framework of traditional art: happenings, performance, street art and visual representation in the form of costumes that are

supposed to shock. Such practices are an expression of their own identity and communication with the world.

Considering the essence of rebellion, it should be assumed that most societies function in an organized, formalized manner under unwritten agreements existing in tribal communities or formal orders established by institutions - to which most citizens agree. A rebel and anarchist appears as a figure of concern and threat, but also as a romantic hero who restores order and order in a conformist society [1]. The multidimensionality of the character is associated with the intentions that guide the person, because rebellion can be considered at the individual level, as a search for their own sense of life, at the local level - as a desire to change the norms obligate family or group at work, and at the global level as a desire to change the world.

Ambiguity in reading the character has strengthened the Internet with the emergence of a prosumer, an actively engaged consumer who is consciously building a brand, including his own [2]. The idea of anarchy assumed niche activities, non-systemic, oscillating on the edge between legal practices and activities against the system. A feature that was inherent in the rebellion was a form of expression that existed outside the official circulation, in isolation from formal structures. We are currently dealing with the phenomenon of public, visible rebellion, especially in social media, which in essence denies the fundamental principle of existence outside the system. In this context, it seems reasonable to ask to what extent the rebellion remained a philosophy of life, integrally connected with the professed views, and to what extent it became a media label, changed depending on the current trends. We live in a society surrounded by a million pieces of information - visual and textual, and standing out from the crowd - also as part of identity building - is becoming increasingly difficult. Key words, hashtags assigned to a given activity, category, group replace the exchange of views, discourse by which we verify the point of view. The essence of media existence is: the more shocking, the more visible, while the foundation-personal identification with views disappears and implementing them in real life. I am aware that the majority may disagree with this view, which is why I will try to present in my work the phenomenon of rebellion taking into account historical and social changes, ways of expressing protest and representation of characters in popular culture. The phenomenon of rebellion has become the subject of many publications, I will refer to some of them in my work.

The idea of a perfect world

The idea of a perfect world was the subject of philosophical considerations, religious, political and social systems. They concerned a vision of a world in which harmony, order and order prevail, and all citizens will be happy and content. Regardless of the adopted beliefs and beliefs system, a common feature of the vision was the concept of social order, i.e. the order regulating the principles of coexistence at the micro and macro levels. In order to maintain order, all members of society had to agree with the prevailing principles, because their strict observance guaranteed a safe status. Any apostasy was severely punished - including the most severe punishment of exclusion from the group or community. The most famous woman in history who was the first to dare to break the divine law was biblical Eve. For punishment, both Adam and Adam were banished from Eden, and as a consequence their descendants burdened with original sin also suffered punishment.

The metaphorical story contains a message that clearly illustrates that any violation of the established order may result in a penalty, even if it is disproportionate to the act committed. The mythological parable of Dedal and Icarus also contains a moralizing thread inscribed in the tragic story of a father and son. Schematic representation of the character: the father - responsible and sensible warns his son - young, rebellious against actions that will bring him doom. Icarus's rebellion against the established rules ends tragically - his death. Despite the consequences, the figure of Icarus, a young dreamer, arouses sympathy by referring to a part of human nature, in which the search for a new, better world is inscribed. Youthful disagreement with the traditional order, in opposition to conformist behavior, fit into the currents of Romantic literature. The call to change, faith in the power of youth and the sense of transforming reality are best expressed by the words from Oda to the Youth of Mickiewicz "Youth! give me wings! Let me fly the world over the dead [3]. In this approach, rebellion appears as a positive phenomenon, the sense of which is reinforced by the marked division into vitality attributed to youth and internal deadness which is a feature of older people. Only young people have the faith and strength to change the established rules, introduce dynamics into the existing social orders, and thus be an element influencing the progress of the world. The duality of perception of social revolts results from the nature of changes that are associated with the violation of safe, static principles constituting social order, and the violence of these changes is often destructive. However, considering rebellion and contestation in the context of youthful faith, the search for alternative solutions and attempts to create a new, better world, it is difficult to clearly assess this phenomenon as negative. Tadeusz Paleczny [4] believes that since the time of Platonic policy, people have strived to create an ideal social creation that would operate smoothly. This attitude was wrong because it is human to search for new solutions. Traditional thinking is based on dogmas that organize the world around us in two dichotomous orders: good-bad, white-black, law-anarchist. This makes it easier to maintain the organization of social life, both in group and individual dimensions. Hence many visions of the ideal world that arose on philosophical, religious or sociological grounds. Paleczny [4] citing thinkers who preached the ideas of a perfect state mentions, among others, Morus, Campanella, Fourier and Rousseau. Utopian theories were continued by other philosophers, sociologists and theorists, especially in the 19th and 20th centuries because they came on fertile ground due to transformations in social, economic and political systems. The Second Industrial Revolution brought changes in the approach to production, and the introduction of Ford's assembly tape improved the work in factories. The freeing of the peasants enabled them to migrate to cities and become members of the new working-class. Production systems focused on the highest profit treated workers unfairly, they were often poorly paid and worked in harmful conditions. The rationality that guided the capitalists, the automation of work, the replacement of unskilled workers with machinery led to the rise of social conflicts. Despite the opposition of people against being treated as a component, a machine cog, sociologists' theories were based on the vision of a society consisting of elements working together like a machine. Maks Weber described a bureaucratic society functioning in a hierarchical structure in which the individual is to submit to the majority, guided by reason and purposefulness. Karl Marx [5], who criticized the bourgeoisie, in response to the class struggle created the "Communist Manifesto" in which he made his theses about the vision of the world, based on

scientific socialism. For Marx, class struggle as the only method guarantees the abolition of social inequalities and the organization of a world in which the working class will rule, a world in which everyone will have equal rights. The revolutionary nature of Marx's thoughts resulted from opposing the automation of people, reducing their value only to economic profit, and restoring individual dignity dying in mechanization processes. The 20th century abounded in a number of systems whose primary goal was to organize society in groups subordinated to higher ideas. Submission to the existing rules was to bring good to the whole society, not excluding the development and good of the individual. National communism, nazism, fascism, and bolshevism found many believers because they seemed to be the guarantor of security and social order in times of chaos and danger. In periods of anxiety and fighting, the pursuit of harmony, balance and stability becomes a natural activity. Ready solutions provided by units with power allowed for gaining peace and alleviating social unrest. The opposite attitude can be observed after periods of balance and satisfaction, in which the existing reality begins to be criticized and contested. Paleczny cites two attitudes that model relationships [4]. Constant searching for models and behavioral patterns occurring in society has developed two concepts of organizing interpersonal relations: a conflict concept and an integrationist concept. According to Paleczny: the first attitude adopted exploitation, injustice, egoism as a natural human pursuit of gaining advantage in social relations. The second attitude was based on compromise, respect for norms and balance between members of society. Both models have settled permanently in the organization of life and the world, representing two opposing attitudes. The first, revolutionary, brought together believers that only rebellion and rapid change can change the world. The second attitude - evolutionary - more gentle in its theses allowed progress based on reason, slow evolution and changes in order to develop the best patterns of functioning of society . Regardless of the models adopted, I believe that two characteristic human attitudes should be attached to the above considerations: conformist and non-conformist, which in their characteristics correspond to the above models. I understand conformity in this approach as an individual or group attitude, which is characterized by passivity, passive compliance with general principles, following the crowd in order to gain benefits and lack of reflectiveness. I equate nonconformity with courage, activity, independence in creating my own views, and independence. Most societies choose a conformist attitude as a guarantor of a peaceful life, organized by others, not requiring responsibility. Traditional principles order the world in a logical and formal way, allowing the unity and continuity of a given community in biological and economic aspects. A rebel attitude raises anxiety, posing a threat to stability and survival, hence the division into desirable and undesirable individuals - as Paleczny writes [4]. It would seem that systems guaranteeing a sense of security of citizens are the optimal state for development and growth, hence the appearance of people who undermine the existing order is surprising. However, observation of historical processes shows that even the most democratic structures have undergone dynamics and transformations. Stagnation and relative peace are crossed by periods of revolt, revolution and war. Comparing the period of stagnation and growth occurring in nature, observation of the world of plants shows similar cycles: growth, menopause and vegetation as a natural dynamics of the organic world. In this context, the division into desirable persons, i.e. maintaining a state of passive satisfaction and undesirable persons - as a negative element of the world is

harmful. Thanks to these people, the world is undergoing changes that are necessary - just like in the world of plants - because without these changes the cycle would stop.

Rebellion and the Polish aspect

In the post-war years, people's democracy was introduced, which as a transitional element in the socialist system was to bring all citizens equal rights, equal opportunities and participation in the creation of an ideal state on a democratic basis [6]. A nation troubled by war, deprived of alternatives through the Big Three pact [7] agreed to the system introduced by communists in Poland. For many people opposed to Soviet power, the agreement was temporary, but for others the new system became an opportunity for social advancement. The formation of conformist attitudes was favored by the ubiquitous fear caused by the extensive apparatus of repression. The use of force and pressure for some time ensured effective suppression of dissatisfaction and rebellion. Another factor that influenced the adoption of conformist attitudes was the promise of prosperity that everyone was supposed to enjoy. The promise of equal distribution of goods, the introduction of collectivization was a consequence of the transformation of Marx's postulate, which socialists and communists readily used. Marxist to everyone according to needs, in practice it was to ensure everyone to supply so many goods that he could dignely support himself and his family. The program introduced by the communist authorities declared the creation of a communist paradise after a difficult transition period - socialism. The myth of ideal utopia proved to be deceptive, as signs of abuse and economic differences quickly emerged from the hierarchy of division between ordinary citizens and members of the party apparatus. The strike in Poznań in 1956 began the waves of student and workers strikes that broke out in Poland in 1968, 1970, 1976 to reach its apogee in the 1980s. The basis of the rebellion was always the political situation and economic failure, which the government tried to cover-up promising improving living conditions. The 1980s brought changes, which were due to several reasons, and as a result led to Poland's liberation from the control of the USSR. A thaw in Polish-Soviet relations, partial lifting of control by the Soviet Union and an attempt to ease tensions on the Party- Citizenship line resulted in the creation of Solidarity - trade unions composed of representatives of the workers' movement. The strategic movement of the party apparatus, which aimed to give the appearance of freedom, resulted in freedom bursts, which were tried to suppress the introduction of martial law.

The second reason for the national uprising was the pilgrimage of Pope John Paul II, the first of which fell in 1979 and, according to many historians, contributed to the creation of Solidarity. Another important consequence of the thaw was the emergence of alternative groups, mainly from academic circles, who began to express their resistance and opposition to the system through various artistic practices: happenings, street performances and graffiti. The most famous group was created by students from Wroclaw who created a group called the Orange Alternative. The initiative has expanded to other cities: Łódź, Warsaw and Lublin. The anti-communist movement was established in cooperation with solidarity circles, one of the most important figures in the group was Major-Waldemar Fydrych. The group's goal was to expose the system's hypocrisy. The fight was conducted in a peaceful manner, members organized happenings (most often suppressed by the Civic Militia) and other forms of artistic practice to express their attitude. The famous project

became painting with patches of paint, which the Militia covered with anti-communist inscriptions. The group placed on them figures of dwarves, which ironically depicted the senselessness of Militia's actions. The group often used irony, a joke, references to surrealism to express their attitude. The punk movement and the newly created alternative music scene have opened up new ways of expressing worldview.

Punk is associated mainly with the British stage and the Sex Pistols band. It appeared in the world in the seventies, his roots come from the hippie movement. Expression of punk style contrasted with the petty-bourgeois and workers' aesthetics of society in Great Britain. The predation of style was emphasized by costumes, careless, torn to stand out from the crowd. The popularity of punk in Great Britain was associated with the possibility of belonging to a group represented by expressive characters who had a great impact on the formation of subcultures: Sid Vicious, Malcolm McLaren, Vivien Westwood, Jamie Reid or Wendy O. Williams. Gradually, the movement was gaining popularity, and members began to call for anarchy and a boycott of all institutions. Participation in a group of similar views, using a common language and image was described by Dawid Muggleton in "Inside a subculture" . By adopting its definition, a subculture can be defined as a group building its identity by adopting a similar style of dressing and listening to the same music. In addition to visual coherence, the most important feature of subcultures is system contestation, marginalization and expressing differences by undermining existing social and cultural systems. The subject of subcultures as a phenomenon was the subject of consideration of researchers from the Center for Contemporary Cultural Studies in Birmighan. Researchers who include names such as: Hebdige, Clarke, McRobbie, Cohen, Willis and Grossberg, Baker [8] cites belonged to the baby boom generation who were interested in rock music and youth cultures.

The idea of punk also found fertile ground among young people in Poland. The phenomenon of the emergence of alternative youth groups troubled the then sociologists, Patryk Zakrzewski [9] quotes from the television material presented after the performance of the Kryzyz group in 1980: "The rough form seems to be an element of negation of the existing world, so also the achievements of culture. This topic is dedicated to sociologists who should find the reasons for the total frustration of our youth". The reasons for rebellion and frustration are illustrated by the text of one of the songs Walka Dzedzej (Lesław Danicki) - "I am not what you are." Young people surrounded by ubiquitous propaganda, forced to be a member of youth party groups did not want to belong to a system whose failure and hypocrisy was visible, especially in the eighties - due to the more frequent contact with Western culture. Young people sought new existential forms, opposed to outdated socialist principles. Paradoxically, sugary Western culture associated with pop culture and disco music also did not find their recognition. they found in alternative groups that expressed their views in sharp, emphatic texts and predatory images. The existence of groups associated with the alternative was possible because the authorities treated them as a kind of safety valve, allowing people to participate in events - which remained under the hidden control of security services. The most important event was the festival in Jarocin. Political changes, the slow collapse of the USSR's hegemony created an atmosphere in which young people found their niches in alternative groups that were increasingly openly proclaiming anti-communist slogans. Bands such as: Dezerter, Abbadon, Tilt took over the stage, and the lyrics of the songs aroused in young people the desire to

openly fight the system. The process of transformation lasted until the 1990s, when free Poland appeared, which changed the view on the phenomenon of rebellion.

Postmodern identity

Young people turned into businessmen because the developing economy created new patterns of needs, but also provided opportunities to meet them. The figure of the rebel fighting the system has become obsolete and unnecessary because a new one has appeared social model - middle class. Yuppie - creative young people doing careers denied anarchic nihilists, and subcultures have become synonymous with losers. Success, material goods determined human needs, and the former enemy-system-ceased to exist after transformation. The economic development transformed people into consumers who after years of restrictions freely used the opportunities created. Meaning maps - the element that binds subcultural groups – Baker [8] believes, has been deconstructed and required processing in new, capitalist conditions. A generation of people for whom the sense of existence determined resistance to power tried to preserve continuity criticizing the actions of the new system, but most people stunned by regained freedom focused on the opportunities that the capitalist economy opened up. Referring to Baker, who defines the nature of subcultures, adopting Cohen's view as one of many positions, the main feature of underground cultures derived from the working class was the rejection of middle class values, i.e. success, professional development and material values [8]. The transformation of Poland in the nineties brought opportunities for creative people who previously could not implement their professional plans. The economic boom opened up new perspectives for them, and the subcultures, adapting to the new conditions, created other groups embedded in the realities of the 90s. People who belonged to subcultures organized around rap music, skateboarders and hip-hop culture. The lyrics were a commentary on a transforming reality in which young people often from poor working-class families could not find their place in the rat race. In response to rap music, a club style came from the UK, organized around rave music. The second group that formed at the turn of the century was the emo subculture. Unlike representatives of rap music, who preferred sportswear, emo representatives - although their roots reached punk music - preferred very sophisticated stylizations. The group's visual identification as a factor building identity has always been very important, but what distinguished the newly created subcultures was the departure from the basics - the philosophy of life, and the original image became an end in itself. The developing market, contact with Western standards created conditions in which people from subcultures could use many previously unavailable goods, thus changing their approach to participation in alternative groups. They did not stay away from commercial goods because they had no problem accessing them. The media and the color press began to popularize emerging styles, although they often expressed in this way outrage by the phenomenon, nevertheless, the mediatization of the phenomenon contributed to the expansion of the circle of people potentially interested in the emo or goth subculture. The authenticity of resistance was lost in mass-produced clones, i.e. people who, playing the role of a subculture member, identified with her only on a visual level. Baker quotes Muggleton's words that the current style of subcultures is only fashion, built on pastich [8]. He notes, however, that the apparent non-characterization of the postmodern world, with a deeper analysis, allows us to see that the bricolage culture allows

reconfiguring the characters while creating new meanings. Baker also refers to Hebdige and Chabers, who claim that goods allow them to build multiple identities[8]. The multitude of available models shallow the authenticity of subculture members who, in search of identity, migrate between many potentially attractive structures, moving on their surface, but without penetrating deeper. The emergence of social networking has launched a mechanism in which the hashtag defining belonging to specific communities and photography advertising a person or product have become more important than the philosophy of life professed in everyday practice.

Current trends force existence by expressing views that guarantee visibility in the media. Membership in groups promoting veganism, eco life, and activity in protest actions organized on Facebook have become an indicator of people aspiring to be recognized as alternative, anarchist and niche personalities. Of course, I do not categorize people who actually identify with a given lifestyle in this way, but I focus on people for whom the existence of media and the number of so-called likes are more important than ideological authenticity. Baker notes the paradox of a consumption culture that provides resources for creative practices that are a consequence of capitalism and the expansion of consumeris [8]. Activity on the consumption market and creative practices are also not the same as expressing resistance, although they certainly allow the creation of a specific image. Consumerism blurs the essence of the alternative order by transferring self-expression, based on a stable ideology, into the sphere of consumer pleasure, immersed in a culture of multiplicity and excess. Assuming the essence of resistance as a rebellion against the dominant power, we can see that current youth cultures do not separate from consumer capitalism, but look for space to negotiate by setting their own conditions of participation. Cultural ambiguity and complexity manifested in the culture of remix provokes discussion to what extent a person's identity is an autonomous, conscious choice, and to what extent a sign of the generated consumer creation and image that brings economic profits.

Another question that is born is the question of how much being an alternative these days is not just about Instagram tags and key words that look intriguing on social media, but do not contain a deeper philosophy and knowledge and boil down to creating hybrid, blurry personality in a liberal society offering diversity - devoid of any formal framework or form. The problem of individuality, realization and self, and coexistence in established social norms and the possibility of expressing one's creation is not a product of the present times. Many philosophers have debated the phenomenon of individual freedom and individuality in combination with the tensions that exist in community existence and how we express ourselves in creative practices. The sixteenth, seventeenth and eighteenth centuries brought new thinking currents, the essence of which was contained in the rights of the individual to individual development, art-based education, which in turn is to enable the individual to self-fulfillment in a socio-political organism. Immanuel Kant considered how a human subject can realize the ideas of reason and experience personal freedom in the sensual world. His ideas were continued by Friedrich Schiller, who expanded Kant's thoughts with his philosophy in the work "Letters on the Aesthetic Education of Man [10]. Schiller wanted to create a pattern a state-aesthetic state in which individuals will be able to harmoniously develop their individuality, which will make it possible to realize the idea of a free society, but united by common aesthetic values, resulting in the organization of a perfect state. The ancient world was the

most perfect model. The fascination of Schiller with Greece resulted from the model of the state that combined culture and nature, man and deity. For Schiller, beauty allowed him to find freedom and harmony with the world. Schiller did not uncritical approach to aesthetic ideals, because in the tenth letter he notes: "What also society gained from the fact that today beauty gives the law of communion, while in the past it was ruled by truth, and that external impression determines respect, which should be attached only to merit? It is true that we now see the flourishing of all virtues that seem to have a pleasant impression and constitute a certain value in society, but all immorality and vice that only clothe a beautiful robe [10]. Schiller draws attention to the appearance that is hidden behind aesthetic values, creative activities that shape a false picture of life. The fundamental issue that Schiller criticized was whether the production of a perfect life - a beautiful appearance - did not contain false or untrue elements. Referring this aspect to the current visual culture, we can repeat Schiller's question to what extent building his own image - especially the network one - does not include pretending, focusing only on visual and textual elements that do not contain deeper content in themselves. Activities visible on social networks often do not transfer into the sphere of practical activities. The phenomenon of clickactivism, belonging to various groups declaring a fight for ideas and values, narrows down to mechanical clicking on the likes button, which does not translate into social and civic activism. Schiller believes that the basis of human change must be something permanent, it cannot exist as a set of potential possibilities, its existence must materialize, and the basis of its realization is reality, which we shape in an endless process of change. The dualism of human existence is contained in the paradox that Schiller described in List Eleven: "One can say, therefore, that man exists only in so far as he is subject to change; it exists as long as it does not change [10]. Personality and identity in this sense should be shaped in a continuous process of production, however, it is necessary to meet the second condition, to work out an unchanging foundation that becomes the starting point for development. Hybrid identities created on the basis of contemporary popular culture patterns seem to confirm the thesis of continuous development, process-based development of one's attitude, existence, awareness, but the multitude of potential possibilities does not contain static elements. Temporality, the smooth transition from one image to the next reduces credibility, coherence so important for subcultural communities, whose existence was based on coherent views.

Summary

Summing up this article, I will refer again to Paleczny, who believes that great philosophers have for centuries debated the concepts of an ideal state in which it would be possible to reconcile two attitudes - individual, directed at personal development, and a community attitude in which individuals are subordinated to the principles of social coexistence. From antiquity, through enlightenment and romanticism, to the 20th century, various ideas of social order were created, from the most gentle forms to radical ones, on the basis of which attempts were made to create the perfect social and political structure. Often ideas were utopian visions that remained theoretical considerations on the organization of a perfect state. The model model of the state assumed the existence of a society built on order. All forms of rebellion were opposed because they introduced chaos that was not conducive to the harmonious development of structures. On the other hand,

rebellion and contestation introduced the dynamics necessary for transformation and growth. Paleczny describes a very important aspect of a society functioning in accordance with existing norms: "Depriving members of the social system of the element of uncertainty, risk, unpredictability and competitiveness would be reducing society to the function of a machine that constantly reproduces a certain pre-defined pattern" [4]. Referring to the above aspect in the context of the consumer society, the second feature of the system thus formed is the property which P. Gębala cited: "Consumer society is the result of civilization and cultural development in the conditions of democracy and free market economy. It is based on the functional understanding of the social structure and the commitment of individuals constructing their identity around goods and services." [11]. Consumerism has provided new forms of self-realization, based on marketing practices, limiting individualism to consumer practices, and media existence depriving the essence of rebellion of a deeper meaning. Passive consumerism does not syntax to reflect on the choices made, reducing anarchy and contestation to a collection of hashtags, keywords and a network image.

Literature

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THE APPLICATION OF 3D PRINTING IN DIFFERENT AREAS OF MEDICINE

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Abstract:

The publication is a review and has been devoted to one of the additive manufacturing technologies, i.e. 3D printing, which has dominated the majority of areas of human life, including industry, automotive, architecture or medicine in recent years. At the beginning of this paper the issues related to steps of 3D printing and application of systems of computer aided projecting and manufacturing process, have been presented. Moreover, the basic information about various additive methods have also been outlined. Then, examples of using of 3D printing methods in different areas of human life have been shown, including applications in various fields of medicine, which have been discussed in detail. Furthermore, the issues connected with effects and future of 3D printing technology have also been determined. The presenting a comprehensive overview of applications of 3D printing technologies in medicine, bioengineering and its other fields has been the aim of the article.

Keywords:
3D printing, rapid prototyping, additive, manufacturing, medicine, biomedical engineering

Introduction

The turn of the 20th and 21th century have brought enormous progress in different areas of human life – which is undoubtedly the dynamic development visible in technical and medical sciences, e.g. in biomedical or material engineering. The increasing importance of human health protection, ageing of the society, aspiration to improve the quality of life or negative phenomena connected with the development of civilization (including the increase in the number of accidents, cases of civilization diseases and increasing obesity) have contributed to the surge of demand for the new and better medical products (e.g. endoprostheses, orthoses, other implants) or treatment methods. In addition, the above-mentioned factors have also an influence on the formation of interdisciplinary teams working on e.g. solutions with regard to the reconstruction of diseased tissues or damaged human organs, which is related to the improvement of biomaterials, including mainly their biological, strength and tribological properties (e.g. biocompatibility, high corrosion resistance in the body environment, high fatigue strength, resistance to abrasive wear etc.) [1-2].

This is neatly related to the intensive development of rapid Prototyping, modeling and manufacturing technologies, additive manufacturing techniques, including 3D printing, which have dominated most areas of human life in recent years. It has primarily influenced by wide access to commercial and commonly used devices – 3D printers, access to materials or their lower prices. Hence, these technologies have been applicated in various fields of industry, ranging from the production of simple components to the more complex parts dedicated to aeronautics, electronics or above-mentioned medicine and other sciences related to it (Fig. 1). Additive methods, whose origins date back to the times after World War II, and essentially 3D printing techniques are now an enormous potential, giving great opportunities for the production of complex and appropriately personalized elements in the form of e.g. implants or prostheses inserted into the human body. Also so-called bioprinting, i.e. production of components from biological material – stem cells and printing of special biocompatible scaffolds or surgical guides constitute other of many applications of 3D printing in medicine [3-4].

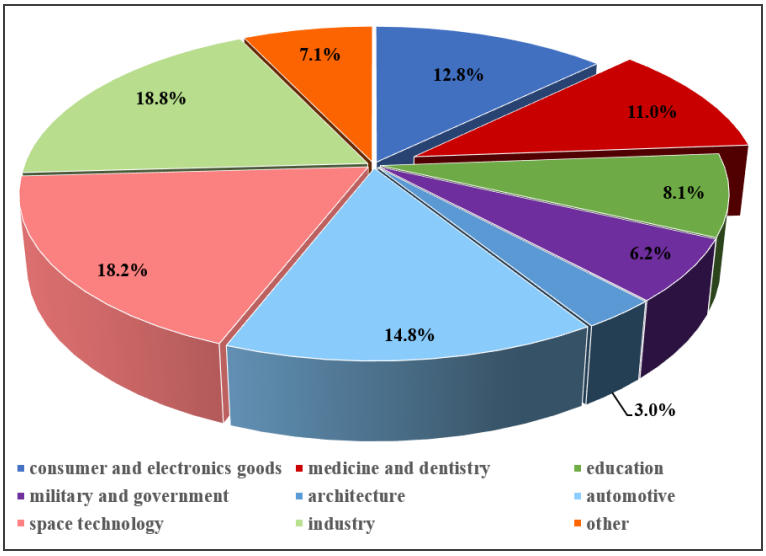

Fig. 1. The application of 3D printing in various fields of industry
Source: own study based on [5]

3D printing technology

Additive techniques, sometimes called as generative, are based on the rule of shaping and manufacturing elements as a result of "adding" material, i.e. applying and curing building material in the form of layers, which together (that is connected) compose a solid, spatial object. The building material can be both polymeric (e.g. thermoplastics – ABS, PET, PLA or elastomers – TPU, TPE), ceramic materials, light-cured resins, metal powders, as well as wood, rubber, sand, carbon fibers or organic materials (e.g. stem cells) [4].

From model to real printed object – 3D print stages

The core of the spatial printing process is building a real element based on virtual 3D geometry (solid or volume closed by surfaces) developed using CAD software (e.g. *Autodesk Inventor*,

Autodesk FUSION 360, SolidWorks, CATIA, FreeCAD, Pro/Engineer, Solid Edge, TopSolid, Siemens NX or Blender, SketchUp, TinkerCAD etc.). As e result, the model saved as a triangle mesh in STL format, is subjected to subsequent actions in the CAM system, i.e. in a slicer program (e.g. *Ultimaker Cura, Slic3er, 3dSlicer, NetFabb* etc.). Here, the virtual model is orientated in space and divided into layers of thickness (called as also height) determining the accuracy of applied 3D printer (usually it hovers 0.1 mm, although more precise devices have already appeared), where for each layer work paths controlling this device is generated. During this stage, other print parameters are also set (including printing speed, type and density of filling, operating temperature, settings for supports, cooling parameters, etc.), which result is a simple record of instructions (consisting of several hundred - several hundred thousands lines of code) to be made by the printing machine. Then, this file saved in .gcode extension is sent (by USB cable or on the microSD card) to the printer, after that the item is manufactured, followed by its cleaning from the remains of building material or supports and at a pinch finishing (Fig. 2) [3-4].

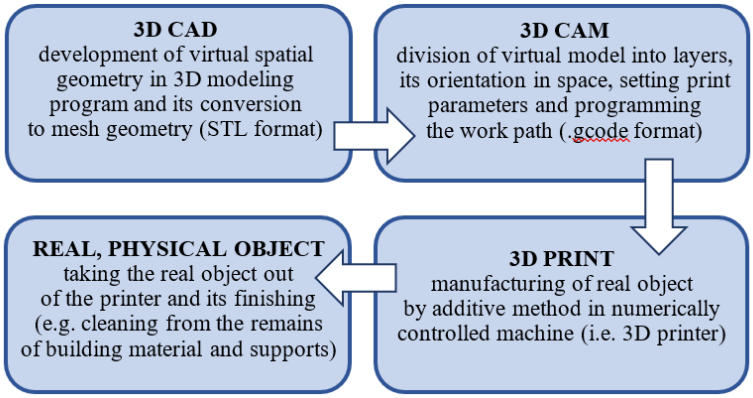

Fig. 2. Main steps of 3D printing
Source: own study based on [3-4]

Therefore, the accomplishment of the entire project is possible due to the application of programs, that belongs to CAx systems, i.e. integrated modern computer techniques aided process of design and manufacturing (CAD, CAE, CAM software), which are presented in Fig. 3 [3-4].

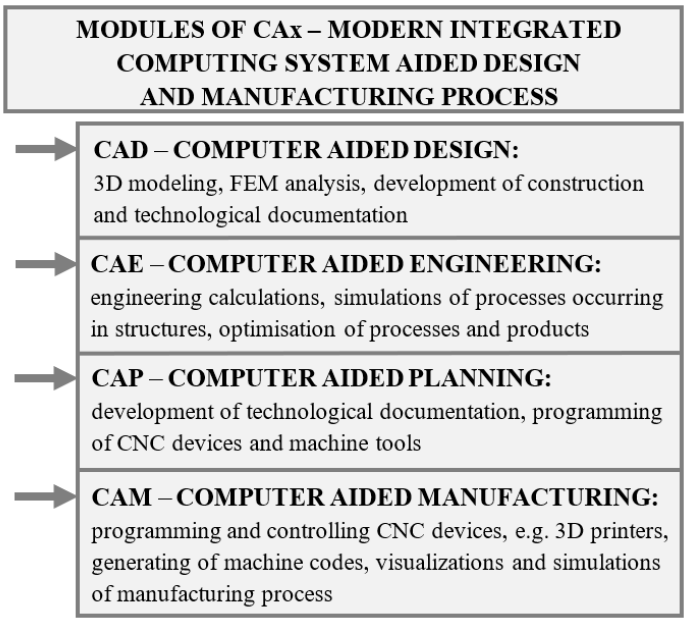

Fig. 3. Modules of CAx - integrated computer system
Source: own study based on [4, 6]

From stereolithography to application of oxygen – 3D printing methods in a nutshell

The beginnings of advanced 3D printing technology date back to the 1980s, when the first method appeared – stereolithography. Since then, a dozen additive techniques have been devised, some of which are dynamically developed, while others are not currently widely used. Choice and use of method depends on the needs of the potential users and possibilities of its effective application. A short overview of currently used 3D printing technologies is presented in Tab. 1 [3-4, 7].

Tab. 1. Review of 3D printing methods

ADDITIVE METHOD
SLA – STERELITHOGRAPHY – uses a UV laser to curing of liquid light-sensitive resins (so- called photopolymers), which are locally polymerized, i.e. layer by layer, point by point, that ensures high quality and accuracy of printed elements
DLP/ FTI – DIGITAL LIGHT PROCESSING/ FILM TRANSFER IMAGING – uses laser light emitted by the projector with the aim of polimerisation of liquid photocurable resins – here the entire layer is cured simultaneously, which ensures high accuracy and very smooth surface of the printed elements
CLIP – CONTINUOUS LIQUID INTERFACE PRODUCTION – where photopolymer resins are cured continuously by laser light emitted by projectors while simultaneous using oxygen as an inhibiting agent
FDM/ FFF/ MEM – FUSED DEPOSITION MODELING/ FUSED FILAMENT FABRICATION/ MELTED AND EXTRUDED MODELING – extrusion of liquid thermoplastic material in the form of a filament through an extruder from a heated nozzle and fusion of subsequent layers of the model under the influence of temperature on the table
SLS / DMLS –SELECTIVE LASER SINTERING/ DIRECT METAL LASER SINTERING – i.e. manufacturing of details or objects from powdered materials (e.g. metals or polymers) which are selective sintered by a high-power laser, that allows components with complex geometry, very good accuracy and quality to be obtained
SLM – SELECTIVE LASER MELTING – where products are manufactured from powdered materials, which are selective melted by means of laser
EBM – ELECTRON BEAM MELTING – uses electron beams to fuse powders (usually metals and their alloys) in a vacuum in a layered manner
3DP/ TDP /CJP – THREE-DIMENSIONAL PRINTING/ COLORJET PRINTING – the fastest and cheapest method, in which powder (e.g. gypseous) is applied in layers on the surface of the work table, then the bonding agent (glue) is selectively sprayed through the head, which bonds the subsequent layers
LENS – LASER ENGINEERING NET SHAPING – i.e. manufacturing of elements from powdered materials as a result of their local application and sintering by laser, whereby the powder is distributed through the head to selected places (not in the chamber now, as in SLS / SLM), which allows correction or repair of previously made parts
LOM – LAMINATED OBJECT MANUFACTURING – i.e. manufacturing of laminated objects from layers of paper or foil, which are joined by means of glue
JM/JS – JET MODELING/ JETTING SYSTEMS – where the elements are stream-modeled, i.e. from droplets of liquid material, which is shot from the nozzle and cured
JP/MJM/MJP – JET PRINTING/ MULTIJET MODELING/ MULTIJET PRINTING – is multi-stream modeling with liquid polymers (melted wax types, UV light curing resins)

Source: own study based on [3-4, 7]

"Rapid" technologies

3D printing technologies are closely related to the so-called "rapid techniques" (RM, RP, RT) generally termed – in literature or popular science publications – as methods of rapid manufacturing and prototyping. These technologies include: [3-4, 7]

- *Rapid Modeling* – i.e. methods applied in the preparation of mockups or project layouts (characterised by lower accuracy and durability than other models) for fairs and exhibitions or in development of simple teaching aids (e.g. anatomical models),
- *Rapid Prototyping (RP)* – techniques for building prototypes with high accuracy and durability, which mimic real products in the best possible way, hence are used in research, initial analyses, engineering tests or medical applications,
- *Rapid Manufacturing (RM)* – used with the object of obtaining appropriately durable elements and parts, which can be assembled in the final products, e.g. various types of machines and devices, hence these techniques are used in unit and job-lot production as well as in the production of spare parts, atypical or non-standard elements (e.g. dental implants, ear inserts),
- *Rapid Tooling (RT)* – i.e. methods for manufacturing of assembly aids, tools, other instrumentation or accessories (including injection mould cavities, moulds, die plates, press tools, waxen standards etc.) used in industry, e.g. in plastic forming or casting.

The progress in these techniques, which took place at the turn of the 20th and 21st centuries, has been related to improvement of their accuracy and expanding the range of more durable building materials. This – in turn – contributed to the use of "rapid prototyping" technologies in many areas of life ranging from industry and technology to art or medicine [3-4].

Application of 3D printing technology in various fields

Modern 3D printing technologies are used in many fields of life. First of all, they have universal application – they allow people to create, form simple or complex decorative elements, everyday objects, gadgets, figurines, souvenirs, other consumer products or even board games elements. In addition, thanks to them various items connected with human hobbies or interests can be manufactured, including also personalised details, which are characteristic in marketing and advertising [3-4, 8].

In turn, in a broad sense industry, 3D printing technologies support the work of engineering departments of various enterprises and companies – mainly during design and construction stages, where they are used to create solutions for automotive, aeronautics, cosmonautics, military, foundry, building, food, clothing, footwear, furniture or architecture industries, but also for art and jewellery sectors. In this way, models or product mockups received (in a relatively short time) thanks to these technologies are – beside the paper documentation – an interactive tool for communication with clients. Moreover, 3d printing is not only used on prototypes or test models, but also in production of spare parts, tools, cases for machines, handles for automotive, space, aeronautics or train industry. An interesting examples are also the first electric car, which was completely printed and after motor mounting was fully functional and the first and subsequent printed building or even baterries. In turn, in pair with 3D scanning it is applied for creation of 3D models of exhibits or relics in museology, archaeology, palaeontology, where they can do duty as substitutive, presentation models or souvenirs. In addition, it is already known about the first attempts to print food, e.g. sweets, bread, pancakes or print items made of chocolate or ice. Furthermore, 3d printing is also applied in fashion sector, which was caused by possibilities of: maintaining sustainable

development (i.e. reduction of waste and using recycled materials) and personalization of clothes, shoes, glasses or jewellery. Examples of application of 3D printing in various industries are presented in Fig. 4 [3-4, 8, 29-31].

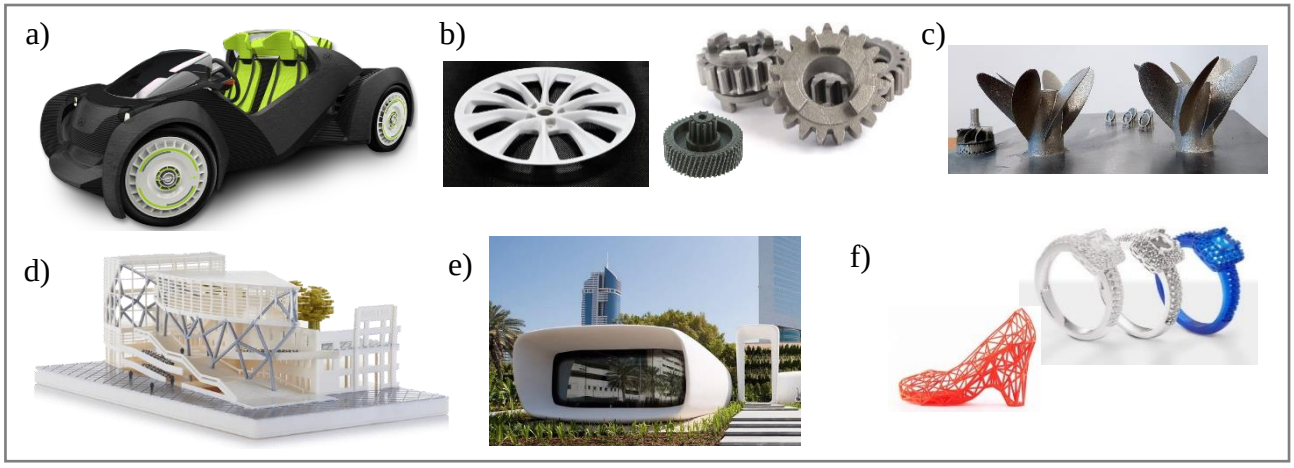

Fig. 4. Examples of 3d printing application in various fields: Strati – the first printed car (a), elements for industry (b), elements for aeronautics (c), structural mockup (d), a printed building (e), models of printed shoes and jewellery (f)
Source: own study based on: [11-12, 28, 30-31]

Application of 3D printing technology in medicine and bioengineering

Rapid prototyping, manufacturing or 3D printing technologies have found wide application in the field of medical science and biomedical engineering. This have been influenced by factors such as: low costs, relatively short time of production objects and avoidance of material losses. Furthermore, these methods expedites design processes by speed prototype testing, which – in turn – allows to reduce production costs and find possible errors in model. Another advantage is a possibility of sending electronically files with print data, which allows to cooperate with specialists from around the world, where each of them can simultaneously obtain their own product printout. The competitiveness of 3D models is supported by the fact that these printers, which are more and more cheaper, can work around the clock, seven days a week. These enforce the application of 3D printing technologies in medical fields. However, the scope of their use depends not on the available materials, but on the requirements, needs or skills of their application by the medical profession [3].

3D printing methods in surgery, orthopedics, preoperative diagnosis and planning

Additive technologies are widely applied in medicine. The use of 3D printing in the production of teaching aids for students, but also for doctor is becoming a daily reality. However, above all 3D printers (of FDM, SLS, SLM, DMLS types) are used in surgery and orthopedics to produce various orthoses, exoskeletons, prostheses (e.g. e-Nable implant), endoprostheses, their components and other implants replacing damaged tissues, organs or supporting their functions, parts of the heart prosthesis (Fig. 5b – 5f). Printing patient tailored (personalised) implants expedites operative procedures and reduces their costs. These implants or their elements are used in the reconstruction of bone defects (Fig. 4a, 4d) or joining bone fragments, where increasingly newer

biomaterials (e.g. PEEK, PEKK, bioceramics, mineral compounds) are applied in this technology [1-3, 9-10, 27].

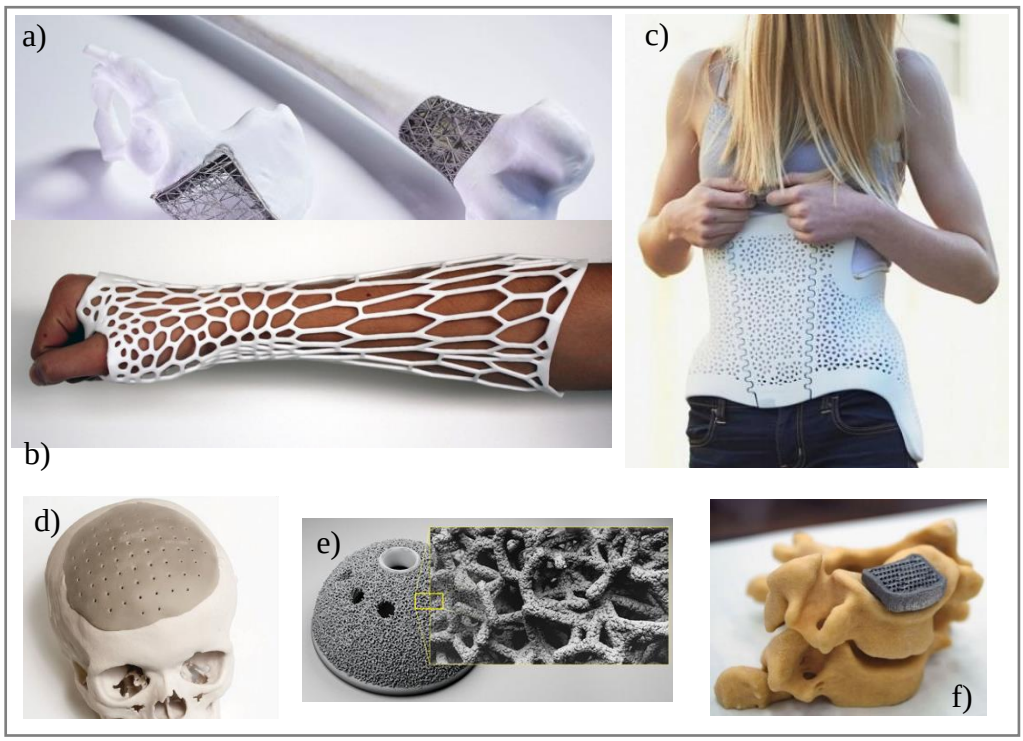

Fig. 5. Examples of application of 3D printing in surgery and orthopedics – elements filling bone cavities (a), Cortex replacing accustomed cast (b), Bespoke back brace made-up by SLS method (c), implant of cranium bones (d), hip joint implant made by DMLS method (e) and intervertebral disc implant (f)
Source: own study based on [11-13, 28, 30]

3D printing also allows to form prototypes of implants, bone or other structures models (obtained on the basis of DICOM images from CT computed tomography or MRI magnetic resonance imaging), which can do duty as tool of visualization of medical cases, helping to better and more precisely get familiar with them, or as tool simplifying communication between physicians, bioengineers and patients. Additionally, 3D printing is used during planning procedures before operation. Printouts – Fig. 6 and Fig. 7 (obtained using CJP or 3DP method) of 3D models of bones, other anatomical or pathological structures (e.g. cancerous tumours) allow doctors to better prepare and plan complex surgeries taking into account all details (which are sometimes difficult noticeable on X-rays pictures). This, in turn, allows appropriate selection of the best treatment technique for the patient, which translates to shortening of the procedure and treatment times and to reduction of risk of post-operative complications. 3D printing also have similar applications for preoperative diagnostics and planning in cardiac surgery, otolaryngology and other medical specialisations (e.g. during fetal surgery in the womb – Fig. 7b) [3, 8-10, 14-15, 27].

Fig. 6. Application of 3d printing in preoperative planning: models of liver (a), kidney (b) and heart (c)
Source: own study based on: [11-13, 28, 30]

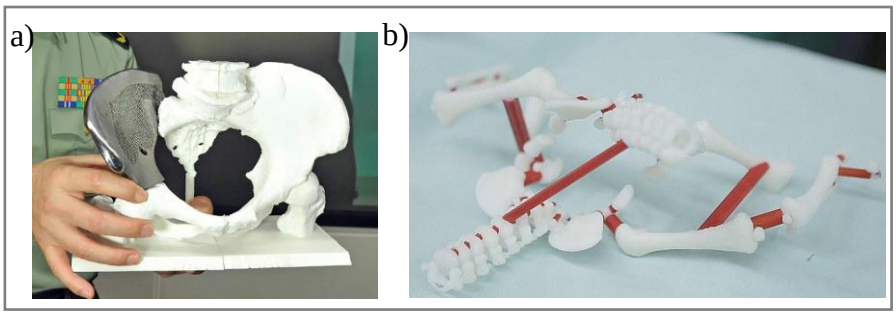

Fig. 7. Application of 3D printing in preoperative planning: model of pelvis with bone implant made by SLM and SLS techniques (a), model of blood vessels of Siamese twins (b)
Source: own study based on: [11-13, 28, 30]

Bioprinting and its expectations

Additive technologies are also used in so-called bioprinting, in which the building material are stem cells. They are applied layer by layer and combined with a special gel substance, what may allow to obtain, organs (e.g. liver, kidneys), vascular, nerves or skin tissues and muscles or cartilage, which in some cases is currently realized (Fig. 8). This is used in regenerative medicine, e.g. in the treatment of wounds and burn marks or in reconstructive surgery, including facial and craniofacial procedures, which example is the case of Polish patient from Gliwice or Eric Moger – patient with cancer, who has been given a printed nylon prosthesis, replacing a part of his face. Bioprinting is also opportunity for transplant medicine, because it can reduce or even eliminate use of organs from human donors. Furthermore, it can be applied in oncology, where printed models of cancerous tumours allow to test the influence of drugs or other types of treatment without infringing on human body and the risk of impairing [3, 8, 10-11, 16-18, 30]. However, it should be noted, that bioprinting technology (based on laser or inkjet using and even FDM method) has been constantly developed and examined – the first organic heart has already been printed from patient cells and biological materials, but this structure is not yet ready for transplant [19]. Currently, bioprinting is still a far prospect due to the complex structure of human organs, although – according to biotechnologists – it can contribute to the development of transplantology and surgery [3, 8, 10, 16-18].

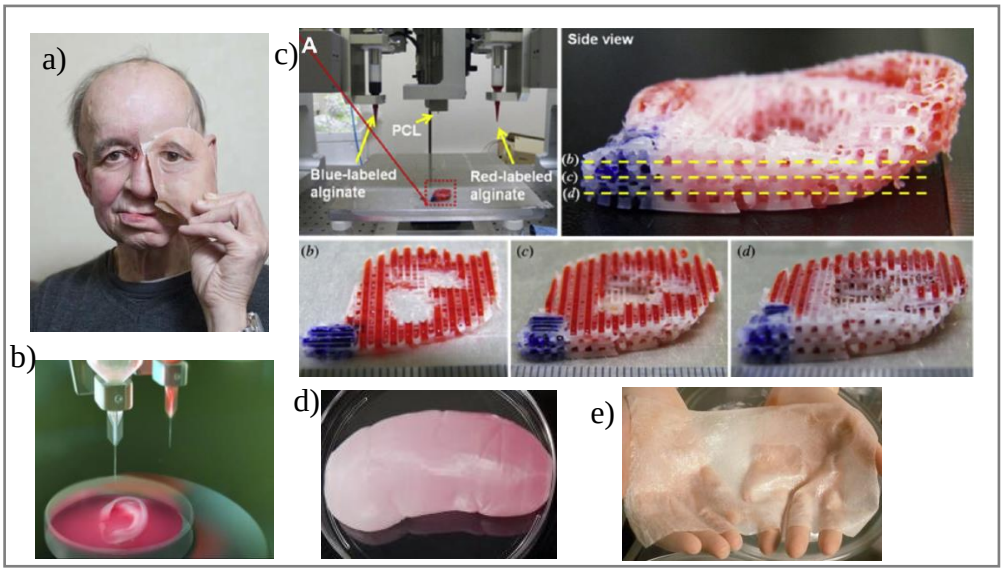

Fig. 8. Application of 3D in reconstructive surgery and transplantology: the case of Eric Moger and his facial implant (a), cartilaginous scaffolds of ear generated by bioprint method (b, c), kidney implant (d), skin implant (e)
Source: own study based on: [11-12, 22, 28, 30]

Application of 3D printing in dentistry and prosthodontics

3D print (particularly, laser-based methods, e.g. SLS, SLM, DLP, JM or – more rarely – FDM) is also used in dentistry and prosthodontics (Fig. 9), where it enables preparation of prosthetic components (including crown-root inlays from metal alloys), surgical guides for implants, substructures of permanent restorations (i.e. crowns and bridges), removable dentures, dental inserts or trial dental veneers and bone substitute materials. Thanks to that technology, fabrication of these elements do not last for weeks, but only a few hours. Moreover, FDM method makes it possible to print impression elements from biocompatible materials (e.g. PLA polylactide) or surgical guides. Additionally, 3D printing is applied in production of anatomical models for education or individually designed nanocellulose ligatures, which are put on after surgeries within in oral cavity [8, 20-22].

Fig. 9. Application of 3D printing in dentistry and prosthodontics – prostheses made by PolyJet and DLP
Source: own study based on: [11-13, 21, 28, 32]

Possibilities of 3D printing technology in pharmacy and other medical sciences

Currently, 3D printers have found more and more applications in pharmacy (Fig. 10a, 10b), because more often belongs to equipment of research and educational laboratories. As an example, in the drug formulations manufacturing technology, additive methods enable to prepare personalised doses to meet the needs of sick people. It involves also compound tablets, which contain several active substances – API. In this case, FDM technology is most often used, because allows to freely form the model shape and its degree of filling. Here, the filament, used during printing, is formed as a result of API incorporation into this media by using the immersion method or hot extrusion [10, 18, 22-26].

3D printing technology is also applied in the production of parts and elements of medical devices, e.g. manipulators, bioprotheses (e.g. e-Nable, as in Fig. 10d) or recently life-support machines (respirators, adapters for ventilators) and even means of personal protection such as face shields (Fig. 10c). Moreover, additive technologies are used in diagnostics, which example is achievement of scientists from MIT, who have already managed to create tattoos (Fig. 10e) changing color influenced stimuli (e.g. temperature) thanks to the bioprint technique. It has the function of a biological sensor, hence it can be a great tool for monitoring e.g. the concentration of specific compounds in the human body [8, 22, 34-35].

Fig. 10. Application of 3D printing in pharmacy, diagnostics: multilayered pellet and DuoCaplet (a), Spritam – drug used in epilepsy (b), protective face shield used during COVID-19 pandemic (c), hand prothesis e-Nable (d) and diagnostic tattoos made by bioprint method (e)
Source: own study based on: [22-23, 33- 34]

Future of 3D printing technology

3D printing methods are dynamically developing, which is also indicated by publications regarding additive technologies. Additionally, all doors are open for them in new areas of science, where the importance of this technology has not yet been appreciated. In general, 3D printing is already being put into mass production by large corporations and the production of spare parts, which can completely change the global economy. In turn, in the field of medical sciences, bioprinting, i.e. printing tissues, organs, personalised prostheses or implants can give huge opportunities [3, 16-18].

In turn, the future of these technologies is associated with the implementation of the fourth dimension – time, which gives 4D printing technology, whose origins can already be found in 2013. Then just at a conference in Los Angeles the architect-artist Skylar Tibbits presented the concept of 4D printing, based on the rule of self-assembly, i.e. shape changes due to external factors (e.g. temperature, humidity, movement or electromagnetism). Therefore, it is strived for printed objects with specific properties or structure to take a different shape influenced taken action. This may allow to obtain e.g. self-assembled everyday objects, furniture, buildings or implants adapting to the patient [3, 28].

Summary

Rapid prototyping and 3D printing technologies allow to obtain newer and better solutions in various areas of human life. Application of the above-mentioned techniques and printed models, prototypes, tools or final products include industry, buildings, art as well as medicine and sciences related to biomedical engineering. This is undoubtedly influenced by factors such as: low costs, relatively short time of manufacturing (sometimes complex and complicated) elements or elimination of material losses. In addition, the use of 3D printing technology during the design process allows to quickly test prototypes and expedites this process. Moreover, it reduces production costs thanks to the possibilities of quick detecting errors in the model and its necessary modification. This, in turn, translates into the costs of the final product and its implementation into production [3].

Furthermore, the undoubted advantage is also the possibility of obtaining own product printout, which is supported by the development of 3D technology, including a decrease in the price of printers, which gives the opportunity for the purchase of this device by an ordinary person. In addition, the production of highly specialised printers, better software and new materials for 3D printing, (incl. composites with a better internal structure and thus improved mechanical or thermal properties of final products) allows of more and more access to this developing technology. The limitation is can be only human imagination, although the concept of 4D printing and bioprinting show that even this is changing. In turn, the combination of 3D printing technology with imaging technology will slowly become an indispensable tool in educating future doctors, pharmacists or medical personnel, which will make the application of this technology in medicine even more advanced. Currently, in a coronavirus pandemic situation, it can be seen that 3D printing is useful for production elements of respirators, adapters for ventilators or means of personal protection such as face shields [3-4, 34].

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DEPRESSION AS A COMMON MENTAL DISORDER IN THE ELDERLY

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Abstract:

Ageing is a natural and common process taking place in the human body. During this process changes in human functioning take place on 4 levels: biological, mental, social and spiritual. The complexity of the aging process and the progressing deterioration of many life processes, including adaptive ones, favours the occurrence of mental disorders. An example of such a disorder is depression, which is in the second place of the most common mental disorders of the elderly. Depression in elderly people is a significant clinical and social problem due to its increasing incidence. The process of diagnosing this disease is difficult due to the co-occurrence of many disease processes, which may mask depressive symptoms. The symptoms of typical depression are divided into two groups: primary (axial) and non-specific (secondary). The methods of treatment include pharmacotherapy and psychotherapy, as well as psychoeducation and social activation. Prophylaxis of depression in the elderly should focus on providing informational, emotional and practical support for seniors.

Keywords:
ageing, depression, elderly people

Introduction

The progress of civilization, especially in medicine, has a positive effect on quality of life and its duration. The Statistics Poland projection states that number of people aged 60 and more has increased. In 2010 elderly people constituted 19,6 percent of total population in Poland, but in 2018 this percentage was almost 25 %.

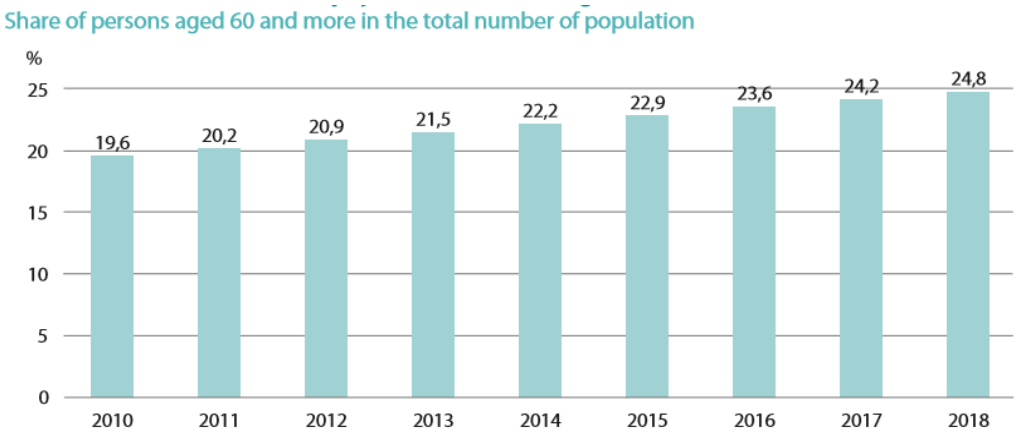

Fig. 1. Share of persons aged 60 and more in the total number of population
Source: Statistics Poland, The situation of older people in Poland in 2018, Warszawa, Białystok 2020

Research point to continuous increase of this indicator. Assume that in 2050 people aged 60 and more will be 13, 7 millions (40 % of total population). This increase have been a challenge for health care, especially finances, because number of senior citizens affects the amount of expenses. In 2018 costs were 34 billions PLN, which is 8,5 percent more than last year. Despite high costs is not equivalent to good quality of healthcare system [1].

Elderly people have amount of various somatic illnesses, but also they suffer from mental diseases. Loneliness, lack of self-esteem, social isolation and financial problem are the everyday life of many people aged 60 and more [2].

A significant impact on mental health has relations with other people. Unfortunately, elderly people experiences loneliness. This situation will have various reasons like poor condition of health, death of loved ones. Furthermore, we live in media times without deep feelings and tighten relationships. It makes that communication becomes more harder than earlier. It is easier to choose television or Internet than make an effort to develop interpersonal skills. Nothing can replace a relationship or exchange of thoughts with other people. Social group also have an impact on mental health and keeping intellectually skills for longer. It is wise to have a friendship with trust and help in difficult or stressful time. A presence is often sufficient and is better support than money. Awareness that you are not alone, lets life happily [3, 4].

Diagnostic problems of depression in the elderly

Diagnosis of depression in the elderly is a challenge for medical personnel due to the different clinical course and the nature of changes occurring in the body as the aging process progresses. This disorder often remains undiagnosed and untreated. It is affected by many factors [5].

Ageing is associated with many limitations, not only due to deteriorating physical condition, but also due to weakening cognitive functions. The loss of a spouse, loneliness or a sense of exclusion from society are just some of the situations that seniors encounter. These factors are often considered to be "common" and natural in the process of aging, which can lead to the downgrading of the first signs of sadness and depression by the surroundings as well as by the seniors themselves. Even if the symptoms are noticed, some seniors are not willing to see a doctor for fear of social

stigmatization. There is also the problem of high fees for commercial psychiatric visits and psychotherapy, which are often not allowed by the financial possibilities of the elderly [6, 7].

Another reason may be a problem with the course of depression in older people. The clinical manifestation in this situation is often different than in younger people. There are no 'extra' symptoms, but some of the basic symptoms of depression are increased in intensity and frequency. An example is the symptom of anxiety and distress, which occurs more often and with greater severity in elderly depressed people. In turn, the symptom of sadness is less noticeable than in the course of the disease in middle-aged people [4].

The most important issue, however, is the multi-drugity and multi-disease prevalence of senior patients. These people often have many co-morbidities and take many therapeutic drugs. The links between these diseases, the medication taken and depression are complex and full of interactions. All these factors can also modify each other [7]. Cardiovascular diseases are an example. It has been observed that depression or depressive symptoms are associated with the development of ischaemic heart disease and increase the risk of myocardial infarction. It has also been demonstrated that the onset of cardiovascular diseases often precedes the first symptoms of depression. In such cases, it is not possible to indicate the cause and effect, which also hinders the diagnostic process [6].

It is also worth noting the problem of masking depressive symptoms. It occurs when there are no symptoms characteristic for this disorder, but typical in the course of other diseases. Somatic and psychosomatic symptoms play an important role here. Headaches and dizziness, cardiovascular problems (palpitations, chest pain or pressure), abdominal pain, dyspnea, gastrointestinal disorders, as well as backache and other painful conditions that are difficult to specify may occur. The elderly also often experience sleep problems and anxiety [7].

Symptoms of depression in the elderly

The symptoms of depression can be divided in terms of the nature of the changes that occur (emotional, cognitive, motivational and somatic) and in terms of the severity of the symptoms (basic and non-specific) [3, 6].

Tab. 1. Symptoms of depression divided by the nature of the changes that occur

Emotional symptoms	Cognitive symptoms
lowering the mood, fear, loss of joy of life (from loss of interests to neglect of biological needs), sometimes dysphoria (impatience, irritability)	negative self-perception, lowered self-esteem, self-prosecution, pessimism and resignation, memory and concentration problems
Motivation symptoms	Somatic symptoms
mobilisation problems to act (these can take the form of psychomotor slowing down, difficulties in making decisions)	daily rhythm disorders (e.g. sleep and wakefulness disorders), loss of appetite, weakness and fatigue, decline libido, sometimes complaining about pain and malaise physical

Source: Own study based on J. Szczepańska-Gierach , L. Jaworska, J. Mazurek, A. Skrzek, *Ujęcie biopsychospołeczne w leczeniu depresji u osób starszych,* Gerontologia Współczesna, (3/2017), Vol. 5, 108-112

The basic (axial) symptoms of depression are:
Lowering of the basic mood - sadness, depression, sometimes indifference and inability to experience joy,
Weakening of the pace of mental and movement processes (psychomotor inhibition) - there is a slowdown in the pace of thinking and movement, there are problems with memory, the feeling of incapacity of the intellect, sometimes there is stupor (movement inhibition), anxiety,
Somatic symptoms and biological rhythm disorders - there is a disturbance of sleep and wakefulness, mood swings during the day, tension headaches, drying of oral mucous membranes, and lack of appetite,
The so-called "slow-moving" anxiety - it remains almost constant, shows a wavy intensity, can also reach significant dimensions and manifest itself in the motion sphere (excitement) or in the form of panic attacks.
Non-specific (secondary) symptoms of depression are:
Depressive disorders of thinking - negative image of oneself, health, past and future, in intensity - nihilistic delusions, guilt, punishment, sinfulness, catastrophic and hypochondriac,
Disorders of complex activity - contact with the environment, self-destruction, self-isolation, reduced interest [8].

Treatment of depression in the elderly

As described above, the diagnosis of depression is a complex process. Although the word depression is often abused in the wrong context, it is extremely easy for older people to ignore the problem. This can lead to the abandonment of forms of therapy or even therapeutic scepticism [6]. Therefore, the diagnosis and treatment should be adjusted to the individual needs of the patient.

The treatment of depression should include psychotherapy and pharmacotherapy. A combination of these methods also gives good results. During a mild form of depression, psychotherapy itself brings noticeable benefits. During this time it will be possible:

- to sort out the rhythm of the day,
- planning new activities,
- to improve sleep,
- to help actively return to everyday life.

The second aspect during depression treatment is pharmacotherapy. Antidepressants, i.e. antidepressants are selected individually. It is important to pay attention to coexisting diseases such as cardiovascular diseases, diabetes or COPD. The rules of using antidepressants in elderly people do not differ much from those of young people. The first-line drug is serotonin re-uptake inhibitor (SSRI). The remaining drugs are shown in the Tab. 2 [10].

Tab. 2 Groups of antidepressants and their side effects.

Group of drugs	Side effects
Tricyclic antidepressants (TLPD)	-weight gain -cholinergic effects -orthostatic drops in blood pressure
Selective serotonin re-uptake inhibitors (SSRI)	-system disorders food -sexual dysfunctions -weight change -somnolence -restlessness
Selective serotonin and noradrenaline re-uptake inhibitors (SNRI)	-nausea -drowsiness -dry mouth -dizziness -insomnia
Selective noradrenaline and dopamine re-uptake inhibitors (NDRI)	-insomnia -nausea -vomiting -tremor -increase in pressure arterial blood -ear noise
Selective reversible inhibitors monoamine oxidase	-sleep disturbance -agitation -dizziness
Drugs with receptor mechanisms actions	-weight gain -drowsiness -fatigue -orthostatic drops of blood -nausea -dizziness
Drugs with other mechanisms of action	-aches and dizziness headache -drowsiness / insomnia -weight gain

Source: Own study based on S. Kałucka, *Cechy depresji w wieku podeszłym- etiologia, rozpoznawanie i leczenie*, Geriatria (2014), Vol 8, 240-247.

The role of the nurse

The nurse as a medical professional takes part in diagnostics, treatment and prevention of depression. She is able to notice disturbing changes as quick as possible, thanks to frequent contact with patient. During diagnostics she can use Geriatric Depression Scale – GDS, which contains 30 questions. Scale is very frequently used to assess depression in elderly. A results also can indicate the type of depression.

A suffering from depression needs support, concern, acceptance. Nurse takes care of the patient and has an opportunity to respond to his needs with professionalism and empathy. Thanks to observation, conversation, theoretical and practical knowledge nurse becomes an important element in treating a patient. However, it is important to avoid over-guarding. This may cause limitations for the patient [11].

Summary

Over the years an increase in the number of people suffering from depression has been observed. In respect of this fact, since 2001, Poland has celebrated the International Day for Combating Depression, which takes place on 23 February. On this day, attempts are being made to change the perception of this disease, as well as to draw attention to people in the risk group. These include the elderly, who are affected by concomitant diseases and lonely lifestyles, which accelerate the development of depression. Although diagnosing depression is a challenge for healthcare, the same treatment for depression is relatively easy. It includes pharmacological treatment and psychotherapy. Interestingly, seniors' clubs, Third Age Universities and health resorts, where seniors have the opportunity to re-establish social contacts and become active, are becoming extremely popular. These places can help to relax, forget about everyday problems and rebuild confidence and sense in life. In this way it is possible to prevent the development or aggravation of the extremely serious illness that is depression.

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POLISH AND EU REGULATIONS CONCERNING BIOFUELS - CURRENT STATE AND PROSPECTS

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Abstract:

The article presents Polish and European regulations regarding liquid biofuels used to power motor vehicles. Presented, among others assumptions of the National Indicator Target, the National General Target and how Poland is dealing with achieving these indicators. By analyzing the article, it can be concluded: the assumed climate goals for 2020 and subsequent years may not be met, mainly due to the new legal regulations, according to which a maximum of 7% of biofuels can come from food raw materials. Also presented the negative effects caused by the introduction of restrictive biofuels regulations as well as new regulations that should counteract this.

Keywords:
biofuels, ILUC, CO_2, climate

Introduction

Many publications [1, 2] state that the causes of climate change are natural and dependent, among others from changing the orbit or the tilt of the Earth's rotation axis (long-term changes like ice ages) or from the activity of the sun or cosmic rays (short-term). However, many more authors of the publication are of the opinion that global warming is largely caused by human [3].

However, omitting the topic of global warming, it is still considered that fossil fuel consumption should be reduced in favor of new alternative energy sources. Fossil fuels cause the emission of substances such as sulfur oxides, nitrogen oxides, heavy elements, threatening human health much more than carbon dioxide. In addition, it is not known how much oil resources our planet has, and newly discovered resources are often more and more difficult to exploit, which increases the costs of extraction and the price of the raw material itself. In addition, when oil stocks run out, it will be difficult to meet other industries that use this material in a different way (e.g. lubricants, oils, asphalt, synthetic materials).

Wondering whether the setting of increasingly stringent standards by the European Union is justified is currently the subject of many discussions. A good question is also whether the CO2 emission factor adopted by the European Union is a good indicator of determining whether energy is "bio"? The automotive industry, and thus the fuel industry, seem to be the main scapegoat in the

quest to increase the share of renewable energy in final energy consumption. Therefore, new biofuels are being developed, which theoretically should reduce CO2 and other greenhouse gas emissions to the atmosphere.

Polish regulations

ACT

Currently, the legal act regulating on the provisions of biofuels is the "Ustawa z dnia 25 sierpnia 2006 r. o biokomponentach i biopaliwach ciekłych" [4]. The latest amendment to this act dates from 19 July 2019 [5]. According to this act, liquid biofuels are considered to be:

- motor gasolines containing more than 10.0% by volume of biocomponents or more than 22.0% by volume of ethyl-tert-butyl or ethyl-tert-amyl ethers, excluding motor gasolines containing liquid bio-hydrocarbons,
- diesel oil containing more than 7% by volume of biocomponents, excluding diesel oil containing liquid biocarbons,
- bioethanol, biomethanol, biobutanol, ester, dimethyl bioether, pure vegetable oil, liquid bio-hydrocarbons, bio-propane-butane, liquefied biomethane, compressed biomethane and biohydrogen - being self-contained fuels.

One of the most important elements of Polish biofuels regulations is the National Indicative Target (NCW). NCW is an indicator that determines the minimum share of renewable fuels and biocomponents contained in fuels or liquid biofuels used in all modes of transport in relation to the total amount of fuels and biofuels in road and rail transport (calculated according to calorific value). The NCW is obliged to implement an entrepreneur carrying out business activities in the field of production, import or purchase of intra-Community liquid fuel or biofuel that consumes or sells it on the territory of the Republic of Poland. For failing to meet the minimum share of biocomponents / biofuels by an entity, fines are imposed on it.

In order to facilitate the calculation of the share of biocomponents by calorific value, a regulation was created [6] determining these values both by weight and by volume. For example, participation in the NCW:

- for gasoline containing 10% bioethanol is 6.40% (BS - 43 MJ / kg, bioethanol - 27 MJ / kg),
- for diesel containing 7%, FAME is 6.08% (ON - 43 MJ / kg, FAME - 37 MJ / kg).

Biocomponents added to fossil fuels and used as an intrinsic fuel meet the greenhouse gas emission saving criterion if the emission reduction is at least 50%.

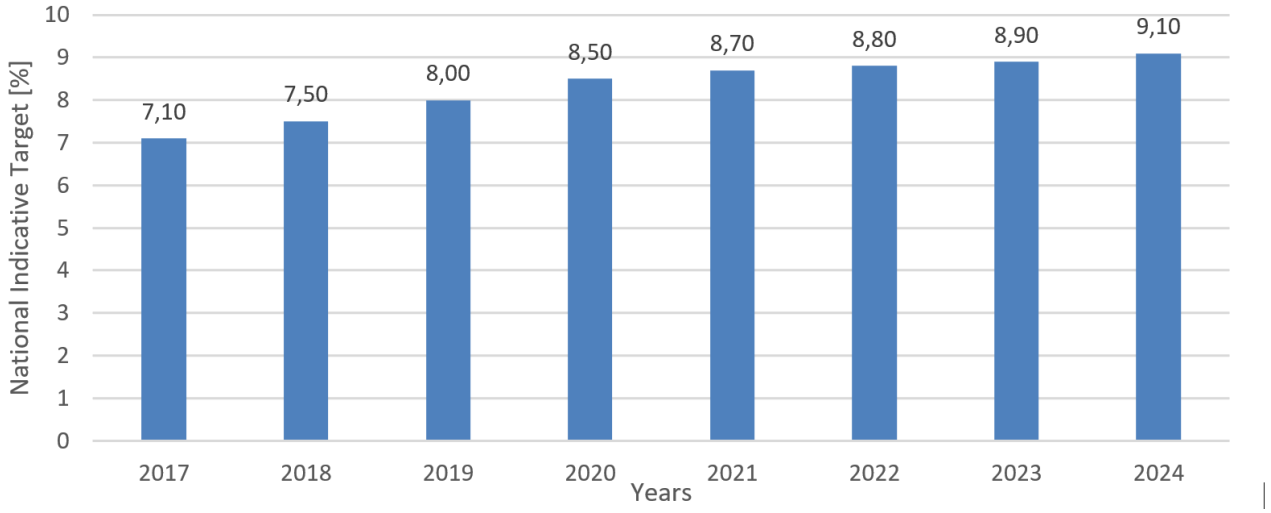

Fig. 1 National Indicative Target in 2017-2024

The aforementioned latest amendment [5] determines, among others levels of the NCW for subsequent years (Fig. 1). At 2021 - 8.7%; 2022 - 8.8%; 2023 - 8.9% and in 2024 - 9.1%.

The new regulations add new types of biofuels to the NCW calculation, including derived from co-hydrogenation (hydrotreatment of fractions from crude oil and biomass processing) or fuels containing biohydrogen (produced using biomethane).

The amendment also specifies the minimum share of biocomponents in conventional fuels:

- gasolines in 2020-2022 it is to be 3.20%,
- for diesel oils, this value in 2020 is 4.90%; 2021 - 4.95%; 2022 - 5.00%.

There is also a provision that restricts the use of biocomponents that have been made from food raw materials. For 2020, it was assumed that a maximum of 7% of these products can be used to produce liquid fuels and biofuels

OZE target

The NCW is one of several elements of the implementation of the national general target in terms of the share of energy from renewable sources in gross final energy consumption (RES target). For Poland the RES target in 2020 is 15%. There are many indications that Poland will not be able to achieve this level. The Ministry of Energy acknowledged it at the beginning of 2019 [7]. Also CSO reports are not very optimistic. The latest report of November 18, 2019 stated that in 2018 the share of energy from renewable sources was 11.16% [8] (Fig. 2).

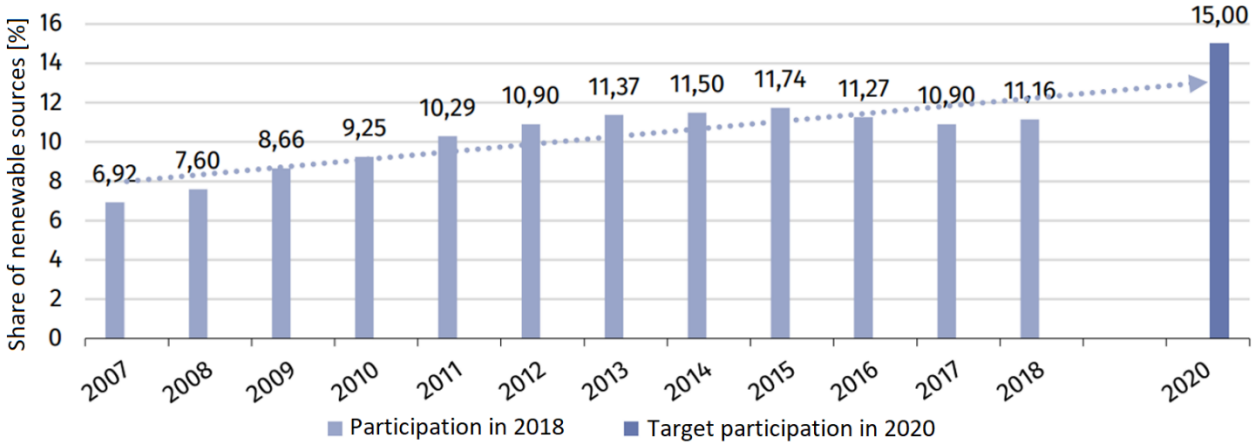

Fig. 2 Share of energy from renewable sources in gross final energy consumption

As already mentioned, the NCW is one of several instruments for implementing renewable energy in transport. Other instruments include use of electric vehicles in road, rail and other transport modes. The target share of renewable sources in transport for 2020 is 10.0%, which at 5.63% in 2018 is practically unattainable (Fig. 3).

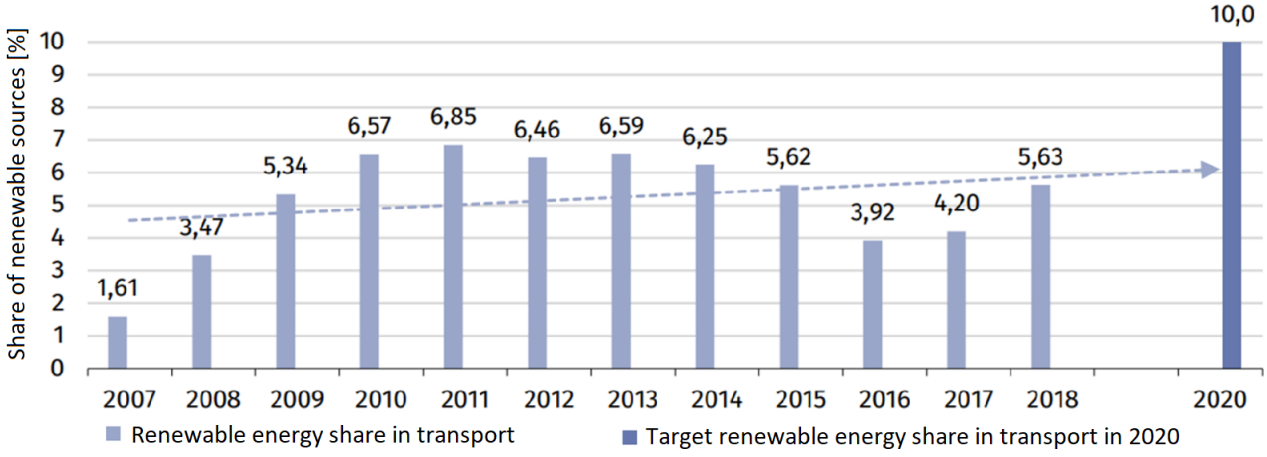

Fig. 3 The share of energy from renewable sources in transport

On December 30, 2019, the Energy and Climate Plan for 2021-2030 was forwarded to the European Commission. The document sets climate and energy goals for 2030 [9]. These include:

- 21-23% share of renewable energy sources in gross final energy consumption,
- 14% share of renewable energy sources in transport.

In the years 2008-2018 the share of renewable energy increased by 3.56%, and in the transport sector by 2.16%. Looking at current forecasts, this goal seems unachievable (an increase of 10% in final consumption and about 9% in transport is needed). An additional premise that may affect the results is the probable crisis caused by the current epidemiological status, which may have a long-term negative impact on many branches of the economy. According to the Minister of Energy, the current target (15%) can be achieved in 2022. By failing to meet it within the set deadline, Poland may face fines consisting in buying renewable energy from other EU countries that have surpluses.

European Union regulations

Since 2008, the European Union has sought to ensure that fuels used in transport by Member States in 2020 come from at least 10% from renewable sources. From that moment, a quick switchover of vehicles to biofuels and dynamic market development was expected. The European Union did not fully anticipate the consequences of this. Paradoxically, the increase in biofuel production caused that greenhouse gas emissions increased. For example:

- according to research, the cultivation of plants for biofuel production causes an increase in carbon emissions to the atmosphere (caused, among others, by deforestation or the transformation of meadows and pastures into fields for the cultivation of cereals intended for production) [10],
- farmers destroy forests and grow plants for the production of fuels instead of food, which according to experts can lead to food shortages in regions of South America and Southeast Asia [11].

This is the so-called indirect impact of biofuel on land use change known as ILUC (Indirect Land Use Change). This is associated with an unintentional increase in carbon dioxide emissions due to changes in the use of arable land (forests, arable fields) for land for crops intended for the production of ethanol or biodiesel, caused by an increased demand for biofuels. Natural lands store carbon in soil and biomass, which allows trees and plants to grow every year. Such replacement of trees and plants with fields for biofuel production has a negative impact on the greenhouse gas emissions balance. Additional negative ILUC factors are: reduction of biodiversity, deterioration of water quality, changes in food prices, migration of employees or cultural issues [12].

To reduce the impact of ILUC, the Directive of 11 December 2018 [13] limits the share of biofuels derived from food and fodder plants (1st generation) to 7%. This is to encourage the use of advanced biofuels of a newer generation. The European Union is aware that such fuels are more expensive and more difficult to produce, and therefore introduced some simplifications.

To discuss them, define the term advanced biofuels. They mean biofuels made from the raw materials listed in Annex IX, Part A (e.g. algae, biomass fractions of mixed municipal waste, straw, manure). For such biofuels, a factor equal to twice their energy value is assumed (i.e. one liter of fuel produced from algae is equal to two liters of first generation fuel assuming that they have the same calorific value). This means that the 5% share of advanced fuels alone allows the standard to be met by 2020. By 2030, the European Union wants fuels used in transport by Member States to come from at least 14% from renewable sources.

In order to classify the biofuel produced for national purposes, the entity producing such a product should undergo certification of compliance with the sustainability criteria, which is set out in the Directive of 2009. In Poland, the Oil and Gas Institute is responsible for developing the certification system [14]. The system defines standards and procedures used in the production of biomass and biofuels. Such a certificate proves that the biofuel produced by such an entity generates lower greenhouse gas emissions throughout the entire life cycle than its mine equivalent.

Slovakia, Poland and the Czech Republic have signed a joint declaration to the European Union in which they call for supporting the local development of biofuels. In the declaration, they assure Europe's huge potential in the production of biofuels based on low-risk ILUC crops [15].

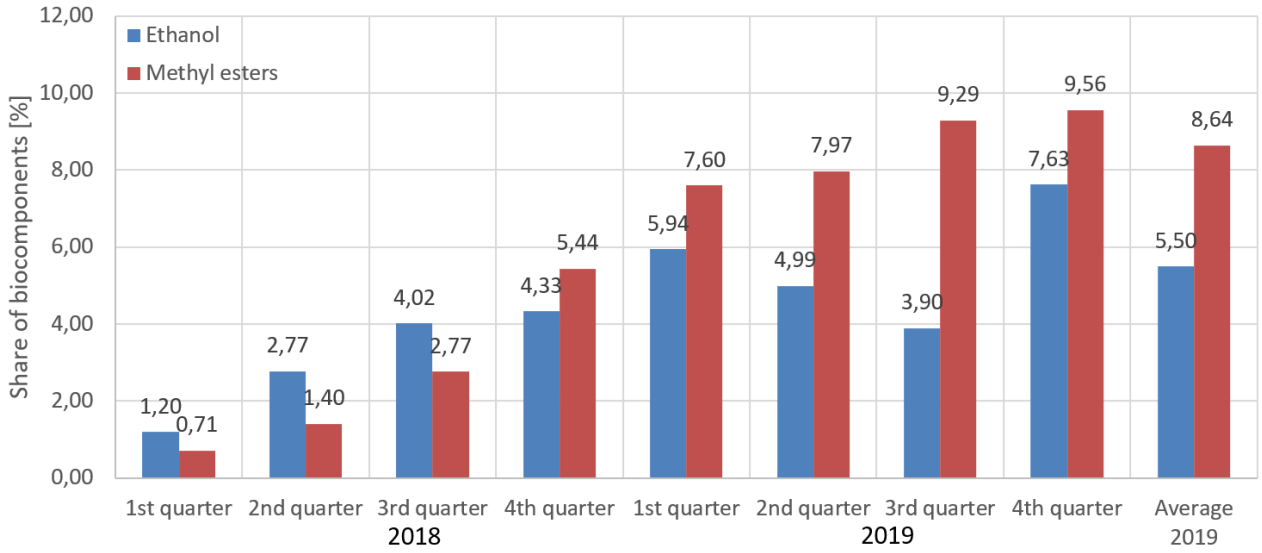

Fig. 4 Percentage share of biocomponents meeting the criteria of sustainable development, which entitles to double counting for NCW implementation

The declaration can be confirmed by data [16] regarding the production of biocomponents. In 2017, Poland did not produce any biofuels that would fall into the "advanced" group. It wasn't until 2018 that the first entities that produced them appeared. The production of "advanced" methyl esters and bioethanol is growing rapidly. In the fourth quarter of 2019, their production was 9.56% and 7.63%, respectively, in relation to all those produced (Fig. 4).

Conclusion

Climate goals for 2020, which assume that 15% of all energy will be produced using renewable sources and 10% of energy consumed in transport will come from renewable sources, is impossible to achieve by Poland. It seems unlikely that the 2030 targets will be met (21% and 14%, respectively).

The main problem in achieving the renewable energy target may be new regulations, according to which a maximum of 7% of biofuels can come from food raw materials. On the other hand, Poland declares with its neighbors the huge potential of non-food crops and low ILUC risk for biofuel production.

Production of biofuels from crops of food plants contributed, among others to an unintentional increase in carbon dioxide emissions. The new version of the directive is intended to prevent this by using newer generation biofuels. An incentive to use newer generation biofuels is to be a factor of two when calculating its share for renewable energy.

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AUTOMATIC ASSIGNMENT ICD CODES BASED ON SEMANTIC INFORMATION

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Abstract:

The paper presents the method of automatic assignment of ICD codes based on semantic information contained in clinical reports of the MIMIC-III database. It is showing the possibility of using multi-criteria optimization methods for simple classifiers fusion in a more precise classifiers complex. ICD code assignment is important in the modern hospital, more accurate automation of assigning codes will make the clinical process more efficient and can help clinicians carry out better diagnostics and effectively improve medical care systems.

Keywords:
MIMIC III, ICD, TFIDF, word2vec, classification

Introduction

For last year's we are watching very fast growth of medical data in hospitals. EHR (Electronic Health Record) data contain various clinical information about the patient, such as medical history, vital signs, laboratory test results, clinical notes, etc., they create a continuous flow of information between the doctor's and the patients. A large part of the health card data is recorded with unstructured text, e.g. clinical observations include the patient's medical history, comments on the doctor's interaction with patients.

International Classification of Diseases (ICD) is a healthcare classification system developed by the World Health Organization. It provides a hierarchy of diagnostic codes of diseases, disorders, injuries, signs, symptoms, etc. Assigning the code is important at many levels in a modern hospital, from providing the exact invoice process to creating a patient care history. However, the coding process is tedious, subjective and requires specialist knowledge. Clinical coders need to extract key information from EHR and assign correct codes based on category, anatomic site, laterality, severity and etiology [8-12].

The article proposes the method that can automatically performs ICD coding given the clinical notes of patients. The method is based on use simple classifiers built on two document representation techniques, the computed similarity score of these classifiers will be synthesized to get a more accurate assignment of ICD codes.

MIMIC-III and ICD-9 codes

MIMIC-III is a large, publicly available database containing health-related data, which contains approximately 58,000 hospital admissions of 47,000 patients who stayed in the Beth Israel Deaconess Medical Center in Boston, Massachusetts, between 2001-2012. The database contains information such as: demographic data, measurements of vital signs at the bedside, results of laboratory tests, procedures, medications, doctor and nurse notes, procedure and diagnostic codes (ICD), imaging reports and mortality outside the hospital [13].

ICD-9 - the Ninth Revision of the ICD is a system of about 15,000 numeric codes representing diagnoses and procedures. These codes are used by health care institutions to facilitate and organize the performance of procedures, diagnostic and treatment procedures. The codes consist of 3-4 characters, of which the first two are headlines code groups, and the third and fourth are a clarification. In Poland, coding procedures are used to determine the cost of treatments or operations. The codes are included as attachments to the invoices issued by the hospital and based on the National Health Fund decides to grant a refund for a given treatment [14].

Preliminary analysis and data cleaning

The purpose of this article is to present the method of automatic assignment of ICD-9 codes based on semantic information contained in clinical reports of patients. The dataset used for this study is MIMIC-III. There are six main tables in the MIMIC III data set [13, 28]:

1. ADMISSIONS - contain all information regarding a patient admission, including a preliminary diagnose.
2. LABEVENTS - contains all laboratory measurements.
3. MICROBIOLOGYEVENTS - contains microbiology information such as whether an organism tested negative or positive in the culture.
4. CHARTEVENTS - contains all charted data including patients' routine vital signs and other information related to their health.
5. DIAGNOSES_ICD - contains information about the ICD codes assigned to the patient in the hospital.
6. NOTEEVENTS contains all notes including nursing and physician notes, echocardiography reports, and discharge summaries.

Each EHR has a clinical note called discharge summary, which contains multiple sections of information, such as 'discharge diagnosis', 'past medical history', 'family history', 'allergies', 'admission exam', 'history of present illnesses. For these semi-structured text data, we will construct machine learning models to analyze semantic similarities between diagnosis descriptions and ICD code descriptions.

Tab.1. Top-10 ICD codes in MIMICIII

ICD code	Description	Admissions
4019	Hypertension	20046
4280	Congestive heart failure	12842
42731	Atrial fibrillation	12589
41401	Coronary atherosclerosis	12178
5849	Acute kidney failure	8906
25000	Diabetes Type II	8783
2724	Hyperlipidemia	8503
51881	Acute respiratory failure	7249
5990	Urinary tract infection	6442
53081	Esophageal reflux	6154

Source: [9]

Data analysis showed that the TOP-10 and TOP-50 ICD codes assigned to clinical notes cover over 76,9% and 93,6% of data available in the MIMIC-III database [9]. For the purposes of this paper we will consider codes from TOP-10 and those patients to whom those codes have been assigned.

Clinical reports representation

Here are some notations what will be used throughout this paper:

$V \in \mathbb{N}$ - number of words in vocabulary.
$M \in \mathbb{N}$ - number of patient's documentation.
$L \in \mathbb{N}$ - number of ICD codes.
$N_i \in \mathbb{N}$ - number of words in note.
$i \in \{1,\dots,M\}$- index of patient notes.
$j \in \{1,\dots,V\}$- index of words.
$l \in \{1,\dots,L\}$- index of ICD code.
$X^{(t)} \in \mathbb{R}^{MxV}$ - vector space model for patients documentations represented by TF-IDF.
$X^{(w)} \in \mathbb{R}^{MxV}$ - vector space model for patient documentations represented by word2vec.
$x \in \mathbb{R}^{Vx1}$ - one-hot encoded vector where $x_j = 1$ if word t_j does appear in the clinical note and then all other words take the form $x_{j'} = 0, j \neq j'$.

Creating a text vector representation means transforming a set of tokens $T^{(V)} = \{t_1,\dots,t_j,\dots,t_V\}$ into a vocabulary in which numbers represent words [8-12][18]. There is a possibility to obtain different variations of representation vector-space for documents $d_i = \{w_{i1},\dots,w_{ij}\}^T$. The popular used in practice include: BoW and its term-frequency based variants [18][22], language model based methods [16][23], topic models [24] and distributed vector representations [25-28]. For the purpose of the article, TF-IDF and word2vec methods will be used for feature extraction of patient's notes $D = \{d_1,\dots,d_i,\dots,d_M\}$. TF-IDF, short for term frequency–inverse document frequency, is a numerical statistic that is intended to reflect how important a word is to a document in a collection or corpus[18]. The TF–IDF value increases proportionally to the number of times a word appears in the document and is offset by the number of documents in the

corpus that contain the word, which helps to adjust for the fact that some words appear more frequently in general[18]. The TF-IDF values are calculated from the formula:

$$w_{ij}^{(t)} = (tf - idf)_{ij} = tf_{ij} \times idf_j) \quad (1)$$

Where tf_{ij} is called "Term frequency", expressed by the formula[18]:

$$tf_{ij} = \frac{n_{ij}}{N_i} \quad (2)$$

Where n_{ij} is the number of occurrences of the word t_j in the document d_i, and the denominator is the sum of the occurrences of all words in the document d_i [18]. idf_j this "inverse document frequency", expressed by the formula:

$$idf_j = \frac{|D|}{|\{d: t_j \in d\}|} \quad (3)$$

$|D|$ - number of documents in the corpus,
$|\{d: t_j \in d\}|$- the number of documents containing at least one occurrence of a given term.

Word2vec is a group of related models that are used to produce word embedding. These models are shallow, two-layer neural networks that are trained to reconstruct linguistic contexts of words[30]. Word2vec can utilize either of two model architectures to produce a distributed representation of words: continuous bag-of-words (CBOW) or continuous Skip-Gram[30]. In the continuous bag-of-words architecture, the model predicts the current word from a window of surrounding context words. In the continuous Skip-Gram architecture, the model uses the current word to predict the surrounding window of context words[30]. For the purpose of the article, the Skip-Gram model will be used [21].

The input layer is represented by a one-hot encoded vector x of dimension V. The hidden layer, h, is defined by a vector of dimension N. The output layer is a vector of dimension V. The weights between the input and the hidden layer are represented by a matrix W, of dimension V×N. The hidden layer h is calculated using the following formula:

$$h = W^T x_j := v_{t_j} \quad (4)$$

Where v_{t_j} is the vector representation of the input word t_j. Similarly, the weights between the hidden and the output layer are represented by a matrix W′, of dimension N×V. Using these weights, we can compute a score u_j for each word in the vocabulary:

$$u_j = v'^T_{t_j} \cdot h \quad (5)$$

Where $v'^T_{t_j}$ is output vector of the the j-th word t_j of the matrix W′. Then we can use a log-linear classification model, to obtain the posterior distribution of words:

$$y_{t_j} = \frac{exp\,(u_j)}{\sum_{j'=1}^{V} exp\,(u_{j'})} \tag{6}$$

After training we will have word embedding $U = \{y_{t_1}, \ldots, y_{t_j}, \ldots, y_{t_V}\}$ and these embedding will be used as feature input to machine learning models. Each patient documentation will be represented as an average of the embedding of the words in the document:

$$d_i^{(w)} := \frac{1}{N_i} \sum_{j \in d_i} y_{t_j} \tag{7}$$

Both (TF-IDF, word2vec) serve different purposes in natural language processing. Word2vec helps in going deeper into the document, measure syntactic and semantic similarities between sentences, helps to derive relations between a word and its contextual words. Whereas TF-IDF helps in visualizing important words in document and topic modelling by using the importance score of words.

Classification

In this type of task, the computer program is asked to specify which of l categories some input belongs to. To solve this task, the learning algorithm is usually asked to produce a function[29]:

$$C: D \rightarrow L \tag{8}$$

The following concepts can be distinguished: supervised classification and unsupervised classification. In unsupervised learning, data points have no labels associated with them. Instead, the goal of an unsupervised learning algorithm is to organize the data in some way or to describe its structure. This can mean grouping it into clusters or finding different ways of looking at complex data so that it appears simpler or more organized[29]. Supervised learning algorithms make predictions based on a set of examples. For instance, historical data about patients and ICD codes assigned to their cards can be used to predict ICD codes for new patients. Each example used for training is labeled with the value of interest - in this case the ICD codes. A supervised learning algorithm looks for patterns in those value labels. May use all information that may be relevant and included in clinical notes and each algorithm looks for different types of patterns. After the algorithm has found the best pattern it can, it uses that pattern to make predictions for unlabeled testing data[29].

Patients notes $D = \{d_1, \ldots, d_i, \ldots, d_M\}$ may have multiple ICD-9 codes assigned $l \in L$, so this is a classification task with multiple labels. The classification of many labels in this case has an additional degree of difficulty, because the number of correct labels for each patient is unknown [2], [9-12]. In the described method, logistic regression model will be used as classifiers. The corpus will be defined $X' \subset X^{(t)}$ or $X' \subset X^{(w)}$ as a set of observed patients notes that should be used to train and test the classifier. A separate classifier will be trained for each ICD code and for

each feature vectors, they predict independent values from the range 0-1 (if the higher value then the higher probability of assigning the ICD code). Logistic regression works on the basis of a function called a logistic function or more often called a sigmoid. This function is responsible for predicting or classifying input data. The function is defined as [5]:

$$z = \beta^T X' \tag{9}$$

$$sigmoid(z) = \frac{1}{1+e^{-(z)}} \tag{10}$$

Weights (represented by β in our record) are an important part of logistic regression algorithms and other machine learning algorithms, we should find the best values for them. At the beginning, we will choose random values and we need measure how well the algorithm uses these random weights. This measure is calculated using the loss function.

$$h = sigmoid(X'\beta) \tag{11}$$

$$J(\beta) = \frac{1}{m} \cdot [-l^T log(h) - (1-l)^T log(1-h)] \tag{12}$$

Where:
m - number of samples in X',
l - target ICD code.

The goal is to minimize losses by increasing or decreasing the weight, which is commonly called fitting. Which scales should be larger, and which should be smaller, this can be determined using gradient methods. Gradient is a derivative of the loss function in relation to its weight.

$$\frac{\delta J(\beta)}{\delta \beta} = \frac{1}{m} \cdot X^T (h - l) \tag{13}$$

The weights are updated as below:

$$\beta = \beta - \alpha \cdot \frac{\delta J(\beta)}{\delta \beta} \tag{14}$$

Where: α- it is usually 0.1

Classifier synthesis

The output values from classifiers can be interpreted as the similarity of patient documentation $d_i \in D$ to the ICD code $l \in L$ and saved in the following form [3]:

$C_1^l(d_i) = f_{d_i}^1(l)$ - similarity rate for classifiers based on TFIDF.

$C_2^l(d_i) = f_{d_i}^2(l)$ - similarity rate for classifiers based on word2vec.

Tab. 2 Sample similarity ranking

L	1	2	3	4	5	6	7	8	9	10
f_d^1	0.31	0.42	0.51	0.62	0.62	0.54	0.54	0.31	0.22	0.51
f_d^2	0.62	0.73	0.62	0.42	0.33	0.23	0.15	0.11	0.11	0.51

Source: own calculation

Patients clinical notes may have multiple ICD codes assigned. As we can see from the example in Tab. 2, different observations are identified differently by classification functions, it means that each classifier has a different information potential and there is variation between classifiers. This feature is useful in combining classifiers [6] [14]. An interesting proposal for solving this type of problems is offered by the multi-criteria optimization theory [1-4]. By creating an appropriate R synthesis model, we can define a task in the form (Y_{d_i},R). Set Y_{d_i} will be the ranking image of the set L for observation $d_i \in D$, given by function f_{d_i}.

$$Y_{d_i} = f_{d_i}(L) = \{y = f_{d_i}(l) \in R^2\} \tag{15}$$

Element $y \in f_{d_i}(L)$ is the image of the label l in the sense of its evaluation by all functions $f_{d_i}^n(l)$ understood as the level of similarity of observations $d_i \in D$ to the ICD code $l \in L$. The synthesis relation shall be the following relation:

$$R \subset f_{d_i}(L) \times f_{d_i}(L) = Y_{d_i} \times Y_{d_i} \tag{16}$$

Defined as follows:

$$R = \begin{Bmatrix} (y,z) \in Y_{d_i} \times Y_{d_i} | \\ "committe\ prefers\ y\ then\ z" \end{Bmatrix} \tag{17}$$

The solution of this task will be the Pareto set, i.e. the set of these ICDs from the pre-estimate set from which there are no more probable, this set will be marked with the symbol [2-4]:

$$Y_{d_i}^{RN} = \begin{Bmatrix} y \in Y_{d_i} | does\ not\ exist\ z \in Y_{d_i} \\ z \in Y_{d_i} - \{y\}, such\ y \leq z \end{Bmatrix} \tag{18}$$

The L_d^{RN} set is a counter image of the Pareto Y_d^{RN} set, the most probable ICD codes, based on the examples from Tab. 2, are:

$$L_{d_i}^{RN} = f_{d_i}^{-1}(Y_{d_i}^{RN}) = \{l \in L | f_{d_i}(l) \in Y_{d_i}^{RN}\} = \{l_2, l_3, l_4\} \tag{19}$$

By calculating the distance of images of these ICD codes from $y^* = (y_1^*, y_2^*)$ so-called ideal point, we can create a ranking of codes for further classification [3]. The coordinates of point y^* should be determined as follows:

$$y_1^* = max\, f_{d_i}^1(l), y_2^* = max\, f_{d_i}^2(l) \quad (20)$$

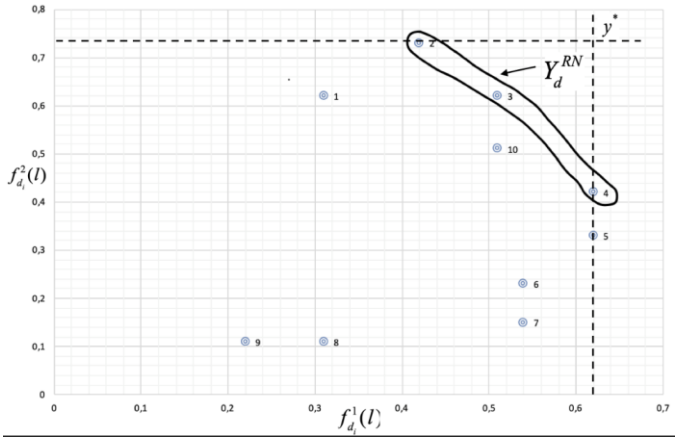

Fig. 1. Front Pareto
Source: own calculation

Conclusion

The paper presents the method of automatic assignment of ICD codes based on semantic information contained in clinical reports of the MIMIC-III database. The method uses classifiers based on the logistic regression model and two different extraction feature method. In the previous chapter showed the possibility of using multi-criteria optimization methods for sample classifiers fusion in a more precise classifiers complex. My future research will focus on studying a wider class of classifiers and trying to merge them, thanks so that I will try to get even more accurate attribution of ICD codes for clinical notes. Even more accurate automation of assigning ICD codes will make the clinical process more efficient and can help clinicians carry out better diagnostics and effectively improve medical care systems.

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HIV BIOLOGY AND MECHANISMS OF INFECTION

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Abstract:

Human immunodeficiency virus (HIV) is classified into two species: HIV-1 and HIV-2. Both of them are capable of causing acquired immunodeficiency syndrome (AIDS), which is the most advanced stage of HIV infection. Targets for HIV are CD4-positive cells: Th-lymphocytes, monocytes, macrophages, dendritic cells – key components of human immune system. To pursuit of knowledge about the HIV replication cycle, pathogenesis, and course of infection is crucial for designing new diagnostic tests, antiviral drugs and vaccines. The eradication of HIV infections and finding a cure for AIDS are some of the most challenging aims for today's medicine.

Keywords:
human immunodeficiency virus, retrovirus, reverse transcriptase, acquired immunodeficiency syndrome

Introduction

Human immunodeficiency virus (HIV) is part of *Ortervirales* order, member of *Retroviridae* family and *Lentivirus* genus [4] (Fig. 1). Retroviruses got their name because they counter the Crick's Central Dogma (DNA→RNA→protein). Reverse transcriptase, a unique enzyme enclosed within retroviral capsids, has ability to reverse the flow of genetic information (RNA→DNA). Retrovirus replication cycle displays several characteristics which distinguish this family from many other viruses. Integration a proviral DNA into host genome is typical example. Retroviruses may cause changes in cells (transformation), what can lead to oncogenesis [1].

Human immunodeficiency virus (HIV) is classified according to its genetic structure and viral antigens into two types: HIV-1 and HIV-2 [1]. A large majority of HIV infections worldwide is caused by HIV-1, while prevalence of HIV-2 is restricted to some regions in West Africa. Both types can potentially cause acquired immunodeficiency syndrome (AIDS) [2]. However, HIV-2 is less virulent and infective than type 1. It is observed, that time necessary to progress to AIDS is much longer in case of HIV-2 [3].

Both (HIV-1 and HIV-2) are the result of multiple cross-species transmissions of *simian immunodeficiency virus* (SIV), which infect African non-human primates [5]. The majority of transmission events was restricted to a relatively small group of infected people. However, in effect of SIVcpz transmission from chimpanzees to human, group M HIV-1 emerged and caused AIDS

pandemic [5]. Nine subtypes: A to D, F to H, J and K has been distinguished within group M HIV-1. They differ by at least 15% [6]. Recombination between different HIV subtypes (and types) is a common phenomenon. When one cell is infected by two virus particles classified to different types or subtypes, fragments of their nucleic acids may be exchanged. Progeny with mixed genome is referred to as recombinant. It has been estimated that about 20% of HIV-1 group M members are recombinants [7]. They are called CRFs (circulating recombinant forms) and deposited in HIV sequence database [8]. Intergroup recombination may also happen, for example – between group O and M in Cameroon [9]. However, recombination between HIV-1 and HIV-2 has not been described so far [1].

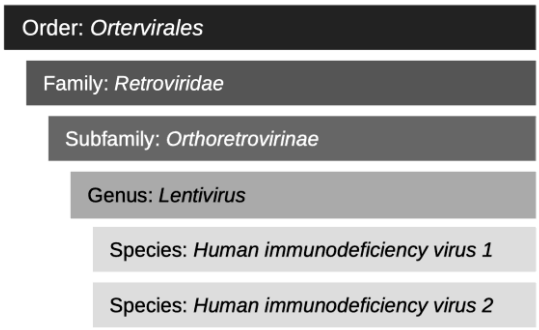

Fig. 1. Taxonomic classification of the HIV
Source: International Committee on Taxonomy of Viruses (ICTV)

Structure of the HIV viral particle

HIV particles are round (100 nm diameter) and enveloped [1] (Fig. 2). In the bilayer membrane key components of the HIV infection process are localized. The trimeric transmembrane protein (TM or gp41) anchors the trimers of surface protein (SU or gp120). Together, they form a knob-like structure, although binding between gp120 and gp41 is not covalent. Both glycoproteins are products of the *env* gene encoding a polyprotein [10]. Below an envelope there is matrix consisting of the p17 (matrix protein, MA). Core capsid is localized inside matrix layer. It is built of the p24 (capsid protein, CA) and contains two molecules of (+)ssRNA, associated with nucleoproteins (NC) and enzymes bound to viral RNA: invertase (IN) and reverse transcriptase (RT). There are 500-100 molecules of RT per virus particle [1].

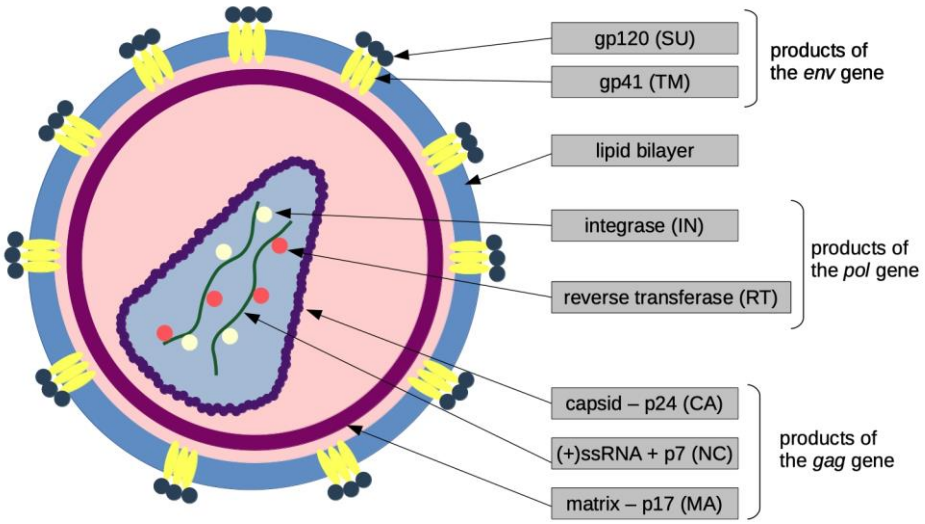

Fig. 2. Structure of the HIV-1 viral particle with genes encoding particular proteins. Abbreviations: gp – glycoprotein, SU – surface protein, TM – transmembrane protein, p – protein, CA – capsid protein, NC – nucleoprotein, MA – matrix protein
Source: [1, 2]

Genome of the HIV

Retroviral genome consists of two identical copies (+)ssRNA associated with NC and is localized within the core of the viral particle. RNA dimer explains why retroviruses are relatively resistant to UV and ionizing radiation: every viral particle has two copies of all genes.

HIV genome encodes three major genes: *env*, *gag*, *pol* (Fig. 3). Each of them encodes a polyprotein. After cleavages fragments of them frequently perform similar functions (Tab. 1).

Several regulatory proteins are also coded within the HIV genome. Their expression is activated at different stages of HIV replication cycle [11]. Few examples: Tat (transactivator protein) promotes the expression of viral genes, Vpr (virus protein r) is responsible for arrest of cell cycle, and Vif (viral infectivity factor) which is for successful infection *in vivo* [12].

HIV genome is flanked by LTR (long terminal repeat) sequences. Within 5'LTR is localized promotor for viral genes' transcription that plays key role after converting into DNA and integration into host genome [2].

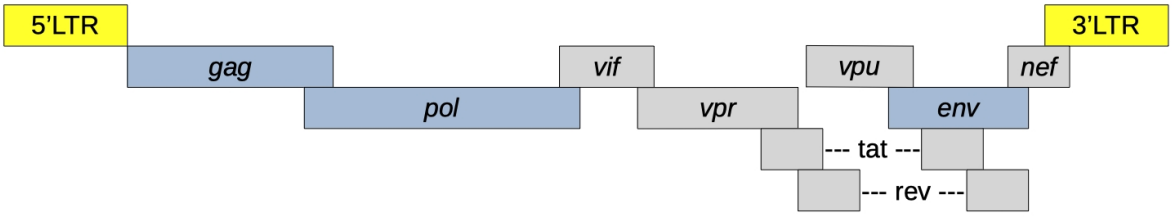

Fig.3. Schematic organization of the HIV genome. Structure genes (*gag*, *pol*, *env*) are blue. Regulatory and accessory genes are gray. Abbreviations: LTR – long terminal repeat, *gag* - group-specific antigen, *pol* – polymerase, *env* – envelope, *vif* - viral infectivity factor, *vpr* - virus protein r, *vpu* - virus protein unique, *tat* - transactivator protein, *rev* - RNA splicing regulator, *nef* - negative regulating factor
Source: [1, 2]

Tab. 1. Structural HIV-1 genes, their products with function

gene	products	functions
gag	p24 (capsid protein, CA) p7 (nucleoprotein, NC) p17 (matrix protein, MA) p6	structural proteins of the core responsible for formation of nucleoprotein, capsid, and inner membrane as well as release of the viral particle
env	gp120 (surface glycoprotein, SU) gp41 (transmembrane protein, TM)	envelope glycoproteins involved in recognizing receptors on the cell surface, responsible for attachment and fusion of viral and cell membrane
pol	p10 (protease, PR) p51 (reverse transcriptase, RT) p15 (RNase H) p32 (integrase, IN)	key enzymes for viral replication, answerable for converting viral ssRNA into proviral dsDNA, its later integration into host chromosomal DNA, PR cleaves Gag and Pol protein precursors

Source: [1, 2]

The HIV replication cycle

Viral envelope knob-like complexes composed of gp120 and gp41 are crucial for initial steps of infection. The HIV entry pathway starts with protein-protein interaction: gp120 and CD4 receptor (Fig. 4). The later - cluster of differentiation 4 – plays a crucial role in communicating between T-lymphocytes and APCs (antigen-presenting cells). CD4 is a co-receptor of the MHC II (class II major histocompatibility complex) [13]. A plurality of immune cells is CD4-positive: Th lymphocytes (T helper), T-cell precursors (localized in thymus and bone marrow), DCs (dendritic cells), monocytes and macrophages, astrocytes, eosinophils [1].

After initial gp120-CD4 interaction conformational changes occur that enable binding to additional proteins. The most common co-receptors of HIV are: CXCR4 (chemokine receptor 4) and CCR5 (chemokine receptor 5), although more have been recognized [14], [15]. The first one is localized on the T-lymphocytes and many other human cells, while CCR5 is present on DCs, monocytes, macrophages and, activated T-lymphocytes. The double binding provides stable attachment between a viral particle and a host cell surface. Interaction between gp120, CD4 receptor and co-receptor triggers further conformational changes in viral gp120 and gp41 proteins. The second viral protein contains a fusogenic hydrophobic peptide on the N-terminus. In effect cell membrane fuse with a viral envelope. Subsequently the HIV viral capsid is translocated into the host cell cytoplasm and partially uncoated [16]. After that viral nucleic acids and viral enzymes are released into the cytoplasm [1].

Processing of viral genetic material can be divided into few steps: firstly (i) reverse transciptase converts (+)ssRNA genome into cDNA (complementary DNA). After that, (ii) RNase H makes endonucleolytic cleavages of the RNA strand in hetero-duplex DNA:RNA. Finally, (iii) DNA-dependent DNA polymerase activity of RT converts cDNA (single-stranded) into double-stranded proviral DNA. What is significant DNA synthesis is slow and error-prone phenomenon.

A mutation rate is estimated at 1 in 10^4 nucleotides per genome per replication cycle. Plenty of quasispecies are produced during a course of infection as a result. Because of substitutes in amino acid sequences, HIV properties are changing over time in the same host individual [1].

HIV proviral dsDNA in form of PIC (pre-integration complex containing viral IN protein) is then transported into the cell nucleus where integration into host chromosome take place. Viral enzyme called integrase (IN) catalyzes this reaction. Place of integration is generally random. Provirus becomes a permanent part of host genome. there is no mechanism for precise excision of integrated proviral DNA. As a result, HIV infection is referred as persistent.

During the HIV replication cycle there is no viral DNA replication and no viral RNA replication. Proviral DNA directs the host transcription machinery to synthesize many copies of viral mRNA. Tat's (p14) function is to accelerate viral mRNA's synthesis. This protein binds to the TAR (Transactivation Response Element) at the 5` end of the HIV mRNA and stimulates further transcription [1, 17]. Viral mRNA is transported into cytoplasm where is translated into proteins or encapsidated into virus particles.

Formation of viral particle is a stepwise phenomenon. Two (+)ssRNA molecules associate together with nucleoprotein (NC), reverse transcriptase (RT), and integrase (IN), after that structural proteins assemble over them. Immature virus particles migrate toward a host cell membrane and begin to bud, simultaneously acquiring fragments of host membrane enriched with gp120 and gp41 [2]. It takes about 24 hours from entry to release the first progeny viruses [18]. Virions' budding mechanism is quite different in case of monocytes and macrophages. They are accumulated within intracellular vacuoles and then release together into the extracellular fluid.

Infected T-lymphocytes are eliminated in several ways: (i) exaggerated HIV viral particles production resulting in cell lysis, (ii) activity of cytotoxic T lymphocytes (Tc, part of antiviral immune response) and, (iii) because of cytotoxic HIV components in intracellular environment [19]. Moreover, newly produced lymphocytes do not perform effectively their functions and targeted by circulating virions. Significant decline of Th-cells is observed. So, in effect symptoms of immunodeficiency are shown [20].

HIV has the ability to lie dormant within infected cells. Latency is a state of convertible and nonproductive infection. Expression of viral genes is stabilized on a relatively low level, so production of progeny particles is practically stopped. Infected cells with long lifespan e.g. memory T-lymphocytes, macrophages, microglial cells seem to be important and stable latent HIV-1 reservoir. Production of virus particles by these cells may be dramatically accelerated as a result of virus activation [1, 2].

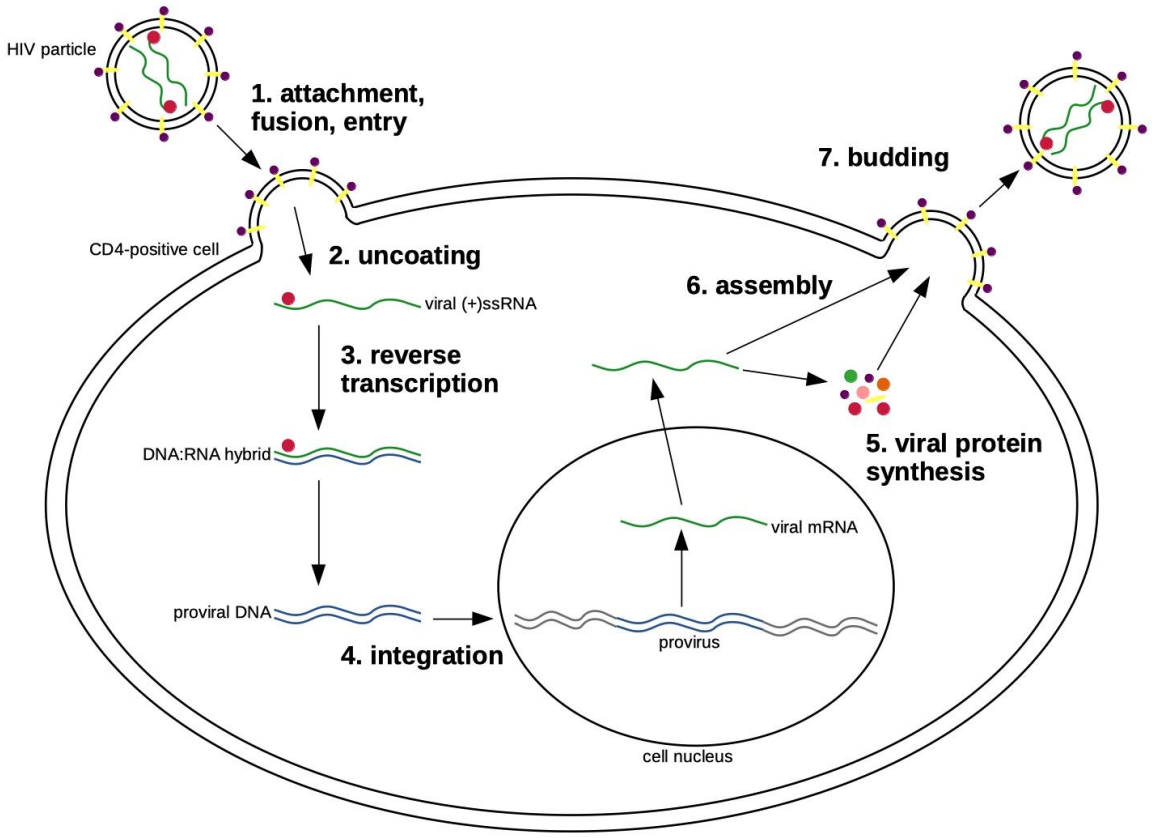

Fig. 4. The HIV replication cycle – schematic wiev. It can be summarized in six steps: (1) binding, cell membrane fusion with a viral envelope; (2) uncoating, when HIV viral capsid is translocated into the host cell cytoplasm; (3) converts (+)ssRNA into proviral DNA by reverse transcriptase (RT) and RNase H; (4) integration of proviral DNA into host chromosome by integrase (IN); (5) transcription of viral mRNA and synthesis of HIV proteins; (6) formation of viral particle; (7) budding – release of the progeny viral particle.
Source: [2]

Course of the HIV infection

Prolonged HIV survival outside the bloodstream or lymph is unlikely. As a result, HIV transmission occurs in contact or transfer of blood, semen, pre-seminal and vaginal fluid, rectal fluids and breast milk. Virus can also enter the body via mucous membranes, injured skin and by parenteral inoculation [1]. HIV is mainly replicating into infected cells which transfer the virus regionally and to immune system cells (e.g. T-cells, macrophages, DCs) [21]. When transmitted by sexual contact, spreading into the bloodstream and regional lymphoid tissue is allowed by infected CD4+ lymphocytes and DCs [22]. Few days after entry virus can be detected in nearly lymphoid tissue [23]. After about 2 weeks – it is detectable in the whole body (also in nervous tissue) and can be found in lymphocytes [24]. After 3-6 weeks, non-specific infection symptoms are manifested: fever, malaise, lymph nodes enlargement, rash [25]. This phase persists next few weeks and is followed by asymptomatic period. Immunodeficiency is usually observed when the CD4+ lymphocytes declined to 300-400/µl. After period of well-being, long-lasting illnesses become more frequent, such progression to AIDS is characteristic feature of HIV infections [26]. AIDS is defined by complications, such as a serious infection or cancers.

Mycobacterium tuberculosis, *Toxoplasma gondi*, *herpes simplex virus* (HSV), and *cytomegalovirus* (CMV) are typical opportunistic pathogens, occurring in AIDS. Neoplasms development (such as Kaposi's sarcoma, carcinomas of the cervix and anus, B-cell lymphoma) is also commonly observed [11].

Conclusions

HIV has been one of the most studied pathogens in the last decades. General knowledge about infection, replication cycle, and pathogenesis is overwhelming. However, current treatment methods still do not meet our expectations. The main barrier is the presence of latent HIV reservoir: memory T-cells, DCs, macrophages. Applying antiretroviral drugs prevents virus from replicating, although production of virus particles by these cells is practically stopped. Nowadays, the main therapeutic approach is to find way to destroy latent reservoirs. Variable strategies are considering and testing: based on gene therapy and targeted at their reactivation.

Different viral subtypes and recombinant forms additionally exaggerate HIV prevention and treatment difficulties. It has been shown that there are some differences in infection cycle which are dependent on virus phylogeny and geographic origin [2]. HIV-1 infection still remains incurable. The development of approaches to eradicate HIV-1 infection will take time. However, this difficult task is believed to be doable. In the future HIV-positive result will not be equal a death sentence.

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IS *CINCO DE MAYO* AN IMPORTANT DATE IN THE MEXICAN OR AMERICAN ANNIVERSARY CALENDAR?

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Abstract:

Historical anniversaries are one of the many important elements that shape nationality identity. However, frequently anniversaries can be used to create historical policy. The aim of the paper is to present a new point of view, by analyzing historical and cultural factors, how the United States of America uses the Mexican victory from 1862 to create its relations with Mexico and the Mexican minority in the USA. The main reference concerns the diversion of attention by Washington D.C. from the American invasion of Mexico in 1846-1848.

Keywords:
Cinco de Mayo, USA, Mexico, temporal retrogression, anniversaries

Introduction

Since the dawn of time, human civilization has been trying to commemorate important events of the past in the form of holidays or o to be precise - solemn celebrations of anniversaries. It was especially important during the formation of nation-states in the New World to build a bond between people of the same nationality through common history. Many important dates, such as regaining independence, have permanently entered the calendar of public holidays. In America, however, there is a holiday that dates back to the nineteenth-century Mexico, which is more eagerly celebrated in the United States. It is *Cinco de Mayo*. The aim of the paper will be to present the issues related to this anniversary and indicating how important in establishing certain holidays is the phenomenon of shaping historical narration by emphasizing elements that may prove important for the policy of a particular country.

The nature of historical anniversaries

History is a science that presents us the past. There are several definitions, but one of the most concise and reflecting the nature of this discipline is the definition proposed by Aleksander Świeżawski. He presents history as a humanistic science dealing with the study of human past in

relation to its life in society, however, indicating that its main task is to study first of all the human activity that followed the invention of writing [1].

One of the most important elements building history, or narrative about the past based on sources, are the facts and the time in which they happened. They really create the essence of celebrating the past in the form of historical anniversaries. What exactly is an anniversary? According to the definition of the online Polish Dictionary of PWN [2], it is a day on the calendar each year after a fact that occurred in the past. The anniversary often is associated with the solemn celebration of a given fact that took place on that day in the past.

Following this trail, it is worth paying attention to an in-depth analysis of historical anniversaries. We can see that during anniversaries we usually pay attention to facts and people who were related in the past to the date on which the specific event took place. Thanks to the in-depth analysis of Maciej Janik, we can see that so-called mechanism of temporal retrogression (combining the value of past time with current reality), the anniversary receives clear ideological motivations related to politics, religion or culture. Therefore, that elements that are considered important for the present are commemorated from the past [3]. In addition, Janik argues that the calendar can be a tool for effective temporal propaganda. Many events that have taken place in the past are used to evoke appropriate emotions or political repercussions in today's world [4].

A specific aspect of the selection of historical elements is pointed out by Jan Żaryn, who says directly that every choice of anniversaries made and the way they are celebrated and commemorated is an application of historical policy [5]. And what is historical politics? Nothing more than the need to develop a proper interpretation and relation to certain events with which our events are related. There are many definitions of this phenomenon, but the remarks of Kazimierz Wóycik are worth emphasizing, who creating his own definition of historical policy, warns against the abuse of this policy. He mentions that it is often used to achieve specific political goals, not necessarily for the good of the general public [3].

Cinco de Mayo en 1862

One of such anniversaries, which is appropriately selected for the purposes of historical politics is certainly Cinco de Mayo, that is May 5. This date commemorates the victory of the Mexican armed group over the French army at the Battle of Puebla in 1862. It is mainly a regional holiday, celebrated loudly in the Mexican capital of the state of Puebla and in the entire state of Puebla, as well as, though to a lesser extent, in other parts of Mexico, and - which may seem somewhat odd - in the United States, especially where they are located large concentration of the Mexican minority. This is not, as many people think, Mexico Independence Day. This event is celebrated on September 16. (This date refers to the start of the process of independence by Mexicans. Numerous riots as well as political turmoil in Spain at the end of the first decade of the nineteenth century caused that in South and Central America began to form juntas, whose purpose was primarily to remove the sovereignty of royal power, because they demanded freedom and self-determination. As time passed, a general uprising broke out that did not cover only the territory of Peru and today's Bolivia. In Mexico, the viceroy blocked the creation of the junta, but on September

16, 1810, Catholic priest Miguel Hidalgo y Costilla initiated the fight to return the land to the Indians and abolish slavery. This struggle led to independence) [6].

The Battle of Puebla in 1862 took place in a difficult historical moment in the history of Mexico. This country, after more than a decade of fighting, finally gained independence from Spain in 1821, but the problems were not over. After a difficult and bloody fight, it was time for many internal frictions on the local political scene and subsequent armed conflicts, including the Mexican-American War (1846-1848) and the Mexican Civil War in 1858. All this completely ruined the national economy, especially since Mexico borrowed money to conduct military operations in several countries, including Spain, England and France. These countries demanded repayment, but France, pursuing an expansion policy, wanted to use the debt issue to establish its own leadership in Mexico. Despite the initial intervention of the three powers, Spain and England withdrew their intention to invade the US's southern neighbor, expecting the Mexican Congress to pay its debts as soon as the country's internal problems ceased. On the other hand, France did not follow in the footsteps of its European neighbors and, under the pretext of executing its debts, took independent actions to establish a relative of Napoleon III - Archduke Maximilian of Austria - ruler of Mexico [7].

The French army attacked the coast of the Gulf of Mexico along the state of Veracruz and began to march towards the capital. Although American President Abraham Lincoln was in favor of Mexico's independence (this position resulted from the Monroe Doctrine developed in 1823 which said that the American continent cannot be subject to further colonization or political expansion on the part of Europe, and the United States will not interfere in the affairs of European countries and their colonies) [8], he was unable to provide any support to the Mexicans because the US was involved in a civil war on its own territory. While marching towards Mexico, the French army encountered strong resistance near Puebla, in the Mexican forts Loreto and Guadalupe. Commanded by Mexican General Ignacio Zaragoza Seguin, a smaller, poorly armed group of soldiers defeated a bigger and better equipped French army, thus saving the country from further invasion. Victory was a glorious moment for Mexican patriots, it became a binder in building national unity. Unfortunately, the victory was short-term. After hearing the bad news, Napoleon III found the argument to send more soldiers abroad to try to attack Mexico again, despite the fact that the French population was clearly dissatisfied with this decision. He sent 30,000 soldiers and a year later Frenchmen had already defeated the Mexican army, took over the city of Mexico, and appointed Maximilian the ruler of Mexico [9].

Maximilian's rule in Mexico also lasted a short time, only three years, from 1864 to 1867. After the end of American Civil War , United States began to give Mexico more political and military support to expel the French, resulting in Maximilian being executed by the Mexicans [9]. So, despite France's re-invasion of Mexico, Cinco de Mayo honors the courage and victory of General Zaragoza's smaller armed group in the Battle of Puebla in 1862.

Celebrations in Mexico or in the United States?

Holiday Cinco de Mayo, which is celebrated in honor of the first spectacular victory over the larger, external invader, is primarily celebrated locally in the state of Puebla. Nevertheless, it gives

way to such anniversaries as Independence Day, even though it was declared a public holiday by President Benito Juárez on May 9 in 1862. Today it is not a statutory, but rather a customary holiday [10].

The anniversary of the battle is commemorated in the state of Puebla, where May 5 is a non-working day. Historical reconstructions are held there depicting clashes between the French army and the armed detachment of General Zaragoza. Also we can see various parades referring to Mexican folklore, as well as numerous feasts. In addition, there is the *Festival Internacional de Puebla*, which gathers national and international musicians and dancers [11].

However, it is worth asking why the anniversary of the victory of the Mexican armed forces at Puebla is more eagerly celebrated north of the Río Grande River. There are many reasons, including trade issues of the United States, which contributed to the promotion of this holiday, gaining more interest than in the south, and thus more income in the country of George Washington [12]. According to Courtney Kane from The New York Times, two weeks before May 5, more spicy sauces, tacos and other products of Mexican origin are sold than in other periods of the calendar year. A great example is the Mexican brewing industry, which reaches almost 100 million bottles sold [13]. In addition, this battle is eagerly commemorated among Mexican immigrants living in the US. In these areas, the festival is a celebration of Mexican culture, food, music, drinks and specific customs from Mexico. (This refers to a story about the joy of victory at Puebla. On May 27, 1862, the Spanish-language newspaper "La Voz de Mejico" proudly announced this news to the Mexican diaspora residing in American California. Mexican miners were so delighted with the news that they spontaneously shoot from guns into the sky and used fireworks, sang patriotic songs, and gave various praises in honor of the winners. Since then, May 5 has become a holiday for Mexican immigrants in the US. From the 1960s this holiday is more recognition by the american society) [14, 15].

Nevertheless, the White House's historical policy and its tool in the form of temporal retrogression play a huge role, because the Americans have pulled out much more elements than Mexico from this event. The event of the Mexican victory were to divert attention from the war that the Yankees had started against Mexico a few years before the French invasion. In the society of their southern neighbors, war in the years 1846-1848 are still alive.

The conflict from 1846-1848 was the result of a policy of establishing borders in the New World after the emergence of new independent states and imperial aspirations of the United States. Mexico firmly protested against an attempt to annex Texas to the United States and against Americans' offer to buy parts of northern lands, including California. In democratic Texas a referendum was held and its result caused that at the end of 1845 Texas already belonged to the USA. This led tensions at the border, which in the spring of the following year turned into an open war. US President James K. Polk had an ambition to set a new border, and some politicians wanted to enlarge areas open to slavery. The war proved disastrous for Mexico; The Americans took over New Mexico and California and attacked the northern provinces of Mexico. In September 1847, American troops under the command of General Winfield Scott conquered Mexico City and practically ended major military operations. Ultimately, as a result of the Guadalupe Hidalgo Treaty, Mexico was forced for $ 15 million to assign to the United States all of its northernmost territories,

including California and New Mexico (and today these are also other states such as Arizona, New Mexico , Utah, Nevada and partly Colorado and Wyoming). In addition, Mexico has relinquished its claims against Texas. Mexicans in the occupied areas became full citizens [8].

Fig. 1. George W. Bush during Cinco de Mayo
Source: https://georgewbush-whitehouse.archives.gov/news/releases/2007/05/images/20070504-11_d-0364-1-515h.html

The dissemination of information about another event among the world community, especially the Mexican one, was intended to divert attention from the American invasion and show that the invasion of European invaders was more tragic and disrupted the order established by Secretary Monroe. On the other hand, there is also a narrative regarding alternative simulations on this historical problem. According to the well-known Mexican historian Justo Sierra, victory of the French at Puebla on May 5, 1862 could be enable them to build a base, and then providing armed assistance Confederate States of America in the Civil War. France, as well as some European countries, sympathized more with the Confederation, because they wanted to maintain trade exchange on expensive and hard-to-reach cotton on the Old Continent [16]. This situation would change the fate of the United States, and thus issues of slavery [17].

Conclusion

The Battle of Puebla was certainly an important event in the history of Mexican statehood. It would seem that also in the history of the entire New World, if we analyze the relationship between US and Mexico policies on the example of uchronical analysis, which shows how important the result of this military game for the Civil War turned out to be.

The historical anniversary of Cinco de Mayo may also be one of the elements constituting a peculiar historical policy pursued not only by major players from Washington, but also by American society, which as a result of guilt tries to divert attention from the stain on the American honor.

The best evidenced of this is fact that politicians in Washington remained deaf to the first votes of diplomacy, and the US Congress proclaimed in early 1847 an act prohibiting peace

negotiations with Mexico under death penalty, in order to achieve their goals only and exclusively by conquest. It is noticeable that often in historical works concerning this war, the Americans were aware of their guilt. One of the signatories of the peace in Guadalupe Hidalgo - Nicolas Trist - claimed that the only thing this conflict brought to the Americans was not pride, but shame and regret for the decisions made by the most important politicians in the country in the years 1846 – 1848 [18].

In the case of this conflict The USA, known as the peace and independence gendarme, turned out to be brutal invader. In a similar way to Cinco de Mayo, Americans used religion and pop culture. In October 1895, during the coronation of image of Our Lady of Guadalupe, archbishop of New York Michael Augustine Corrigan invited to the ceremony, gave a toast in honor of "Our Lady of the Americas", which became a symbol of the unity of two neighbors [19]. On the other hand, in the pop culture, the symbol of the first superhero - Zorro was also used to justify American actions. The writer Johnston McCulley in 1919 in the novel The Curse of Capistrano, based on oral reports of an outlaw Joaquín Murrieta, who was acting as a defender of the poor and oppressed from the actions of the American authorities in California in the 1850s, presented the fate of young don Diego de la Vega, but from the turn of 1820 and 1846. Adapting the adventures of Zorro to the time before the war means that Americans create the image of then Mexico as bad and corrupt, in which it was necessary to intervene to save the interests of US citizens and maintain internal peace [20].

Thanks to such propagation of the Mexican victory, it was possible to create a product for political as well as cultural and economic purposes, connecting the Mexican minority in United States of America and turning Cinco de Mayo into the day of Mexican culture on American territory, thereby providing considerable profits to entrepreneurs every year in organizing this anniversary.

Summing up all these aspects, it must be realized that result of the battle of Puebla brought unexpected military, political or economic benefits to the Americans causing that this holiday (in spite of lack of an official status like others holidays in both Mexico and the US) is celebrated more eagerly in the United States.

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ORVIETO PAINTED WITH A POEM. JAROSŁAW IWASZKIEWICZ "W ORVIETO" ("IN ORVIETO")

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Abstract:

In the life of Jarosław Iwaszkiewicz, Italy played a decisive role, not only as a destination for his journeys, but mainly as an important element of his work, and this is best illustrated by the poem "W Orvieto" (In Orvieto), being an excellent example of ekphrasis. It was inspired by Signorelli's frescos in the Orvieto Cathedral. This poem not only refers to the work of art, but also is its interpretation, so it gains some symbolic sense and becomes a starting point for further reflections. The way in which Iwaszkiewicz presented the Signorelli's painting has become a stimulus to explore secrets of the Italian culture by successive generations of Polish writers, i.e., Herbert or Miłosz. Thus the culture not only can inspire, but also can connect the generations.

Keywords:
poem, art, Italian culture, Herbert, Miłosz

Works of Jarosław Iwaszkiewicz, abundant and diversified, present to us a poet who is exceptionally gifted and versatile. His literary output includes stories, novels, and essays, but also dramas, letters, articles and poems. The writer functioned within all literary genres with a great skill. However, particular attention should focus on his poetry, in which Aestheticism, Expressionism and Classicism are intertwined. Iwaszkiewicz's poetry is strongly embedded in the literary tradition. It draws both from the Polish and the European literature. It is abundant in its references to Baroque, Romanticism or Modernism. It is the poetry characterised by extensive sensual sensitivity, bringing the world presented in his poems within a reach of our hand. We can not only see it, but also touch, smell and hear it. In many cases the poet translates from the language of art to the language of poetry, using his poems as a medium. It was the Italian art that inspired him in particular. Therefore, it is not surprising that Iwaszkiewicz visited Italy so many times. Of course, his travels were not limited to Italy only, their spectrum was much more extensive, including, for example, Germany, Austria, Switzerland, France, Denmark, USSR, Spain or the U.S. This is one of the reasons why Iwaszkiewicz is perceived as a travelling writer. His works include all traditional genres being an account of a journey, such as letters in a form of a reportage or memoirs, but also an artistic journey. His works include many items dedicated to travelling,

e.g., "Pejzaże sentymentalne" ("Sentimental Landscapes") (1926), "Petersburg" ("Saint Petersburg") (1976), "Listy z podróży do Ameryki Południowej" ("Letters from a Journey to South America") (1954), "Książka o Sycylii" ("The Book About Sicily") (1956), "Podróże do Polski" ("Journeys to Poland") (1977), and "Podróże do Włoch" ("Journeys to Italy") (1977).

For Iwaszkiewicz, journeys also became a stimulus to considerations of an existential nature. Usually, a widely understood art, and the Italian art in particular, is a pretext for deeper reflections. Italy is a country where object of cultural heritage of the modern and the ancient art exist side by side. On one hand, they show to us a durability of the previous culture, while on the other they make us aware of inevitability of universal passing and fragility.

Therefore, it is not surprising that the writer so willingly returned to Italy. There were many other causes for Iwaszkiewicz's frequent visits to the homeland of Virgil. As a president of the Society for Polish-Italy Friendship, a member of jury of the Balzan Prize, and a member of organisations of European writers he frequently went to meetings and symposia, at which he could meet figures of cultural and political life. He went 30 times to Rome and 13 to Sicily. His first trip to Italy took place in 1924, and the last one in 1978, and then he was awarded the Mondello prize for his all works.

Iwaszkiewicz's fascination with Italy assumes different forms. They include reports from his journeys, such as "Książka o Sycylii" and "Podróże do Włoch", and prose works – "Nowele Włoskie" ("Italian Novellas") and lyrical novellas, including poems from volumes "Śpiewnik włoski" ("Italian Songbook") and "Inne życie" ("Other Life").

The volume "Inne życie" was published in 1938 and was the last one created before the war. It was unambiguously considered outstanding by the critics. Four poems should be noted here: "Wieczór późnej jesieni na polach pod Sieną" ("Late Autumn Evening in the Fields of Siena"), "Quintin Matsys","Breughel" and "W Orvieto" ("In Orvieto"). Czesław Miłosz wrote about them, adding also "Sonety sycylijskie" ("Sicilian Sonnets") from the same volume, that they were 'apparently the only Polish poems about the art that could be published in some journal entitled "A Man and the Art"'. These works, dedicated to painting, are the best manifestation of the poet's worship of the art. Some of them directly relate to a specific work or a motif, like "W Orvieto", other use intertextual references ("Wieczór późnej jesieni na polach pod Sieną"). What is characteristic for this volume, is its structure based on a contrast, a dichotomy. As Jerzy Kwiatkowski noted, "Wiersze 'Innego życia' occur between doubt and faith, between thoughts about death and a thought about resurrection, between despair and hope" [1].

Here we can find elements belonging both to the widely understood tradition of Baroque, but also to Classicism. In the case of the latter one, two concepts, Apollonian and Dionysian, are worth noting, around which the Iwaszkiewicz's poetry is focused. The poet skilfully oscillates between these two symbolic areas of the art. Iwaszkiewicz's Classicism is also the Classicism based on a unity of the Ancient and Biblical tradition, aiming at the universalisation of values.

The Classicism can also be found in the poem "W Orvieto", being, at the same time, an ekphrasis. In "Słownik wiedzy o literaturze" "(Dictionary of the Literature"), the following definition can be found: "It is both a description and an interpretation of a work of art, it is a representation of a representation, as it shows what was shown by someone else but using

different means of artistic expression (painting, sculpture, applied arts, etc.). The literary ekphrasis presupposes some fictitious or real picture. In the literary ekphrasis, the picture frequently plays a symbolic role and motivates actions of a lyrical hero or a character" [2].

Therefore, the ekphrasis not only refers to the work of art, the frescos of Luca Signorelli, but also represents their interpretation. Using the literary means, the poet presents the painting of the Italian artists to the reader. This way, the work of art gains a symbolic meaning and becomes a starting point for further considerations, particularly, because the poem is rich in numerous references to tradition, as it is already indicated by the subject of the poem being the resurrection. Furthermore, both the contents and the form of the poem are close to the ideal of the Classicist aesthetics. The very reference to the work of the Renaissance artist is a bow to the Classicism.

Although Iwaszkiewicz does not describe Signorelli's frescos in his poem, focusing only on selected details, the knowledge of the painting of the Italian artist is necessary to fully understand the meaning of this work, "for the reader to know that piece of art already and - even better - for it to have its place not only in the reader's erudite but also 'aesthetic' memory" [1], as Jerzy Kwiatkowski writes. It is actually recommended for the reader not only to know that work, but also to have a fundamental knowledge in the history of art, to facilitate correct understanding of Iwaszkiewicz's poem. It should be noted that the poet was particularly interested in the Italian art, similarly as in the nature, they both inspired him and he sought in them answers to his philosophical and existential questions [3].

Iwaszkiewicz selected resurrection as the subject of his poem. It was inspired by one of Luca Signorelli's frescos entitled "Resurrection of the Body". This painting belongs to a series of frescos entitled "The Last Judgement", adorning walls and ceilings of the Della Madonna San Brizio chapel in the cathedral in Orvieto. These paintings became exceptionally popular already during the Renaissance, and have continued to attract significant interest to this day. In Zbigniew Herbert's opinion, a vision of the Last Judgement depicted by Signorelli is even more perfect than the one of Michelangelo in the Sistine Chapel, as he writes in one of his essays entitled "Il Duomo", belonging to a collection "Barbarzyńca w ogrodzie" ("A Barbarian in the Garden"): "Finally, we can express that blasphemy against authors of textbooks: the frescos in Orvieto are much more impressive than Michelangelo's frescos in the Sistine Chapel. Michelangelo knew paintings in the San Brizio chapel and definitely was influenced by them, but the vision of the successor is tainted by the fading beauty, and the language, too flexible and free, rather wraps around the objects than expresses them" [4].

"The Resurrection of the Body", referring to the Apocalypse of John, shows to us, as its title already suggests, a moment of the resurrection. The dead arise, emerging from under the ground to the music of angels playing trumpets, surrounded with standards with the Cross of St. George. This cross is usually shown in the standard of victory held by the resurrecting Christ. This way, the artist reminds us that the resurrection of the humans was preceded by the resurrection of Jesus.

The dead getting onto the surface look both gruesomely and comically, because the process of resurrection progresses in stages. Some are still the skeletons, other already fully "dressed" on their bodies, all waiting for the Last Judgement. Some raise their eyes to heaven, other raise their arms up

in pleading, waiting for the great moment that is soon to come, and which is awaited by all Christians. The fresco of the Italian artist reminds about the other life, bearing its witness [5].

The poem shows that for Iwaszkiewicz the vision of the rebirth of the mankind presented by Signorelli is equivalent to a profession of faith in the resurrection of the body and the eternal life:

„We shall rise up a living body from the eternal gangrene
And we shall lift our eyelids upon our open eyes,
Over dead worlds and dead centuries,
Just like Luca Signorelli painted it" [6].

On a basis of the painting, the poet creates his own vision of the resurrection, without describing the fresco. He omits elements in the foreground, to focus on the details:

"Dant looks scared. The Singer of Agrigento
Sees what is coming and what is true,
He worships the resurrected life lying on his face "[6].

Of many people surrounding the frescos, including Petrarch, Boccaccio, Raphael or Columbus, Iwaszkiewicz recalls Dante and "The singer of Agrigento". Their selection is not accidental, taking into account Iwaszkiewicz's interest in the subject of the resurrection, as Dante in "Divine Comedy" also shows the history of mankind through the history of salvation, in which God's sacrifice in a form of a man is a moment decisive for redemption of all people. The love of the Creator to his creation proves to be stronger than death [7].

"The singer of Agrigento" i.e., the Greek philosopher Empedocles, believed in metempsychosis. He proposed that the human soul contains a divine particle, so it exists eternally. However, the body is a grave for it. A man should release the soul from the body, through religion and science, so it can join with the deity. When the man does not achieve this in a specific incarnation, the soul will wander endlessly [8].

The poem is also abundant with Biblical references. The resurrection is inseparably associated with bread and wine, symbolising body and blood of Christ. They are to remind us about the sacrifice that became a source of salvation, and, at the same time, of endless joy. Therefore, bread for the man is a basic food, giving us strength and keeping us alive. Wine, besides bread, also is a part of our daily food. It is one of important elements of Eucharist, during which Christians find joy in the presence of Christ Himself [9]:

"The wine, the bread will be experienced by our bodies of gold
A reborn cluster hanging on the deities' trunk" [6].

There is no doubt that the vision of resurrection presented in the poem is positive. It is filled with an atmosphere of miracle, and although it is built on fear, this is natural, taking into account the greatness of the work. The way in which Iwaszkiewicz presented resurrection perfectly matches

the structure of the poem. The poem was written in the Polish alexandrine, and with rhymes, which even increase its melodiousness and harmony. The poem is light, slightly archaic in its style, and this additionally emphases the importance of the described event. Everything is ideally harmonized. The influence of the Signorelli's painting is also important here, as it is a perfect example of the painting harmony, conforming to the Renaissance assumptions.

It can be said that both the painter and the poet agree in their vision of the rebirth of the mankind. A special understanding, a spiritual bond formed between Iwaszkiewicz and Signorelli [3]:

"Only then, Luca, will we understand that life
Is full of God's truth, not cruelly empty,
And that the angels truly gave us the lutes,
To sing openly – not to hum secretly" [6].

Furthermore, as a collective lyrical subject is used, when it expresses their thoughts, it identifies with the entire mankind, thus emphasising the feeling of the community.

Iwaszkiewicz believes that the art is to stimulate us to reconsidering our own life. He also reaches a conclusion that the artists and their works make it easier for us to find answers to the questions concerning our existence:

"Where would we take a greater proof of the truth of life
Than in such a resurrection from cold ash
With a burning body, with a soul suffering with others,
Like Luca Signorelli painted it?" [6].

Iwaszkiewicz is not the only poet fascinated with the work of the Italian artist. The Signorelli's frescos also became an inspiration for successive generations of the great writers. Before Herbert visited Orvieto, Miłosz, at Iwaszkiewicz' instigation, went there first. The painting made an enormous impression on him, as proven best by these words: "At every moment, I remember the fresco of Luca Signorelli in Orvieto, depicting the coming of the Antichrist. 'What a bitter colour! What a known horror! how much this painting tells about us!' The Devil's power. The wing of the Antichrist. A brother bringing ropes for his brother! A hateful crowd, killing each other. And in the margin, at the edge of the painting, two artists that are silent, not participating in the great feast of the false god. Lost in thoughts, they only watch, as we watch today, to encapsulate it later in hermetic forms, describing the truth only to the insiders" [10].

However, the frescos mainly became for him a pretext to reflections of a political, sociological and historiosophical character. To him, the Signorelli's work is a symbol of all-engulfing evil and lies, hidden under a mask of goodness. Miłosz, similarly to Iwaszkiewicz, notices details; however, in his case the saying that "the devil is in details" is most true: "The Antichrist is in a form of Christ. He points with his hand to his heart, wrapped in flames. His smile of goodness is somehow tainted with a grimace of irony, or maybe it is only the viewer's impression. But things happening at the margins of the painting prove who he really is: torturers kneel on breasts of their victims, strangle

them with a loop of rope or raise their knives to strike" [11]. Miłosz notices the Satan in the figure of Christ, a demon killing cunningly, both literally and figuratively. The Antichrist is actually a symbol of the totalitarian state that destroys the individual by killing their independent nature, taking away their soul and a hope for internal life.

On the other hand, Zbigniew Herbert notices mainly the artistic value of the Signorelli's frescos. He came to Orvieto 22 years after Miłosz, on his clear request, even command. In his letter to Miłosz, he gives a report on his stay: "So here I am, as you commanded me, in Orvieto. Everything is true: the grass in the square and the cathedral, which I walk around: I cannot cope with it at all. You must believe that my eyes are popping out, and only return to their place at night, and that not always" [12]. Herbert remains greatly impressed by the cathedral, both its exterior and interior, noticing the skill of the painter, who "transfers over the space of delicately sieved planes - sharp accents, light and shadow, and volumes, and his light always come from outside. Things and people are always vessels of darkness" [4]. Doubtlessly, the writer has a great knowledge of the history of art and exceptional sensitivity, and the subtle, poetical way of describing things impresses, also Iwaszkiewicz. "Some descriptions of the landscape, architecture or still art are simply descriptions of unpainted pictures" [13].

To Herbert, similarly as to Iwaszkiewicz, Italy is a special, it can even be said blessed, place. Thus it is place, to which you do not travel but rather go on a pilgrimage, and the works of art, particularly those on religious subjects, should incline the viewer to reflection and contemplation.

Furthermore, it is also clear that these three visions of the Signorelli's work, although they differ significantly in some aspects, have one thing in common. Each of these writers created a special bridge of words, which we can cross, gaining an exceptional chance to experience the mastery of the Italian art. So the words inspired by the art become a carrier of the cultural heritage of the whole mankind. The poet's task, on the other hand, is to write in such way "that the whole poem recalls images to the eyes of the reader" [14].

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INITIAL CLEANING OF VARNISHED ALUMINUM COATINGS BY CHEMICAL METHODS FOR FOUNDRY PURPOSES

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Abstract:

Aluminum is one of the most popular non-ferrous metals. It is a metal with a number of advantages and the wide spectrum of applications, that why it is so popular and valuable for metallurgical industries branch.. In today's world, the issue of recycling possibilities is of great importance. One of the strategic options for obtaining secondary aluminum is the packaging industry including beverage cans. However, this is problematic waste due to the protective varnish used in their production. The work attempted to develop a chemical method that allows cleaning the can of protective varnish layers without significant damage to the surface of the precious material.

Keywords:
aluminium, cans, recycling, chemical methods, removal of protective coatings

Introduction

Aluminum is one of the most important metals used today in the steel industry. Considered as the material of the future, it was obtained on an industrial scale for the first time in 1886 by electrolysis [1].

Aluminum is a silvery-white metal with many desirable features that make it popular for many applications. Lightweight, non-toxic, non-magnetic, non-sparking, able to conduct heat and electricity as well. It is a soft and ductile metal, so it can be easily cast, molded and extruded. In order to improve its functional properties, it is doped with small amounts of other elements, such as iron, silicon, zinc, copper, magnesium, tin, titanium or lithium [1, 2].

In its elemental form, it is very reactive and naturally never occurs as a free metal. Aluminum compounds constitute about 8% of the earth's crust and are found in the form of ores, bauxites whith could be found in the areas of Africa, West India, South America and Australia [1, 3].

Primary aluminum

Bauxite minerals contain up to 60% alumina hydrates and constitute the basic raw material of primary aluminum. Over the years, scientists have discovered and identified several forms

of hydrated alumina compounds. In this group we distinguish such varieties as gibsite, bajeryt, bohemite, diaspora. These hydrates subject to high temperatures undergo decomposition, from which we obtain aluminium oxide in various forms, where the last phase is always corundum (α-Al_2O_3). The transition to the alpha phase depends significantly on the temperature increase (Fig. 1) [4, 5].

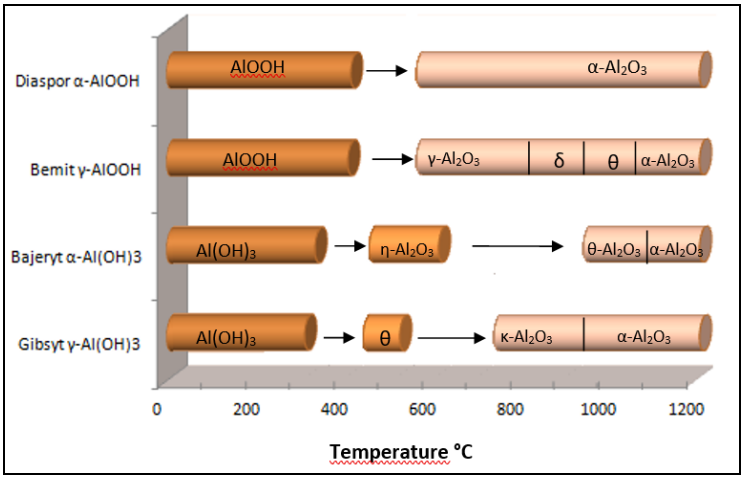

Fig. 1. Scheme of aluminum hydroxide decomposition as a function of temperature.
Source: Adapted from Łodziana [5]

Primary aluminum production is divided into two basic stages. The first is to obtain Al_2O_3, which in the second, final stage, by electrolysis is used to obtain pure aluminum.

Anhydrous, pure Al_2O_3 is obtained by reacting raw materials rich in aluminum with alkali (NaOH or Na_2CO_3) or acids (H_2SO_4, HCl, HNO_3, H_2SO_3) [6, 7].

Acid methods rely on leaching of aluminum ore with acid solutions. As a result, aluminum and ferric salts are obtained. Then the product is purified from iron by calcination and thermal decomposition, where finally we get anhydrous alumina [6].

One of the most popular and most commonly used alkaline processes for obtaining anhydrous Al_2O_3 is the process patented in 1888 by C.J. Bayer. This process takes several gradual. Initially, from powdered bauxites mixed with sodium hydroxide base in autoclaves at appropriately selected conditions of elevated temperature and pressure (depending on the ore being processed) we obtain sodium aluminate and waste so-called red mud (iron oxides, silicates). Sodium aluminate is then purified and placed in electrolysers, where crystalline aluminum hydroxide is obtained, which is finally dehydrated by calcination at a temperature above 1000°C [7, 8]. The next stage of primary aluminum production is obtaining pure metal from the separated Al_2O_3. This oxide is dissolved in a suitable electrolyte containing molten cryolite (Na_2AlF_6). Overall, the electrolysis takes place in tanks with carbon lining, where the cathode is the body of the tank, and the graphite anodes are immersed in the electrolyte. In this way, metallic aluminum is separated, in which the main impurities are iron and silicon. In order to purify the final product, metallurgical aluminum (99.8% - 99.95% Al), an additional process is carried out, which is electrolytic refining or zonal melting.

Unfortunately, the process of obtaining aluminum from primary raw materials is very energy-consuming. In modern factories producing aluminum for industry, it is estimated that about 12 kWh of energy is used to produce 1kg of metal [6, 7].

Secondary aluminum - recycling

Considering the widespread use of aluminum in the chemical and mining industry (production of explosives), food packaging (cans, thin films) and in medicine (dentures), its recycling is extremely important for economic and environmental reasons. Obtaining 1kg of secondary aluminum requires significantly less energy expenditure, where only 5% of energy required to obtain aluminum from bauxite ore is consumed [7 - 10]. A significant increase in the use of aluminum material in which aluminum raw material is obtained from secondary sources has been noticeable since 2000. Currently, the use of recycled aluminum has been widely implemented and has a significant impact on reducing the use of primary raw materials to reduce environmental pollution due to the very extraction of aluminum [11].

The recycling of aluminum packaging used in the food industry, including beverage cans, is a major challenge for waste management. Contemporary beverage containers are not a hazardous waste group, but they are quite problematic in relation to the recovery process.

Individual elements of the can, such as the body, the lid and the seal are made of various compositions of reactive metal alloys, as shown in Tab. 1 (the data in the table is used as a reference to the production of cans, according to American Society for Testing Materials: ASTM) [12]. These packaging are quickly degraded in contact with the atmosphere or aggressive environment [8, 13]. Therefore, for protection, a varnish layer is applied to the surface of the packaging.

The only economic method of recovering aluminum is to remel the used cans. However, direct remelting, without prior degradation of the varnish, is economically unprofitable due to the low yield and for ecological reasons. When conducting such a process, substances harmful to man and the environment are released. Very large amounts of carbon oxides and dust, including coal dust, and sulfur dioxide are released into the biosphere. The dusts also contain heavy metals [2, 8, 14]. To prepare aluminum waste for remelting and use, it is necessary to remove the protective coating without damaging the material. Mechanical, thermal, chemical and biochemical methods are used to remove protective coatings [15].

Modern industry associated with secondary aluminum rarely uses chemical methods for the initial preparation of scrap metal in the recycling process. This is due to the occurrence of a number of difficulties associated with complete cleaning of the element, with emerging waste or inability to disassemble the cleaned detail.

Therefore, today's technologies are primarily based on the drying of aluminum chips and the thermal removal of unwanted coatings, as well as milling and other mechanical processing, and in the case of sheepskin or salt slag arising in the metallurgical process, concentration methods are used [14, 15].

The use of chemical methods, also known as "wet" methods, involves cleaning components using acid solutions, alkali solutions, or organic solvents. They require a thorough knowledge of the processes and reactions that the material undergoes in contact with the substances used. This also means that the same formulation cannot always be used for all metallic waste groups. Its selection

largely depends on the type of material being processed, the type of protective coatings used (most commonly used lacquers for coating metallic surface are based on oleoresinous, vinylic, acrylic, phenolic, and epoxy-phenolic), and the quality of scrap metal. In these methods, the choice of substances used must be the result of the possibility of gradual penetration of solvent into the coating, causing its swelling and in the final stage of breakout or gradual dissolution [14-17].

Tab. 1. Chemical compositions of alloys used in the manufacture of aluminum cans

Components	**Si (%)**	**Fe (%)**	**Cu (%)**	**Mn (%)**	**Mg (%)**	**Zn (%)**	**Cr (%)**	**Ti (%)**	**Other (each) (%)**	**Other (total) (%)**
Body (ASTM Al alloy 3004)	0.3	0.70	0.25	1.0-1.5	0.8-1.3	0.25	-	-	0.05	0.15
Lid (ASTM Al alloy 5182)	0.2	0.35	0.15	0.2-0.5	4.0-5.0	0.25	0.10	0.10	0.05	0.15
Seal (ASTM Al alloy 5082)	0.2	0.35	0.15	0.25-0.4	3.3-4.0	0.25	0.15	0.10	0.05	0.15

Source: Adapted from Holzschuh [8]

The presented work focuses on striving to effectively remove the paint layer, using chemical methods. On the basis of the information available in the specialist literature and on the basis of own knowledge in the field of chemistry, the conditions of the experiment, the substances used and their concentrations were selected in such a way that the extent to which the solvent fulfills its role and does not cause serious damage to the tested material can be observed.

Objective of the work

The main purpose of the research was to find a mixture of solutions, which would allow the cleaning of aluminum can samples, both from the outer paint layer and from the inner layer of colorless varnish isolating the food product. In addition, the indirect goal was to check how individual solutions affect the tested material and to what extent cause its degradation in the purification process.

Material and methodology

In order to examine the effect of selected solvents on the varnished surface of the aluminum packaging on beverages, samples in the form of small plaques were prepared. The plates were made by cutting an aluminum can, after an energy drink from a known producer, into rectangular pieces of similar size. Next three types of mixtures were prepared. The composition, concentration and volume ratios of the substances used are given in Tab. 2.

Tab. 2. Mixtures used to clean the surface of aluminum can samples

Mixtures	**Proportions**	**The percent concentration of acid or alkali solution**			
H_2SO_4 + Ethanol	1:1	1%	5%	10%	20%
NaOH + Ethanol	1:1	1%	5%	10%	20%
Ethylene glycol + Oxalic acid	1:1 oraz 1:2	----	----	10%	----

Source: own source

The metal plates were placed in a glass beaker (200 cm^3), into which 20 cm^3 of the prepared mixture was introduced. The samples were treated with reagents for the following time:
a) H_2SO_4 (in all concentrations) + Ethanol: 24 hours
b) NaOH (in all concentrations) + Ethanol: 24 hours
c) Ethylene glycol + 10% Oxalic acid (in both proportions): 1 hour.

In the absence of visible effects of the "cold" process, heating was additionally carried out in a water bath. Heating was carried out at 90°C for 1 hour. After the purification process was completed, the samples were removed from the vessel, washed with distilled water and dried. Finally, the samples were vertically included. Sample 0 was additionally prepared, which was a plate that was not subjected to the purification process.

The surface thus prepared was examined using a scanning electron microscope having an X-ray energy dispersion spectroscopy detector (SEM-EDS).

Results

The use of prepared mixtures gave very different end effects. Depending on the type of solvent used (acid, alkaline, organic), different behaviors of the aluminum surface were observed.

In the case of an acid solvent (H_2SO_4 + Ethanol), positive effects were obtained after 24h at concentrations of 5, 10 and 20%. For a solution containing 1% H_2SO_4, an additional factor should be used, which was the increased temperature. At lower concentrations, a change in the surface structure of the plaque was observed. Samples became white, dull. Presumably, a passivation reaction occurred on the surface, causing it to become covered with white Al_2O_3. In contrast, pieces of varnish layer floated in the solution (Fig. 2).

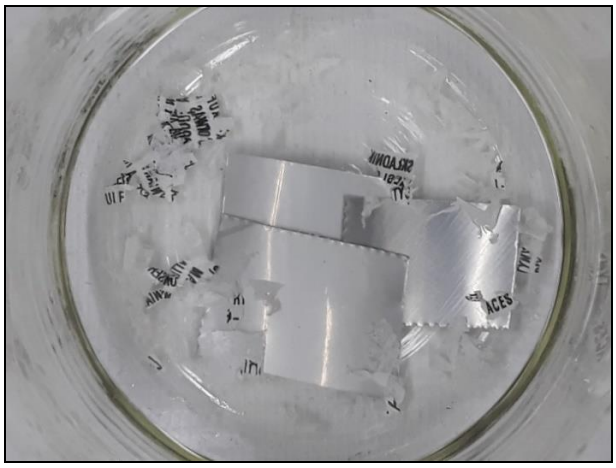

Fig. 2. Metal plates treated with H_2SO_4 + Ethanol
Source: own study

In the case of an alkaline solvent (NaOH + Ethanol), after 24 hours, positive effects were obtained at 1% concentrations, with a higher than in the case of acids, higher level of etching of the tested material could be observed. Higher concentrations caused an aggressive reaction with the metal surface causing intense gassing and complete metal transition into solution. The resulting solution turned brown - black (Fig. 3 a-d).

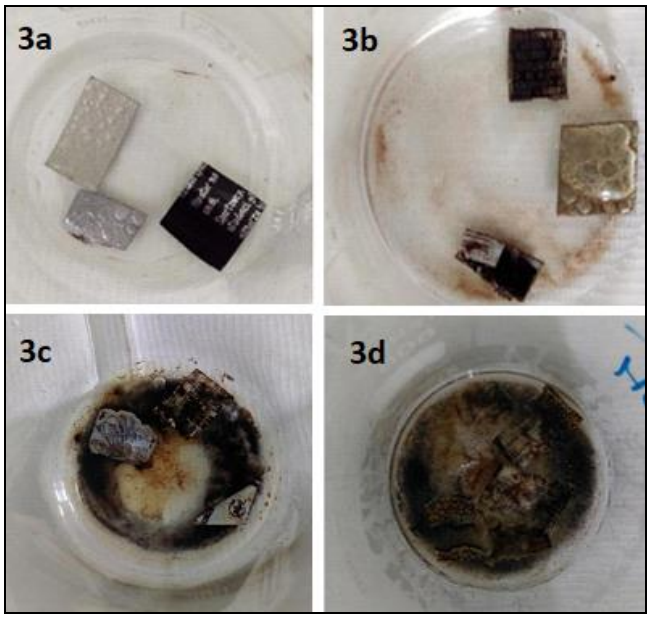

Fig. 3. Metal plates treated with NaOH + Ethanol:
a) 1% NaOH, b) 5% NaOH, c) 10% NaOH, d) 20% NaOH
Source: own study

In the case of an organic solvent (Ethylene glycol + 10% Oxalic acid), the best results of cleaning painted surfaces were observed. The purification process took much less time than in the case of acidic or alkaline solvents. However, to initiate the process, it was necessary to use an additional factor, which was an elevated temperature. The surface of the metal plate did not cover with any coating and showed a small degree of degradation in the environment used (Fig. 4 a-b).

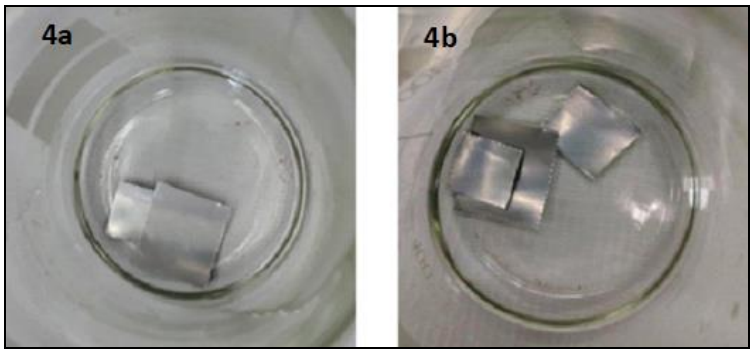

Fig. 4. Metal plates treated with Ethylene glycol + 10% Oxalic acid: a) proportion 1:1, b) proportion 1:2
Source: own study

Comparing the images obtained using the SEM-EDS technique for sample 0 (Fig. 5) and for samples treated with solvents (Fig. 6-8), it is clearly seen that the degree of material degradation is varied. At the same time, elemental analysis of individual layers was performed to distinguish them. The layer of colored varnish contained titanium (dye - titanium white).

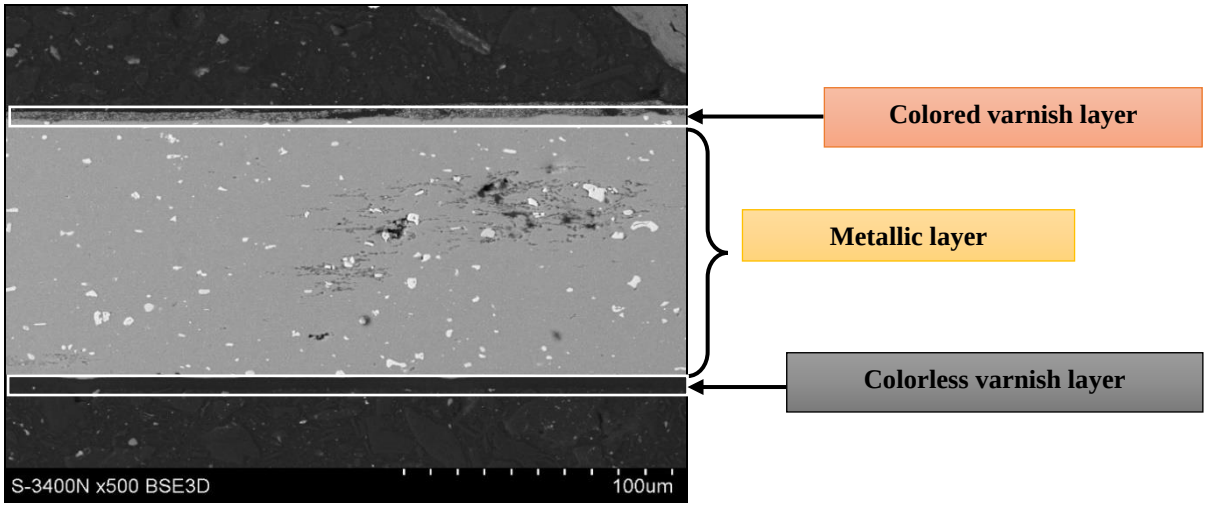

Fig. 5. SEM-EDS: Metal plate out of treatment by solvents - sample 0
Source: own study

The solvent prepared with 1% NaOH showed the greatest affinity for the metal layer. It caused changes in the surface of the tested material, just below the varnish surface without its degradation. It also caused visible changes in the layer of colored varnish, which increased its volume compared to sample 0 (Fig. 6).

Similar surface changes were observed in the photos taken for the metal sheet placed in the solvent containing 1% H_2SO_4 solution, with complete disappearance of the colored varnish layer (Fig. 7). In the case of higher concentrations of the acid used, significant differences in the effect on the metallic layer could be seen. One could see the etching of the metallic layer and the total disappearance of the colored varnish layer, without other changes in the structure of individual layers of the lamellar (Fig. 8).

Solutions containing ethylene glycol and oxalic acid worked identically regardless of the volume ratio used. On the obtained images one could observe the disappearance of the colored

varnish layer and a slight etching of the metallic layer. There were no other significant changes in the structure of the tested material (Fig. 9).

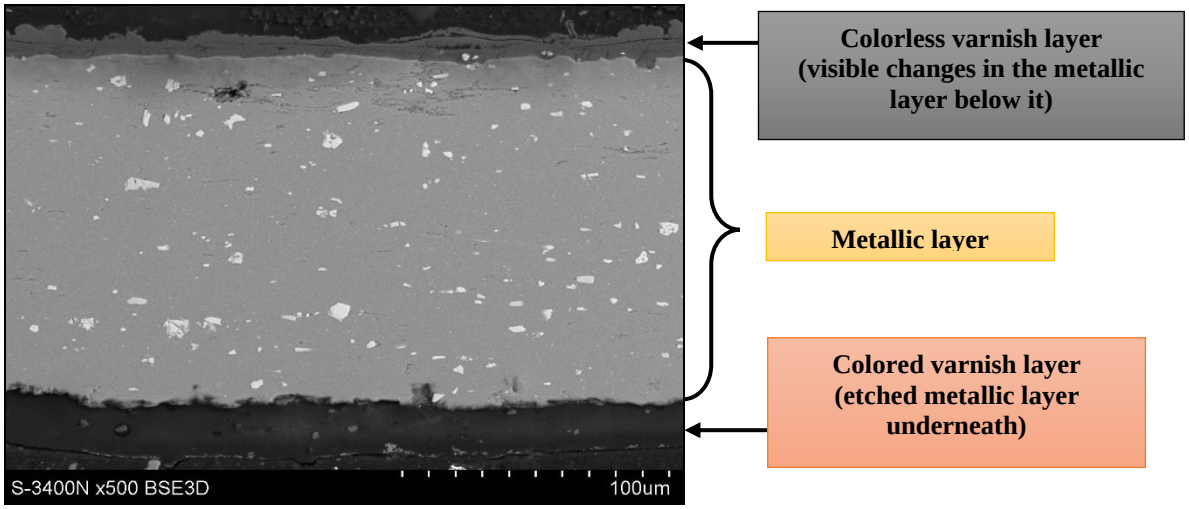

Fig. 6. SEM-EDS: Metal plate exposed to an alkaline solvent
Source: own study

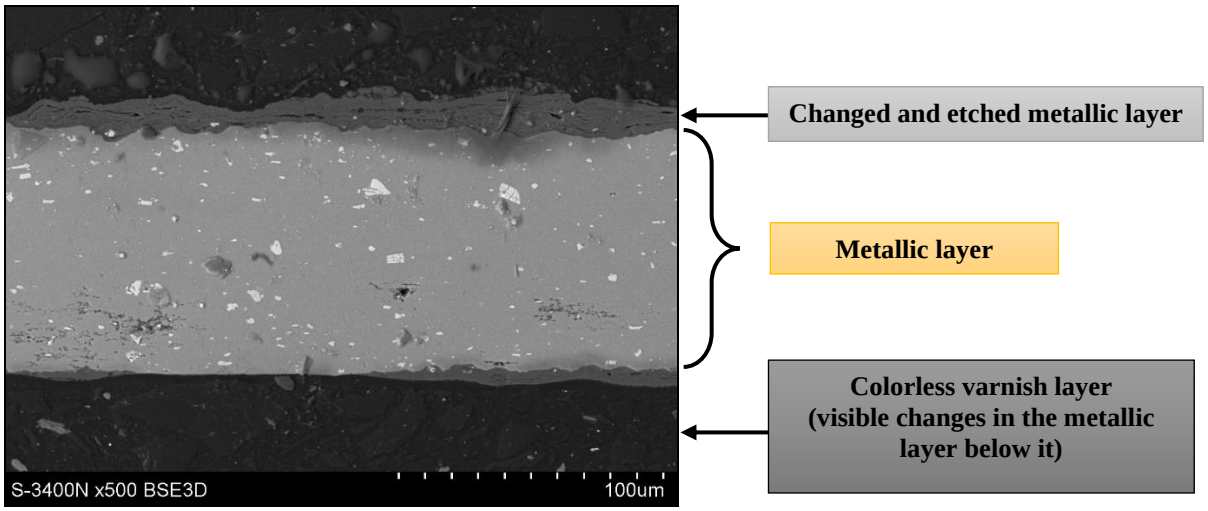

Fig. 7. SEM-EDS: Metal plate exposed to an acidic solvent – low concentration
Source: own study

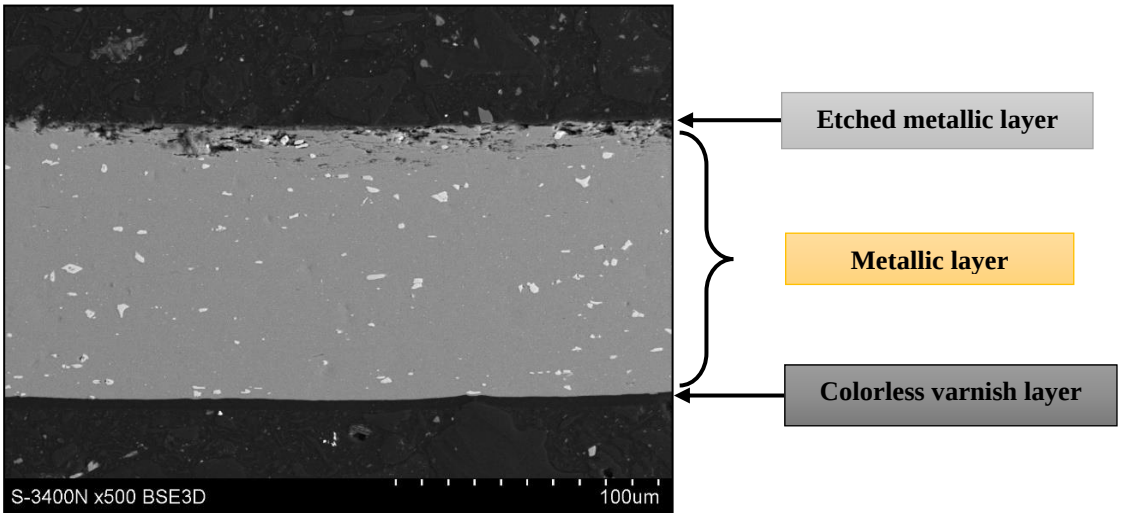

Fig. 8. SEM-EDS: Metal plate exposed to an acidic solvent – high concentration
Source: own study

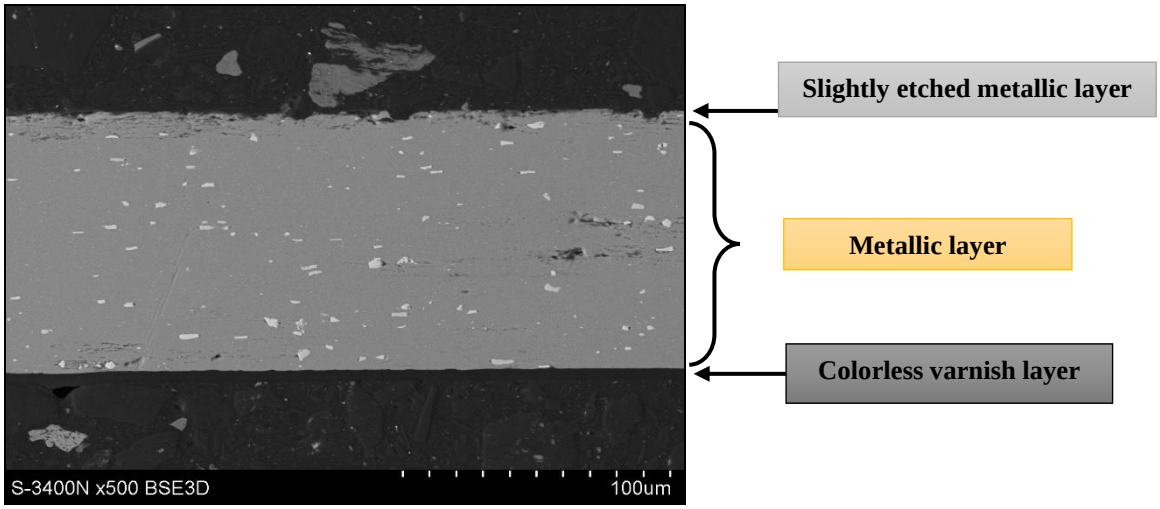

Fig. 9. SEM-EDS: Metal plate exposed to an organic solvent
Source: own study

Conclusions

Based on the conducted research it was found that:

1. Cleaning aluminum cans from the outer layer of varnish using prepared solutions is effective in the case of an organic and acidic solvent, especially with concentrations above 5%. Alkaline solvents do not fulfill their role when cleaning aluminum surfaces for foundry purposes.
2. The solvents used remove the colored varnish layer, with varying degrees of etching of the metallic layer of the material. The organic solvent used proved to be the least destructive to aluminum.
3. At this stage of research, it was found that the prepared solvents did not affect the transparent varnish layer.

The results presented above form the basis for further research steps to be taken to ascertain the actual impact of the above substance on the individual layers of the material being analyzed. Further work is also planned with the use of an organic solvent, including its implementation in the process of preliminary cleaning of aluminum surfaces entering the foundry furnaces, measuring the efficiency of the aluminum recovery process and the degree of pollutants released. In addition, work is planned to determine the optimal conditions for the applicability of the solvent (the number of uses, quantitative action, the possibility of recovery after the process, how to dispose of the used solution).

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A NON-HUMAN ANIMAL PERSPECTIVE ON THE CORONAVIRUS PANDEMIC

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Abstract:

Nowadays the coronavirus, dubbed Covid-19, is affecting the human-animal world. The first infections are linked to the Huanan Seafood Wholesale Market in Wuhan. There are plenty of animals commonly sold there. Despite there is no direct evidence of possible transmission of disease between pets and their owners, people have raised concerns about the future. Bearing in mind that Covid-19 is a zoonotic disease, different species of animals are tested for precautionary reasons after noticing the symptoms of disease. The coronavirus affects the animal beings all over the world – some of them are exterminated, animals in zoos might have to be fed up to others, the experiments are conducted. Another problem is that pets are abandoned at home, and they are at the risk of dying. Their owners are evacuated and some of them do not return home. The aim of the paper is to present what impact does the coronavirus have on animals and humans.

Keywords:
animal studies, coronavirus, animals, disease, slaughter

Introduction

According to World Health Organization, which is responsible for international public health, among basic protective measures against coronavirus it is advised to wash hands frequently, maintain social distancing, avoid touching face, practice respiratory hygiene and stay informed [1]. These rules are essential for everyone who wants to stay protected from droplets which spread virus. It is recognized that coronaviruses (CoVs) may emerge from possible animal reservoirs and cause fatal diseases in every organism. Avoiding contact with people who have symptoms and staying home when we feel unwell is required for people but there are no ideas how animals should behave during coronavirus pandemic. With this in mind, let's look at a more recent study to check the human-animals bonds.

The essay is structured as follows. I begin with a short summary and explain the concept of Anthropocene and how it influences my research. Then Jeremy Bentham, Charles Darwin and Peter Singer's theories are mentioned because their research changed the situation of animals. Afterwards

I retrace the history of some diseases which changed the human world briefly. In the light of SARS-CoV-1, MERS-CoV, EVD and SARS-CoV-2 it would be easier to understand the human-animal world during epidemics or pandemics. The second half of the essay and its final part takes a look at the situation of animals nowadays. The chosen examples can help to visualize a non-human animal perspective.

The species war

The problem of the Anthropocene, a new geological epoch, is essential to be discussed in the light of this research. Nowadays the human intervention is highly meaningful and cause irreparable losses. Not only global warming and climate changes are worth to mention. Also crossing the boundaries between humans and animals may result in lack of solution [2]. The problems are different (including the growth of cattle population, extinction of some species or industrialized food production) and essential. A man chooses the way of behavior and it is related to his human nature. As Jeremy Bentham, an English philosopher and the one who started *animal liberation movement*, says:

> Nature has placed mankind under the governance of two sovereign masters, *pain* and *pleasure*. It is for them alone to point out what we ought to do, as well as to determine what we shall do. On the one hand the standard of right and wrong, on the other the chain of causes and effects, are fastened to their throne. They govern us in all we do, in all we say, in all we think: every effort we can make to throw off our subjection, will serve but to demonstrate and confirm it [3].

Thanks to Bentham universal principles of utilitarianism were highlighted. He claims that animals can be terrified but this fear cannot be used on the plus side. What is more, non-humans do not kill their brothers and sisters for pleasure. They do it because of hunger. According to Bentham, people should murder only these animals which attack or make them unsafe [4]. Also, Charles Darwin's theory of evolution and the concepts of ethology are essential for this study. British naturalist argues that the feelings of pleasure, fear, misery and pain (ascribable to humans) can be also used with regard to animals behaviour [5]. There is one more researcher whose ideas are worth to mention. The author of controversial book *Animal Liberation*, Peter Singer, says "We are the animals" [6]. In his opinion everyone should be interested in the life of animals as well as theirs.

Non-human animals can be thought as a part of human world. When fast spreading diseases appear, people have to struggle with them but the life of animals is also in danger. In 2002 Severe Acute Respiratory Syndrome (SARS-CoV or SARS-CoV-1) was reported in Asia. The symptoms of it were flu-like (fever above 38 °C, cough, muscle pain and lethargy). Arinjay Banerjee, who is a postdoctoral researcher at McMaster University in Hamilton (Institute for Infectious Disease Research), Canada, specializes in coronaviruses. According to him, SARS shares 99,8% of its genome with civet coronavirus [7]. It means that a small nocturnal mammal can be thought as a source. What is important, in order to prevent spreading of disease, in 2004 the authorities in

southeastern China decided to drown or electrocute thousands of civet cats. It was done to eliminate a possible source of SARS [8]. Some scientists say that the prime source of the virus was the horseshoe bat whose strains may have caused SARS outbreak [9]. Sara Platto, a professor of animal behavior at Jiangham University, Wuhan, argues that "The problem is not the animals, it's that we get contact with them" [7]. The disease has not resurfaced since 2004 but there is still a threat [10].

Another zoonotic disease — which is essential to mention — is Middle Respiratory Syndrome (MERS-CoV), also known as *camel flu* [11]. Most cases have occurred in the Arabian Peninsula since 2012. The signs and symptoms are SARS-like: fever, cough, myalgia. The World Health Organization (WHO) reports that this virus is transmitted between people and animals. It was identified in dromedaries (it is because its dubbed *camel flu*) but the possible source is a bat. According to WHO, *chiropteras* could pass MERS-CoV to camels in the past [12]. What is more, the high risk of the infection is connected with the consumption of undercooked food (milk or meat). The danger is high because approximately 35% of diseased people have died [13]. What is interesting, in Australia between 2010 and 2014 about 150 000 camels were killed because their population was too high. The meat of these animals is processed for the export market. As it was underlined, the Australian camels might have been the principal reservoirs of MERS [14].

Nevertheless, there is one more health problem despite it is not from the coronavirus family. Ebola virus disease (EVD), known also as *zaire ebolavirus disease*, cause a severe hemorrhagic fever in humans and animals. It was first identified in 1976. The Ebola virus is transmitted between humans and animals through body fluids [15]. Magdalena Bermejo, director of the Ngaga research station and the world authority on the western lowland gorilla, reminds how the Ebola virus disease started. It is thought that the virus is animal-borne:

> It's thought the outbreak started because of the bats eating from the persimmon trees in the forests. Bats, gorillas and chimpanzees love the fruit. That year when the trees ripened, the bats flocked to the trees and everything was covered in bat guano. During the day the gorillas and chimps ate the [bat guano covered] fruit and developed Ebola. It spread quite quickly after that.[…] Hunters found the [gorilla carcasses] and used them for bushmeat and then got the Ebola from the [dead] animals [16].

Nowadays The Democratic Republic of Congo (DRC) struggles with measles, cholera, malaria and coronavirus epidemics in the same time. According to The United Nations Children's Fund, which is responsible for providing aid to children worldwide, more than 5,000 kids died because of measles and there are more than 31,000 cases of cholera in DRC. Other risks are connected with malaria and coronavirus [17]. According to Theodore Treffon, there are some African markets in DRC too. Despite Ebola outbreak, people sell and buy bats [18]. Central Africans eat about six million tons of bushmeat every year [19]. When it comes to *wet markets*, the situation is similar to the Chinese. Animals' meat is sold without any tests and it may result in diseases.

Coronavirus COVID-19, which paralyses almost all the countries' economy, is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). There are some symptoms which

can appear after the contact with an infected person: fever, cough, difficulty breathing, tiredness [20]. COVID-19 causes illness in people but not only. The animals are also nonimmune. The source of the current outbreak of COVID-19 is not known but the first infections are linked to the live animal market — Huanan Seafood Wholesale Market in Jianghan District in the Chinese city of Wuhan. It is considered as a *wet market* or *live-animal market* because everyone can sell meat of different dead animals there, e.g. wolf pups, turtles, beavers, rats, foxes, peacocks, baby crocodiles, camel meat, snakes, porcupines, giant salamanders. What is the most terrifying, "live fish splashing in tubs of water, melting ice keeping meat cold, the blood and innards of slaughtered animals" [21]. It is said that before you see something around the market, you smell it. The temperature in China is often high and there is no refrigerating. It is possible to compare these places to abattoirs [22] because there are also live animals (often in small, dirty cages) which are extremely stressed. The risk of disease transmission rises is getting higher because they are exhausted and terrified. Their faeces and body fluids are everywhere [21]. According to People for the Ethical Treatment of Animals (PETA), we should not ignore the link between *live-animal markets* and the outbreak of COVID-19. They are filthy warehouses, the home for caged mammals, soak with blood [23]. PETA prepared the graphic which illustrates animals and the zoonotic diseases connected with them:

Fig. 1. Responsibility of the meat industry
Source: [24]

Margo DeMello, considering the interactions between humans and animals, underlines that there is a gap between pets and animals, mostly farm animals. Being a friend with livestock might be seen as something curious. The human-animal studies scholar says that it is — unfortunately — common [25]. Nonetheless, people who live in Asia say that *live-animal markets* are needed and their treating animals is nothing bad. Here are some opinions: "In Hong Kong you can take a pig and throw it on the ground and hack it apart and there's no legislation preventing that" [26],

" […] in China, anything with four legs but a table, and anything with two legs and not a person — we'll eat it" [27].

Nowadays COVID-19 can spread easily from one person to another. It is very similar to past viruses (also mentioned in this article), especially when it comes to symptoms. What is more important, the zoonotic diseases are caused by germs (not only viruses, but also bacteria, parasites and fungi) which cause illness. In the picture below there are some important issues in the matter of above diseases:

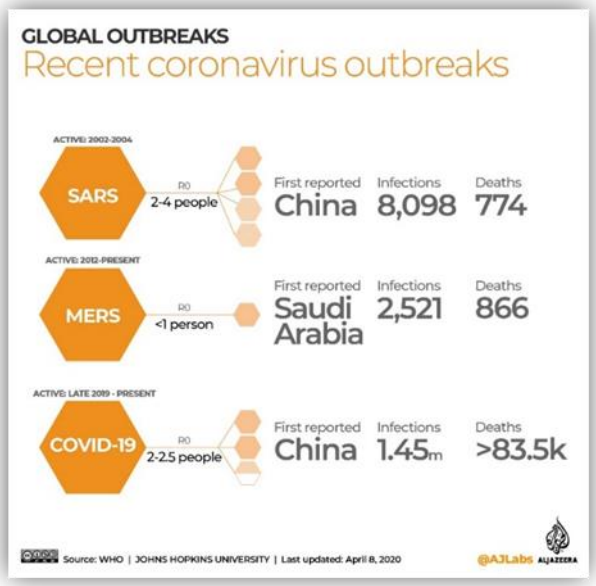

Fig. 2. Differences between SARS, MERS and COVID-19
Source: [28]

Significantly, the reasons and consequences of mentioned illnesses are not always the same. Animals are being held liable for not keeping the distance and being kept in cages.

Animals are dying

Nowadays pets are considered as outright members of the family. Their passing away is compared with the experience of losing a relative or a close friend. *Éric Baratay's theory is based on Bentham, Darwin and Singer's ideas. He underlines that the animal status changed and it is easily noticeable. Different species of animals accompany humans in every field. According to Baratay, the most popular animal friend is dog [29] but there are also others: cats, fish, guinea pig… It is supposed that the close relationship between humans and non-humans can have an influence on the possible suffering. There are a couple of reasons why the owners abuse animals. The most popular ones are connected with the pressure (the work of non-human should be fast and effective) and clear conscience (ill and weak non-humans are killed in a slaughterhouse) [30]. The biggest problem is that there is no one universal (and fully ethical) theory of animal rights. Humans kill animals constantly and* consistently. *There are at least two forms of doing it: euthanasia (pets) and slaughter (wild animals). The second option is concerned to so-called food*

chain. Humans are said to be at the top, animals lower [31]. Today more and more organizations try to persuade people to treat animals better even if the situation is difficult (hair allergy, misbehaviour of a pet, fear).

The Centers for Disease Control and Prevention (CDC), the leading national public health institute, published the special article in which they write about important issues concerning coronavirus. They recommend how people should behave if they have animals. They admit that some coronaviruses can be spread to people by infected animals. Anyway, CDC advises treating pets as human beings. They should not interact with the owners who are infected. If there is someone who is diseased in the household, the person should be isolated from everyone, also pets [32]. It will not be cutting-edge if I say that the relationship between animals and humans is often deep. For instance Michael Fleischer underlines how emotional can dogs be. Despite people cannot humanize animals, they can easily see the similarities between species. It was mentioned before that animals can feel happiness, pain or longing [33]. Another researcher — Werner Fischel — gives an illustration of chimpanzee and dog. While dog connects the past situation to the activity, chimpanzee looks for the future effects [34]. It shows that chimpanzee has more in common with human being.

According to the United States Department of Agriculture's (USDA), the first wild animal which is infected SARS-CoV-2 is a 4-year-old Malayan tiger at the Bronx Zoo in New York. Its name is Nadia. In a short time the zoo started to test other animals because of a dry cough they had. It is supposed that a zoo employee spread the virus to Nadia. Nonetheless, it is not easy to receive the result of the coronavirus test when it comes to zoo animals because they have to be put under general anesthesia. Bronx Zoo Chief Veterinarian Paul Calle said that the animal test is different from human test: "The COVID-19 testing that was performed on our Malayan tiger Nadia was performed in a veterinary school laboratory and is not the same test as is used for people. You cannot send human samples to the veterinary laboratory, and you cannot send animal tests to the human laboratories, so there is no competition for testing between these very different situations" [35].

It is worth to know that the amount of infected animals is getting higher. According to *Live Science*, the coronavirus attacked a domestic cat in Belgium. This is the example of human-to-cat transmission. The cat started to have diarrhea and it vomited [36]. In Hong-Kong two dogs were checked. A 17-year-old Pomeranian died while a German shepherd had no symptoms of COVID-19 [36]. Despite these cases, health experts agree. There is no need to worry: "Previous experience with SARS suggests that cats and dogs will not become sick or transmit the virus to humans. At that time, a few pets tested positive but none became sick. […] Importantly, there was no evidence of viral transmission from pet dogs or cats to humans" [37]. World Health Organization prepared the poster in which everyone can find information if pets can spread the disease:

Fig. 3. One of the myth busters prepared by WHO
Source: [38]

The animal susceptibility of SARS-CoV2 might help to find the answer if animals can pass the infection. The researchers from The State Key Laboratory of Veterinary Biotechnology in Chinese Academy of Agricultural Sciences, Harbin decided to carry out an experiment. They use five 8-month-old outbred domestic cats which were inoculated with virus. Three of them were scheduled to euthanized after six days to check viral replication in organs. Others were placed in cages next to the healthy cat. The transmission of COVID-19 might have been occurred through respiratory droplets. As the result of this experiment, it is found that dogs, chickens, pigs and ducks replicates poorly, the other way round – cats and ferrets [39]. Another virologist Chao Shan found that rhsus macaques' lungs are similar to human's in the time of infection. The researchers looked after these animals and killed them simply. They would love to carry out more experiments but there is not as many animals as the laboratory needs, for instance mice [40]. Choosing this rodent is nonrandom. They are inexpensive and easy to work with. The researchers say that infecting animals can help understand the body's response and the supporters of this kind of experiments repeat that the most important medicine accomplishments were made thanks to biomedical tests on non-humans [41]. There is no place for discussion about ethics. [42]. As far as we know the virus that causes COVID-19 might affect animals and humans. Future tests will show what are the consequences of being diseased. Another example is connected with the difficult situation of zoos, especially in Germany. In spring Berlin Zoo was often crowded, now it is like a ghost place. The director asks for donation which can help to survive. Neumünster Zoo's Verena Kaspari told the daily newspaper "Die Welt" that they had to prepare a kind of *slaughter list*: "If it comes to it, I'll have to euthanise animals, rather than let them starve […]. At the worst, we would have to feed some of the animals to others" [43]. The estimated loss of income is about €175,000 [43]. Another problem of zoos is that animas feel lonely and bored. They are accustomed to visitors and the current situation is unbearable.

All things considered, it seems reasonable to assume that we live in the Anthropocene. The boundaries between humans and animals are dangerous, and they do not lead to all the worst. Referring to the views of Baratay, the picture of incomprehension is common because people understate the extent of the problem [29]. Neglect, indifference and silence can hurt both species (*homo sapiens* and more than one million thousand animal ones). Nowadays Coronavirus disease kill people as well as animals. There is only one solution — wait for the better tomorrow.

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IMPROVING DIFFERENTIAL POWER ANALYSIS OF XMSS

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Abstract:

Hash-based cryptography is one of the leading post-quantum digital signature candidates, which is associated with provable-secure constructions [1]. However, during implementing solutions in the real world, it is important to consider aspects related to other attacks, such as side-channel attacks. It is known that hash-based digital signatures have high resistance to side-channel attacks and the first such analysis appeared in [2]. The authors presented a full Correlation Power Analysis attack on SPHINX and on a modified version of XMSS in relation to RFC [3]. The modification consisted in hashing the iterator in the PRF function and therefore the attack is not practical. The aim of this paper is to fill this gap and present an attack on XMSS compliant with RFC and analyze its effectiveness.

Keywords:
Differential Power Analysis, post-quantum cryptography, hash-based cryptography, digital signatures

Introduction

Side channel analysis involved methods of inferring about secret key processed by a device without direct observation, but observing side sources of information, such as execution time, power consumption or electromagnetic emission. It has been shown that they are very effective in relation to secure cryptography in terms of current achievements in cryptoanalysis, if the implementation itself is not protected [4, 5]. Subsequent research has shown that implementations with countermeasures are not always secure and their selection is a kind of challenge [6, 7, 8].

Extended Merkle Signature Scheme (XMSS) is a provable-secure signature scheme [1], which has been described in RFC [3]. The security of XMSS consists in the proper selection of hash function and pseudo-random function. In the aforementioned RFC, SHA2-256 [9] was proposed as a cryptographic primitive, which security is well known. In addition hash-based cryptography is considered to be highly resistant to side channel attacks, which makes it adequate for application in real world solutions. Of course, in practical applications, it is also important to deal with the length of keys and acceleration of the hash function.

Related work

It should be noted that high resistance does not make the attack impossible, which was confirmed by researchers last year. In their paper [2] was presented Correlation Power Analysis attack on SPHINX and XMSS. In the case of XMSS, the attack was carried out on a modified version with respect to RFC and it was based on the HMAC attack [10]. Without this change one has to deal with a small of differences necessary to carry out the attack.

Outline

This paper presents a Power Correlation Analysis attack on XMSS compliant with RFC. Empirical research was conducted by modifying the source codes of the simulator, which was made available on the github [11]. In order to approximate the practical conditions, some of the tests were carried out for the reduced cut-off threshold of Pearson's correlation coefficient and a wider trace.

This paper is organized as follows. The Section 2 introduces the context of our attack including significant operations of SHA2-256. The Section 3 describes our contribution on how to take advantage from diffusion operations to exploit differences necessary to conduct the attack and how to compensate for differences where they interfere. The Section 4 gives a conclusion to this paper and further work perspectives.

Background

We will now present the background of the research, including the description of XMSS scheme, pseudorandom number generator and SCA.

XMSS

XMSS digital signature consists of two basic ideas that involve using of two types hash trees: L-Tree and XMSS Tree. The first of these is related to WOTS+ scheme [12] which is connected with a one-time signature algorithm. The key generation algorithm uses the chaining function:

$$c_k^i(x) = \begin{cases} x, & for\ i = 0 \\ f_k\left(c_k^i(x) \oplus r_i\right), & for\ i > 0 \end{cases}, \quad (1)$$

built on the basis of the hash function $f_k: \{0,1\}^n \longrightarrow \{0,1\}^n$, parametrized by key $k \in \{0,1\}^n$, in the following way:

$$X = (pub_0, \dots, pub_{l-1}) \in \{0,1\}^{n \times l}, pub_i = c_k^{w-1}(priv_i),\ i = \overline{0,l}, \quad (2)$$

where:

security parameter $n \in \mathbb{N}$,
length $l \in \mathbb{N}$,
compression level $w \in \mathbb{N}$,
random mask $R = (r_1, \dots, r_{w-1}) \in \{0,1\}^{n \times w-1}$,
private key $PRIV_{WOTS+} = (priv_0, \dots, priv_{l-1}) \in \{0,1\}^{n \times l}$,
private key $PUB_{WOTS+} = (X, R, k)$.

In order to compress the public key to n-bit value one can construct hash tree, where pub_i are nodes, which we call L-Tree. After generating the keys, it is possible to sign message $MSG = (msg_0, \dots, msg_{l-1})$ using the private key in accordance with the next procedure:

$$SIGN_{WOTS+} = \left(c_k^{msg_0}(priv_0), \dots, c_k^{msg_{l-1}}(priv_{l-1})\right). \quad (3)$$

XMSS Tree refers to compressing method of compressed WOTS+ public keys treating L-Trees as nodes. XMSS Tree and L-Tree are constituted according to the same procedure using hash function $g: \{0,1\}^{2n} \longrightarrow \{0,1\}^n$, generating nodes:

$$NODE_{i,j} = g\left(\left(NODE_{2i,j-1} \oplus b_{l,j}\right)||\left(NODE_{2i+1,j-1} \oplus b_{r,j}\right)\right), \quad (4)$$

where bitmask $(b_{l,i}||b_{r,i}) \epsilon \{0,1\}^{2n}$ is uniformly distributed. XMSS Tree is a binary tree and its height is denoted by *H*. Therefore, its nodes $NODE_{i,j}$ meet dependencies $j = \overline{1,H}$ and $i = \overline{0, 2^{H-j}}$. It follows that XMSS is statefull digital signature with a maximum number of signatures equal to 2^H. L-Tree is not a binary tree, because *l* might not be a power of 2, and its height is $\lceil \log l \rceil$.

Public key of the XMSS is the root of XMSS Tree and seed to generate random masks $PUB_{XMSS} = \left(NODE_{0,H},\ SEED_{PUB}\right)$. The private key consists of all the keys to the *WOTS+* signature and in practise it does not store these data, but it is generated using the secret seed and the iterator *i*, $PRIV_{XMSS} = SEED$. The signature generation is carried out as follows:

$$SIGN_{XMSS} = \left(i,\ SIGN_{XMSS},\ PUB_{WOTS+,i},\ AUTH\_PATH_i\right), \quad (5)$$

where $AUTH\_PATH_i$ is the authentication path from the $PUB_{WOTS+,i}$ to the public key of the XMSS scheme allowing the verification of the relationship between the public key and private key.

SHA-256 PRNG

According to RFC8391 [3] for recommended parameters together with the hash function SHA2-256, the private keys to *WOTS+* are generated according to the following procedure:

$$SHA2-256\left(toByte(3,32)||SEED||toByte(i,32)\right), \quad (6)$$

where $toByte(x,y)$ is the *y-byte* string containing the binary representation of *x* in big-endian byte order. As a reminder, we include Compress Function, and the entire schema specification is included in FIPS 180-4 [9].

1: Input: IV (256 bit), m_i (512 bit)
2: $W_t \leftarrow m_i^{(t)}$ $0 \leq t \leq 15$
3: $W_t \leftarrow \sigma_1(W_{t-2}) + W_{t-7} + \sigma_0(W_{t-16}) + W_{t-15}$ $16 \leq t \leq 63$
4: $A \leftarrow IV^{(0)}$; $B \leftarrow IV^{(1)}$; $C \leftarrow IV^{(2)}$; $D \leftarrow IV^{(3)}$
5: $E \leftarrow IV^{(4)}$; $F \leftarrow IV^{(5)}$; $G \leftarrow IV^{(6)}$; $H \leftarrow IV^{(7)}$
6: **for** $t = 0$; $t < 64$; $t++$ **do**
7: $T1 \leftarrow H + \Sigma_1(E) + CH(E,F,G) + K_t + W_t$
8: $T2 \leftarrow \Sigma_0(A) + MAJ(A,B,C)$
9: $H \leftarrow G$; $G \leftarrow F$; $F \leftarrow E$; $E \leftarrow D + T1$
10: $D \leftarrow C$; $C \leftarrow B$; $B \leftarrow A$; $A \leftarrow T1 + T2$
return $[IV^{(0)} + A, IV^{(1)} + B, IV^{(2)} + C, IV^{(3)} + D,$
11: $IV^{(4)} + E, IV^{(5)} + F, IV^{(6)} + G, IV^{(7)} + H]$

Fig. 1. SHA2-256 Compress Function
Source: own elaboration

Side Channel Analysis

We will briefly present the attack on XMSS published in [2], the concept of which is based on the results of the attack on HMAC [10]. After analyzing the structure of the scheme, the authors decided that the only place for SCA application is the pseudorandom generator. The attack consists in reconstructing the intermediate state of the generator, which allows generating private keys. The result is not practical only because it was carried out for the modified version of XMSS, which consisted of changing the function *toByte(i,32)* to *SHA2-256(i)*.

Despite the fact that the change may seem small, it has facilitated the whole attack. Taking into account the introduced change, from the beginning we are able to attack operations on 4 bytes, and the changes themselves are favored by avalanche effect of hash function. Using gathered traces with variable iterator *i* we can recover the 512-bit intermediate state of the generator as follows:

1. $T1_0 = \underline{\delta_0} + W_0, \delta = H + \Sigma_1(\mathrm{E}) + \mathrm{CH}(\mathrm{E},\mathrm{F},\mathrm{G}) + \mathrm{K_t}$
2. $E_1 = D_0 + T1_0 = (D_0 + \delta_0) + W_0$
3. $A_1 = T2_0 + T1_0 = (T2_0 + \delta_0) + W_0$
4. $\mathrm{T1_1} = \mathrm{H_1[G_0]} + \Sigma_1(\mathrm{E_1}) + \mathrm{CH}(\mathrm{E_1},\mathrm{F_1},\mathrm{G_1}) + \mathrm{K_1} + \mathrm{W_1}$
5. $\mathrm{CH}(\mathrm{E_1},\mathrm{F_1},\mathrm{G_1}) = (\mathrm{E_1}\ \mathrm{and}\ \mathrm{F_1[E_0]}) \oplus (\overline{\mathrm{E_1}}\ \mathrm{and}\ \mathrm{G_1[F_0]})$
6. $\mathrm{MAJ}(\mathrm{A_1},\mathrm{B_1},\mathrm{C_1}) = (\mathrm{A_1}\ \mathrm{and}\ \mathrm{B_1[A_0]}) \oplus (\mathrm{A_1}\ \mathrm{and}\ \mathrm{C_1[B_0]}) \oplus (\mathrm{B_1}\ \mathrm{and}\ \mathrm{C_1})$
7. $\mathrm{H_0} = \mathrm{T1_0} - \Sigma_1(\mathrm{E_0}) - \mathrm{CH}(\mathrm{E_0},\mathrm{F_0},\mathrm{G_0}) - \mathrm{K_0} - \mathrm{W_0}$
8. $\mathrm{E_2} = \mathrm{D_1[C_0]} + \mathrm{T1_1}$

Let's note that the 4-byte values of the $secret = [A_0|B_0|C_0|D_0|E_0|F_0|G_0|H_0]$ are marked in red, while the attacked operations in green. The bottom index is the number of iterations from the recovered state.

The attack was carried out on the XMSS trace simulator [11], additionally using the knowledge of the exact place of the leakage of the appropriate intermediate value with the correlation coefficient equal to 1. The probability of the attack was estimated for the Hamming Weight byte and 4-byte leakage model.

In our approach, we focused on the HW byte model, however some properties were calculated for the 4-byte model, which may be helpful in assessing the complexity of the attack in this case as well.

Our contribution

In this section, we will present an attack on RFC-compliant XMSS and discuss several aspects relevant to the practical environments.

First of all, let's pay attention to what happens when we perform an attack for one add modulo 2^{32} operation in two different situations. Fig. 2 presents CPA for the case, when we know exactly at which point the intermediate value is leaked in the entire trace. In practise, we rarely have such knowledge, unless we control the device and then we can select Points od Interests and build its statistical profile. Fig. 3 shows the same attack, however information was provided that the leak is within 500 points. We are dealing here with theoretic traces and in practise the correlation coefficent is not 1, which depends on the characteristics of the measurement environment and the device being attacked. In practise we can have more candidates, so in order to approximate this conditions we cut-off all keys at 0.8 threshold. We can see that in the first case we managed to select one candidate, and in the second one, fifteen. Considering that the process of recovering the secret consists in using recovered values, the search space is increased and in the further part of the work we will show how much. Real traces may differ from each other and there may be situations where the intermediate value disappears completely due to noise and small theoretical differences. Due to the form of these figures, in practice it may be necessary to set an appropriate environmental-depending cut-off threshold. Otherwise, given the noise and the fact that several values have a similar correlation coefficient, choosing the highest one can lead to errors.

During the experiments, the worst case for which we assigned the key concerned the attack for exact point at cut-off threshold equals to 0.8 and for 500 points at cut-off threshold equals to 0.95. Under such assumptions the simulator may reflect some environments, provided that the changes we observe are not so small that they can be obscured by potential noise, what will be discussed later. Maybe in the second case, the cut-off threshold at 0.95 is small, but we leave this issue for future research, depending on what problems appear in the real traces.

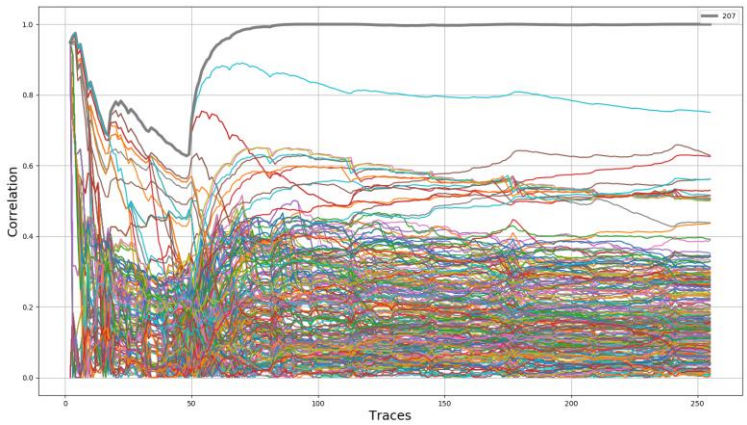

Fig. 2. CPA for adding mod 2^{32} operation, HW Byte model and over exact point in trace
Listed candidates for the cut-off threshold 0.8
Source: own elaboration

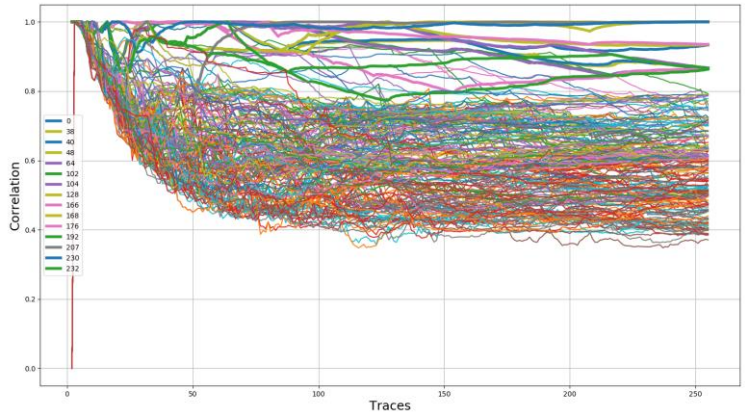

Fig. 3. CPA for adding mod 2^{32} operation, HW Byte model and over 500 points in trace
Listed candidates for the cut-off threshold 0.8
Source: own elaboration

Let's now consider the possibility of performing CPA on the XMSS digital signature. According to RFC8391, the parameter *H* for SHA2-256 is from 10 to 20, which means that it is possible to sign 2^H messages. Iterator *i*, being the PRNG parameter, is identified with the number of the messages being signed, so in this case its largest value can be written on two and a half bytes. Note that used SHA2-256 works on 4-byte blocks, from which it follows that having 2^{20} traces we are able to recover about half the bits of the key. This is a very large number of traces, after which the XMSS private key is no longer active. In addition, it results from a binary record, the most changes are observed on the least significant byte, and the least on the most significant.

We will show now how to exploit changes only on the least significant byte of the iterator to recover the full key:

1. $T1_0[3] = \delta_0[3] + W_0[3]$
2. $E_1[3] = D_0[3] + T1_0[3] = (D_0[3] + \delta_0[3]) + W_0[3]$
3. $\Sigma_1(\mathrm{E}_1)[2^{24}\ \mathrm{CPA}]$
4. $\mathrm{T1}_1 = \mathrm{H}_1[\mathrm{G}_0] + \Sigma_1(\mathrm{E}_1) + \mathrm{CH}(\mathrm{E}_1, \mathrm{F}_1[\mathrm{E}_0], \mathrm{G}_1[\mathrm{F}_0]) + \mathrm{K}_1 + \mathrm{W}_1$

5. $E_2 = D_1[C_0] + T1_1$
6. $\Sigma_1(E_2)$
7. $T1_2 = H_2[F_0] + \Sigma_1(E_2) + CH(E_2, F_2[E_1], G_2[E_0]) + K_2 + W_2$
8. $CH(E_1, F_1, G_1) = (E_1 \text{ and } F_1[E_0]) \oplus (\overline{E_1} \text{ and } G_1[F_0])$
9. $CH(E_2, F_2, G_2) = (E_2 \text{ and } F_2) \oplus (\overline{E_2} \text{ and } G_2)$
10. $A_1[3] = T2_0[3] + T1_0[3]$
11. $\Sigma_0(A_1)[2^{24} \text{ CPA}]$
12. $T2_1 = \Sigma_0(A_1) + MAJ(A_1, B_1[A_0], C_1[B_0])$
13. $A_2 = T1_1 + T2_1$
14. $MAJ(A_1, B_1, C_1) = (A_1 \text{ and } B_1[A_0]) \oplus (A_1 \text{ and } C_1[B_0]) \oplus (B_1 \text{ and } C_1)$
15. $MAJ(A_1, B_1, C_1) == MAJ(A_2, A_1, A_0)$
16. $E_3 = D_2[B_0] + T1_2$

Calculate:

1. $T2_0 = \Sigma_0(A_0) + MAJ(A_0, B_0, C_0)$
2. $T1_0 = A_1 - T2_0 = (T1_0 + T2_0) - T2_0$
3. $D_0 = E_1 - T1_0 = (D_0 + T1_0) - T1_0$
4. $H_0 = T1_0 - \Sigma_1(E_0) - CH(E_0, F_0, G_0) - K_0 - W_0$

As previously, 4-byte values of the secret are marked in red and attacked operations in green, while the bottom index is the number of iterations from the recovered state. Record $T1_0[3] = \delta_0[3] + W_0[3]$ applies to the attack for least significant byte, and $T1_0 = \delta_0 + W_0$ for all 4 bytes.

An important element of the attack is the recovery of states using operations known in block ciphers as diffusion layers. Here we use operations Σ_1 and Σ_0 to determine likely candidates for a 4-byte vectors based on a 1-byte known value. Note that points 1, 2 and 10 are implemented for one byte leakage model, which is impossible in the 4-byte leakage model. An attack for 4-bytes should be made in this place, which of course will affect the probability of its success.

After recovering the 4-byte outputs from the Σ_1 and Σ_0 functions, we are able to use the changes on 4-bytes, however, it should be noted that in some cases changes through the attack may be minor. In this situation, we can assume that we are not able to recover the intermediate value and all candidates are just as likely, which will be compensated in the next steps. During the attack, CPA and verification of the correlation between already known vectors to eliminate the wrong candidates are repeatedly performed.

Relevant elements of the attack and empirical estimation of their success can be found in the following subsections.

Σ_1 and Σ_0

For the 4-byte value $X = x_3|x_2|x_1|x_0$, the mixing functions use the cyclic right shift $ROTR^y(X)$, which is the parametrized by number of bits *y*. They are defined in the following way:

$$\Sigma_1(X) = ROTR^6(X) \oplus ROTR^{11}(X) \oplus ROTR^{25}(X) \quad (7)$$

and

$$\Sigma_0(X) = ROTR^2(X) \oplus ROTR^{13}(X) \oplus ROTR^{22}(X). \quad (8)$$

Note that taking into account the HW byte leakage model, we can distinguish in each of them 8 intermediate values for the $\oplus$ operation itself. Of course, one could also consider operations $ROTR^y(X)$, but during the study they were not considered. It should be noted that the intermediate value for the first $\oplus$ operation at second byte in least significant order was not taken into account, because the differences were not visible.

In Fig. 4 we present the number of candidates for entry into Σ_1 and Σ_0, while in Fig. 5 the probability of the proper solution among candidates for Σ_1. The probability of the proper solution among candidates for Σ_0, was not presented, since practically from the beginning it was 1. In order to increase the probability of success with fewer traces for Σ_1, one could delete the appropriate intermediate values.

In Fig. 6 we present the number of candidates entry into Σ_1 and Σ_0 in HW 4-byte leakage model. The probability of the proper solution among candidates for Σ_1 and Σ_0 from the beginning was 1, which is due to the fact that this model does not represent restrictions on the appropriate properties of the hamming weight of byte intermediate values.

In Fig. 7 we present the number of candidates for entry into Σ_1 and Σ_0 over 500 points HW byte leakage model.

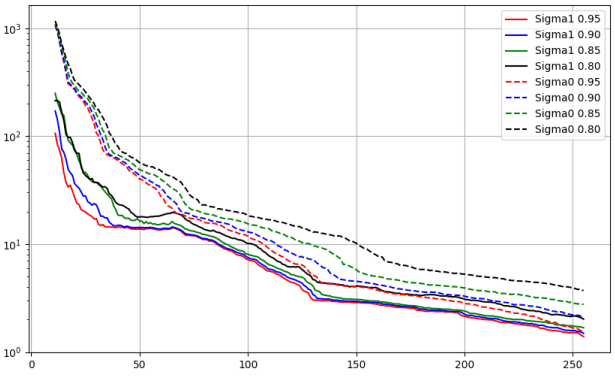

Fig. 4. Average number of candidates over 200 probes for entry into $\Sigma_1(X)$ and $\Sigma_0(X)$ depending on the used number of traces and the cut-off threshold in HW byte leakage model
Source: own elaboration

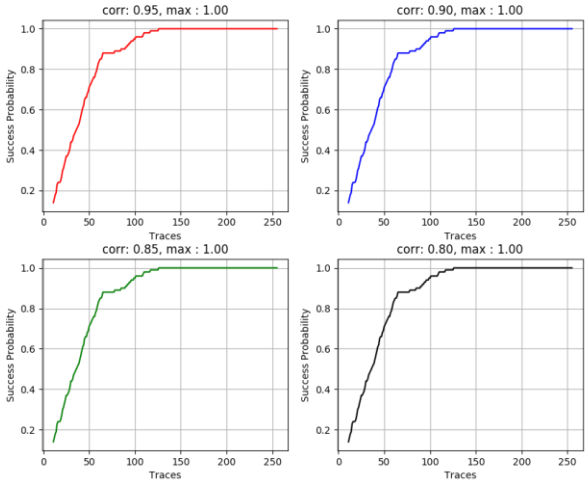

Fig. 5. Probability of the proper solution among candidates for Σ_1 over 200 probes depending on the used number of traces and the cut-off threshold in HW byte leakage model
Source: own elaboration

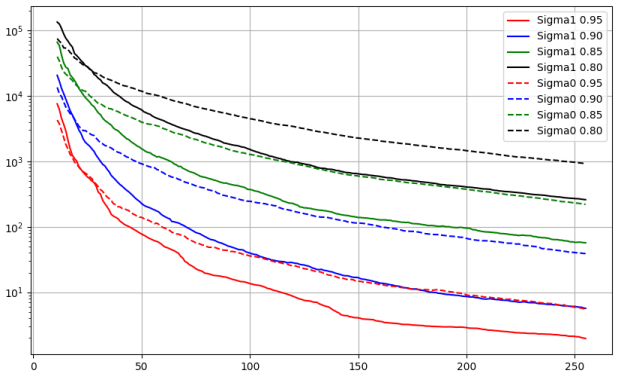

Fig. 6. Average number of candidates over 200 probes for entry into $\Sigma_1(X)$ and $\Sigma_0(X)$ depending on the used number of traces and the cut-off threshold in HW 4-byte leakage model
Source: own elaboration

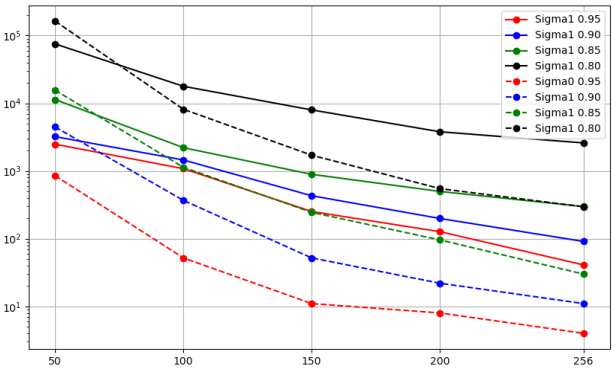

Fig. 7. Average number of candidates over 100 probes for entry into $\Sigma_1(X)$ and $\Sigma_0(X)$ depending on the used number of traces and the cut-off threshold in HW byte leakage model over 500 points
Source: own elaboration

Divide CH and MAJ strategy

In order to recover $T1_1$ we have to predict output of CH function defined as:

$$\mathrm{CH}(\mathrm{X},\mathrm{Y},\mathrm{Z}) = (\mathrm{X}\ \&\ Y) \oplus (\overline{\mathrm{X}}\ \&\ Z) \tag{9}$$

and to recover $T2_1$ output of MAJ function defined as:

$$\mathrm{MAJ}(\mathrm{X},\mathrm{Y},\mathrm{Z}) = (\mathrm{X}\ \&\ Y) \oplus (\mathrm{X}\ \&\ Z) \oplus (Y\ \&\ Z). \tag{10}$$

In both cases there is a problem and the attack will not succeed for every key. This is due to the fact that the output from CH may not be constant and depends on the change of the input marked as X. The fluctuations are associated with the carry bit. However, we are able to predict in which traces these fluctuations will occur and deal with this situation.

Therefore, a *divide CH and MAJ strategy* was introduced. This method depends on the division of traces into two parts or, if the number of carry/no carry traces is too small, on the shade of unnecessary data. The timing of the decision change between the two cases should be set depending on the task, in particular the number of traces. Of course, not for all cases the occurrence of carry bit means changing the value of the output. Therefore, it is possible in the first place to launch an attack without this strategy, but if it fails to use it. All experiments were carried out using this strategy.

Non-correlation cases

Another class of problems related to the analysis of the SHA2-256 based PRF concerns the lack of correlation caused by the small differences in the vectors that are being compared. The authors of [2] took this situation into account, however they mentioned the case when attacking operation is & and the argument is 0. Then it is obvious that the output value is also 0, resulting in a vector filled with zeros. On this basis, with a sufficient number of traces, the probability of success was estimated, which was confirmed experimentally. However, there are other cases where the

correlation coefficient does not retain its properties, despite the comparison of the model for the right guess key to the right place in the trace. In order to present this fact, let's consider the comparison of two vectors $A = [2, 4, 6]$ theoretic HW byte model and *B* trace using the correlation coefficient:

$$\text{meanA} = 4$$
$$\text{sumA} = (2-4) + (4-4) + (6-4) = -2 + 0 + 2 = 0$$
$$corr = sumAB\,/\,(sumA \cdot sumB).$$

In the example above, the result of the correlation coefficient is an indefinite symbol, which we identify with 0. It may also come to a situation that *sumAB* will be a zero, which represents the sum of the product of deviations from the mean of both vectors. During empirical tests, such situations often occurred, what is related to the fact that during the attack we rely only on changes on a single byte. Here, however, it is also caused by the action on the theoretical trace, where there are no fluctuations, but in practical applications it will probably be the reason of the potential confusing the right values with the wrong ones.

As it was previously identified, we observed that the AND operation is particularly susceptible, which applies to verification of correlation as well as CPA. We can identify these situations, but we decided on a different approach due to work in a larger area of the trace. A sufficient approach in the case of an attack on a specific point was the use of a test consisting in verifying whether the elements of the vector generate a set with a number of elements less than 3. When considering the correlation coefficient, it is necessary to assign a maximum value to it, and in the case of CPA, all candidates for keys that fulfill this property should be designated. On the basis of experimental tests, it can be stated that this is a good approach and there has not been a situation of incorrect rejection of the proper path of the code execution. If an error related with this will be identified, one increase the cardinality of the set or use a more radical approach and assume that in the case of an AND CPA, all keys are just as likely. This decision will be compensated in the next stages of the attack.

In the case of an attack over 500 points, this approach was also sufficient and only in 10% of cases we had to apply a more restrictive approach. It should be noted that the mentioned cases were not characterized by a noticeable higher computational complexity.

Experiments

In order to verify our assumptions, we have planned several computational experiments. During them, the case of an attack on the exact point and a part of the trace consisting of 500 points was considered. For the first of them, 200 experiments were carried out for four cut-off thresholds: 0.8, 0.85, 0.90, 0.95 and number of traces: 50, 100, 150, 200, 256. Each experiment concerned a different key that was generated by calculating a SHA2-256 from the experiment number starting from 0, so the results can be verified. For the second case, 40 experiments were carried out for the 0.95 cut-off threshold, which is caused by the need for more computing power. We decided that we will carry out further experiments for the case, which will represent a leak from the real device.

Another issue is choosing the right attack rating metric. In the scientific community of side-channel attacks, guessing entropy and success rate are often considered and they often involve attacking a single byte, which in this case is impossible. Due to the complexity of the attack, no

tests have been carried out for a diverse number of traces, but in reality it consists only of multiple CPA calls. We can then assess its effectiveness by referring to the effectiveness of a single CPA. The difference will be computational complexity, because the number of candidates for a single CPA affects the number of calls of all CPAs during the attack. A different case is the recovery of a 4-byte vector from operations Σ_1 and Σ_0, which is why these operations have been thoroughly examined in the previous part of the article. Therefore, during the entire attack, appropriate candidaces for these values were provided.

For all the cases considered, it was possible to determine the correct keys. The difference consisted in the number of potential candidates and the number of operations needed to select them. For the reasons set out here, the number of candidates and the number of calls needed for a single CPA attack on the + and & operation and the verification of the correlation between the known vectors were taken into account as indicators. Let's take into account that a CPA attack on 500 points needs about 500 times more time than on a single one.

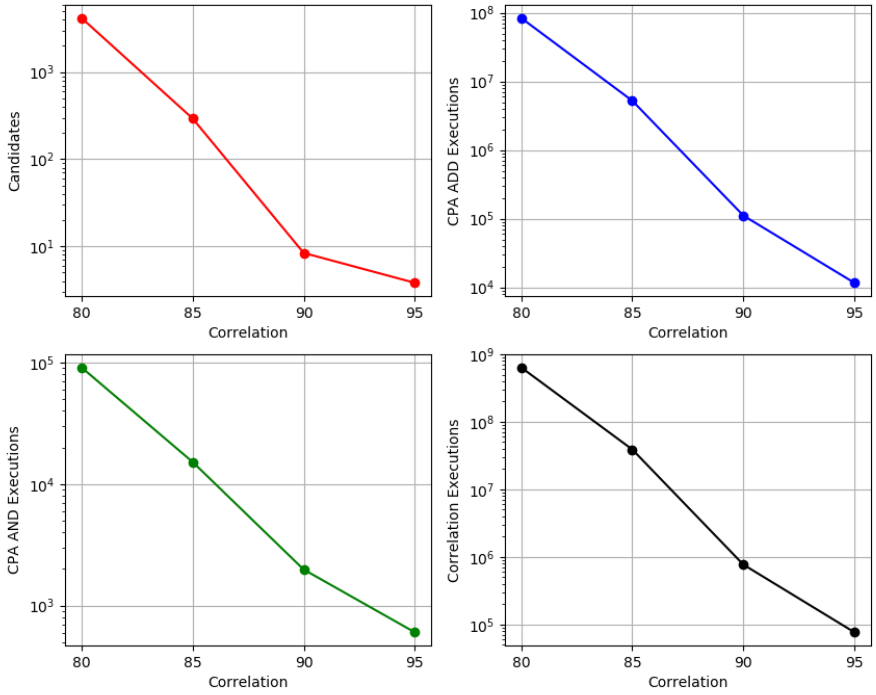

Fig. 8. Average number of candidates and executions of CPA ADD, CPA AND, correlation verification over 200 probes during the attack depending on the cut-off threshold in HW byte leakage model using 256 traces
Source: own elaboration

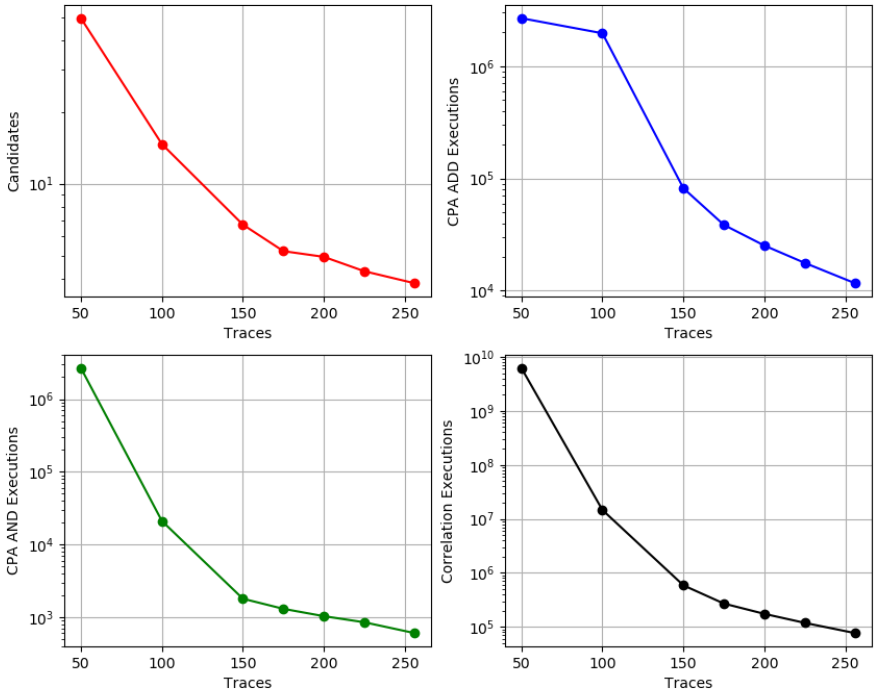

Fig. 9. Average number of candidates and executions of CPA ADD, CPA AND, correlation verification over 200 probes during the attack depending on the used number of traces in HW byte leakage model with cut-off threshold equal to 0.95
Source: own elaboration

Tab. 1. Average number of candidates and executions of CPA ADD, CPA AND, correlation verification over 40 probes during the attack in HW byte leakage model over 500 points with cut-off threshold equal to 0.95 using 256 traces

Candidates	CPA ADD	CPA AND	Correlation Verification
103,72	17 006 077	41 607	255 588 774

Source: own elaboration

Conclusions

In the article we presented an attack on a pseudo-random generator based on the SHA2-256 function used in the XMSS digital signature according to RFC. The carried out experiments give us an overview into the cost of its use and we can see that its complexity in some cases is not negligible. The whole attack was not simulated in the 4-byte model, but its design does not differ significantly from the presented methods.

As it has been pointed out by researchers, PRNG may already be a potential vulnerability and this aspect should be taken into account when defining standards. Countermeasures used with other algorithms can also have their application here, which should also be verified. The attack will fail if a single CPA has no effect.

As further research directions, we are considering launching an attack on a real device.

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