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SCIENCE AND INDUSTRY IN A COUNTRY OF CHANGES

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LIGNOCELLULOSIC BIOMASS AS A FEEDSTOCK FOR THE CELLULOSE ETHANOL (2G) PRODUCTION

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SCIENCE AND INDUSTRY IN A COUNTRY OF CHANGES

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SPIS TREŚCI:

Dear readers!

In September this year, the European Commission published the communication "Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people". The path of emission reduction, which was to lead to climate neutrality in 2050, has changed. In the new plans, the reduction of greenhouse gas emissions in the entire EU economy by 2030, compared to 1990, is to be lower by at least 55%. Achieving climate neutrality, however, requires a significant intensification of efforts in all sectors. In Poland, a "National Renewable Energy Action Plan" has been developed. The EU plan already takes into account the situation caused by COVID-19. According to the EU, the epidemic crisis has contributed to improving air quality and reducing environmental degradation. Only if we are be able to live in harmony with nature after returning to normality. It is certainly supported by the latest scientific achievements, e.g. the production of the second-generation bioethanol from lignocellulosic biomass and the commercialization of the projects, e.g. concerning the production of biogas in agricultural installations.

I encourage you to read and take care of the environment every day!

Magdalena Borek-Daruk
Deputy Editor-in-Chief

Links to:
- *EC Communication "Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people": https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52020DC0562*
- *National Renewable Energy Action Plan: https://www.ebb-eu.org/legis/ActionPlanDirective2009_28/national_renewable_energyyszne_plan_poland_en.pdf*

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LET'S REALIZE THAT WATER IS NOT INEXHAUSTIBLE

ELŻBIETA STĘPIEŃ
Economist, self-governing organization activist, M.P. of the VIII Seym cadence
Tagged with: energetic safety, forests, water, water resources

JULY, 24, 2020

The subject of limitation of water resources in Poland comes always back to the discussion accurately at the moment when the problem of draught appears in a public space. The foresters prohibit entrance to the forests, the farmers say: "we have a natural disaster again; we address the government for the support". This year, the draught which lasted in April and in May caused greater commotion among the Poles – perhaps due to the smaller occupation during the isolation period; the people could observe personally that the surrounding rivers resemble rather streams. Yes, it was the moment when almost all people were strongly moved by the problem of draught

We may nowadays notice that the interest in the increase of the possibilities of more effective utilizing of water resources and more responsible use of water is growing although we are still far from the level of the discussion, running in the Western Europe.

In my opinion, the level of knowledge of the inhabitants of our country in respect of water resources' protection is insufficient – we have water in our kitchen and bathroom taps and there is a plenty of rivers, ponds and lakes in Poland. We enjoy the green meadows, forests and pastures. This idyllic picture is, alas, deceiving and the problem of water deficit is approaching us in an insidious way.

Only a high awareness of the problem and feeling of social responsibility may encourage us to undertake the measures which would contribute to a reasonable use of the apparently most common chemical compound.

The scientists pay attention that the consequences of irresponsible use of drinking water may affect already our generation and we should also remember about our children and our grandchildren.


Fot. Pixabay

The nature signalizes spontaneously that water as well as air need our protection. We should consider its effect on the whole ecosystem. We should look more widely what water is and what is its role. H_2O is our common, free weal, remaining still universally available – it is the basic element of our existence.

Although as much as 71 % of the Earth surface is found under water, only 3% of its resources are suitable for consumption. Let's refer to imagination – if we compare our planet to the basketball, water would have a size of tennis ball and its 'sweet" (fresh water) version would have volume of small pea grain.

The resources of surface waters – those being fit for consumption – should be considered in aspect of the level of quantity and the state of quality.

When considering the hydrological conditions and geographic situation of Poland in the transitory moderate climate, we may say that the water resources in our country are small. The utilization of fresh water has a very wide application in households, in agriculture and in the industry.

The basic application of water in our houses is its use for consumption, hygiene and cleanliness maintenance. In agriculture, water is a basic factor in process of plant vegetation and in animal breeding. The industry utilizes water in the highest degree and, especially, in energetics; if we had no water, we would not have electricity in our houses.

Therefore, it is a justified statement that there is a need of implementing the system of the management of water resources in all levels of life and economy.

However, without active involvement of the government, local self-governing entities, non-governmental organizations and all of us, the protection of water resources and mitigation of the climate changes, with the simultaneously assurance of the economic development and higher quality of social life is possible.

I have met with a quite distinct statement that the successive war which will divide the world may be a conflict of struggle for water and certain prognoses say that even 200 million Europeans will be forced to migration for searches of water sources. We have still some time for the measures as to prevent such scenario coming true.

FAVOURABLE WINDS BENEATH THE WINGS OF POLISH ENERGETICS

Tagged with: Dawid Piekarz, energetyka, Energetyka24.com, farma wiatrowa, gospodarka, miks energetyczny, OZE

SEPTEMBER, 02, 2020

There are ca. 400 heat power plants and electric power plants in Poland, functioning in smaller and greater localities. They are the so-called "sleepy" actives of energetics. From one hand, they are theoretically mostly endangered to the risks connected with the more and more restrictive energy and climate policy of the EU and on the other hand, they may serve as a backbone of energetic transformation what requires reasonable and realistic strategy as well as investment plan.

The problem of local heat and power plants consists, first of all, in the fact of their relatively small scale of activity and basing mainly on coal. Meanwhile, the environmental rules will require more and more new investments, limiting the impact on the environment. The energy, produced by such units, will be loaded with the costs of the rights to emissions of CO_2, while the entities either have at their disposal a limited investment budget (being most frequently a property of self-governing authorities or a local company) or they recognize a given investment as unprofitable after exceeding a certain threshold of the costs. Nevertheless, the enterprises of such type have one advantage which cannot be overestimated: they are "the network", i.e. they are distributed on the whole territory of Poland and most often, they are in the possession of transmission infrastructure covering the area of its operation. It will have a great meaning as together with the energetic revolution, the destination of the discussed plants will be changes. Their tasks will be not limited to the heating of the objects and lighting the territories of their operation but, together with the development of OZE (renewable energy sources) they will play a role of stabilizers as clusters or energy cooperatives at the periods of insufficient production of renewable energy.

The discussed above plants may be generally modernized and de-carbonized by two methods. The first one – being more expensive and total in its nature – consists in the reconstruction of installations into the gas-operated ones. From one hand, however, the investments rise up highly the costs of fuel and from the other hand, they are reasonable in such places where the permanent receipt of big heat quantities is expected; although, the co-generation improves the financial indicators of such project to a small degree.

Another indirect method includes a gradual exchange of coal boilers into the multi-fuel ones, allowing also combustion of wastes, biomass and similar fuels, generating a lower emission. It is especially a favourable model for local self-governing bodies as the multi-fuel energy plant may be fired with wastes, biomass, coal or other local fuels, constituting post-production residues. Moreover, the discussed plants may help the self-governing organs in waste management, disposing a part of them for energy purposes and also, destine them for the needs of local agriculture, utilizing e.g. straw.

The discussed type of technology may be supported by the additional infrastructure such as gas peak load and reserve boilers (being *ad hoc* activated at the peak of demand on energy) and also, heat storage batteries allowing its accumulation and then, utilization. The possibility of utilizing and, simultaneously, producing hydrogen is another interesting option which should be considered in a long term perspective. The problem of OZE (renewable energy) instability consists in fact of too small effectiveness when 'it does not shine and does not blow" and also, of the excess of energy, produced by the mentioned sources in favourable atmospheric conditions.

The utilization of energy excess in hydrogen production is the optimum solution. It may be later on introduced to the market or utilized – in a certain type of closed circuit –in heat plant or i energy plant as zero-emissive fuel, being additionally produced from OZE at the moment when its value is almost equal to zero. We should remember that is cannot be sold when it is in excess and the price may be negative. Of course, such installation for production of hydrogen will gain the meaning in the perspective of several years – when hydrogen may become the alternative fuel of the future. We should mention here some projects oriented to the discussed direction. First of all, NCBR is running the research-innovative project "Energy power plant of the future" which will be focused on a small co-generation and support of OZE. Wrocław Cogeneration (PGE) plans to replace (in 2023) the coal heat power plant with a new plant "Nowa Czechnica" in Siechnice, being fired with the low-emission gas fuel. The connection of heat power plant Czechnica to the distribution network GAZ-SYSTEM is a project, considering the utilization of gas, supplied by the LNG Terminal and gas pipeline Baltic Pipe system. In 2022, the peak part of the new plant will be put into service; it will guarantee the trouble-free passage from the operated coal plant into the new one – based on gas. In turn, Veolia company is developing the heat plant in Zamość based upon the closed circuit economy, utilizing also incineration of municipal waste.

ENERGETIC REVOLUTION GRADUALLY, THAT IS, HOW TO ADAPT THE SMALLER POWER PLANTS TO THE CLIMATE POLICY

Tagged with: energetic safety, Dawid Piekarz, heat and power plant, energetics, NCBR, OZE, PGE, Veolia

JULY, 24, 2020

Web portal energetics.24.com has published the article by Dr Dawid Piekarz on the place of windmill farms in Polish energetic system. The Vice-President of the Staszic Institute indicates that it just the offshore windmill farms are expected to be the OZE (renewable energy sources) what will allow – in the greatest degree – replacing the professional carbon-based energetics.

Generally, we should stress two aspects which will be favourable for Polish, or more precisely, Baltic wind-driven energetics.


Fot. Pixabay

The first one is constituted by natural conditions, i.e. "better" winds as compared to those ones occurring over the North Sea because they blow more steadily, without gusts; the winds of such type drive the electricity-generating windmills best. The second aspect includes a certain type of "profit coming from underdevelopment": as we are commencing the construction of windmills as late as now, we will build those ones based upon the newest technology and the most effective available turbines. Their mean power would oscillate around 1 MW – Dr Piekarz writes.

It is worthy to mention also the further effects of developing the offshore wind energetics such as building of its infrastructure. The Government, in a special resolution, will indicate Gdynia as the place where the installation terminal for the needs of building the offshore wind farms will be constructed. The cost of the mentioned terminal would amount to ca. 500 million PLN. It would ensure the service not only to the investments at the Polish coast but also in other Baltic countries or in Sweden. Due to the needs and logistics, the second terminal would be most probable established in the Szczecin harbour – states the Vice-President of the Staszic Institute.

More to be found at: https://energetyka24.com/autorzy/wiatr-w-skrzydla-polskiej-energetyki

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LIGNOCELLULOSIC BIOMASS AS A FEEDSTOCK FOR THE CELLULOSE ETHANOL (2G) PRODUCTION

BIOMASA LIGNOCELULOZOWA JAKO SUBSTRAT DO PRODUKCJI ETANOLU CELULOZOWEGO (2G)

***Summary**: In the paper, the possibilities of utilizing the lignocellulosic biomass in the second generation bioethanol (2G) production were presented. The most important groups of lignocellulosic raw materials were characterized. The composition and structure of biomass and the methods for its conversion to ethanol were described. Moreover, the conceptions of utilizing the lignocellulosic biomass not only as the renewable energy source for production of biofuels but also of other products with the value added within the frames of integrated technological processes in biorefineries, with the consideration of the estimated costs of cellulose ethanol production were presented.*

***Keywords**: lignocellulosic biomass, biofuels, cellulose ethanol, the second generation (2G) bioethanol, biorefinery*

***Streszczenie**: W pracy przedstawiono możliwości wykorzystania biomasy lignocelulozowej do produkcji bioetanolu drugiej generacji (2G). Scharakteryzowano najważniejsze grupy surowców lignocelulozowych. Opisano skład i budowę biomasy oraz metody jej konwersji do bioetanolu. Ponadto zaprezentowano koncepcje wykorzystania biomasy lignocelulozowej nie tylko jako odnawialnego źródła do produkcji biopaliw, ale również innych produktów o wartości dodanej w ramach zintegrowanych procesów technologicznych w biorafineriach, z uwzględnieniem szacunkowych kosztów wytworzenia etanolu celulozowego.*

***Słowa kluczowe**: biomasa lignocelulozowa, biopaliwa, etanol celulozowy, bioetanol drugiej generacji (2G), biorafineria*

Introduction

The demand on energy has been systematically increasing for many years. It results, first of all, from the increasing number of population as well as due to the intensive development of industry. At present, the energetic needs are mainly satisfied by the traditional fossil fuels, however, their incineration is not neutral for the environment. The greenhouse gases (GHG) as emitted during combustion, constitute the greatest problem [1]. At the present moment, about 20% of the world energy is used on the electric energy whereas 80% are spent for the fuels [2]. In 2015, the transport sector itself was responsible for 19% of the world final demand on energy; the majority of it derived from fossil fuels [3].

One of the methods of climate changes' mitigation, with the simultaneous ensuring the energetic safety is production of alternative transport fuels [4]. The most important are biodiesel and bioethanol which is a substitute and bio-component for petrol. Bioethanol is produced first of all from the saccharose or starch-abundant raw materials [5]; however, their utilization stays in collision with the production of food and feeds [6]. They are the so-called first generation fuels, the participation of which in renewable energy in transport up to 2020 has been limited up to 7% in the Directive of the European Parliament and of the Council 2015/1513 of September 9, 2015. The mentioned Directive contains also the records concerning the necessity of supporting the studies in respect of advanced biofuels, including bioethanol of the second generation (2G).

The biofuels, produced from the lignocellulosic materials generate a low net emission of GHG and by this, decrease a negative effect on the environment, counteracting the unfavourable climate changes [7]. Production of advanced biofuels decreases the dependence on the fossil fuels, especially of crude oil import; it contributes also to the minimization of negative consequences for natural resources and food safety, supply and quality of water and soil on the local, regional and global levels [8].

In 2016, the European Commission submitted the legislative proposal, changing the Directive on the renewable energy sources and laying down the policy for the period after 2020. According to its assumptions, the participation of traditional biofuels should be further gradually decreased from 7% to 3.8% in 2030; the advanced biofuels should increase its share to 1.5% in transport fuels in 2021 and then, every year at least to 6.8% until 2030. According to the report of the International Renewable Energy Agency [9], 22% of transport fuels in 2050 will come from liquid biofuels and biogas.

Lignocellulosic raw materials

Bioethanol is produced from biomass, containing polysaccharides or carbohydrates which may be transformed into fermentable sugars. They are fist of all, sugar crops and by--products coming from sugar refining, starch-containing plants; it may be also lignocellulosic biomass [10] which is not only the renewable but also abundant source [Fig. 1). It is a sustainable alternative for petroleum-derivate fuels, it is universally available and reveals a smaller competition with production of food and feeds as compared to the substrates used for production of the first generation biofuels [11].

The complex structure (Fig. 2) is one of the main technical and economic barriers to utilization of lignocellulosic biomass as a raw material in production of biofuels [13]. The lignocellulosic biomass contains first of all polysaccharides, including cellulose (20–50%) and hemicellulose (15–35%), aromatic polymer – lignin (5–30%) [14, 15] and extracts and ashes [13]. Cellulose is the most popular natural polymer with a linear chain composed of glucose molecules. It consists of 100–1000 units, connected with β-1,4- glycoside bonds [16]. The cellulose chains constitute the so-called fibrils. The cellulose fibers, linked with the hydrogen bonds [17] are found in the lignocellulose matrix what makes that they are very resistant to enzymatic hydrolysis [18]. Hemicellulose creates the branched chains, composed of xylose molecules (usually C5 sugars). The degree of polymerisation of hemicelluloses is lower in comparison to cellulose and is found within the range of 100–200 units [19]. They act as physical barrier, limiting the availability for the enzymes [18]. Lignin is a heteropolymer composed of phenol alcohols' derivates, including p-coumaryl, coniferyl and sinapyl alcohols [20]. Lignin blocks the access of enzymes to cellulose; it may also irreversibly adsorb cellulases [18]. It is resistant to chemical and biological degradation. The presence of lignin in lignocellulosic substrates makes the fermentation process difficult in a considerable degree [21].

Fig. 1. The main groups of cellulosic feedstock [12]

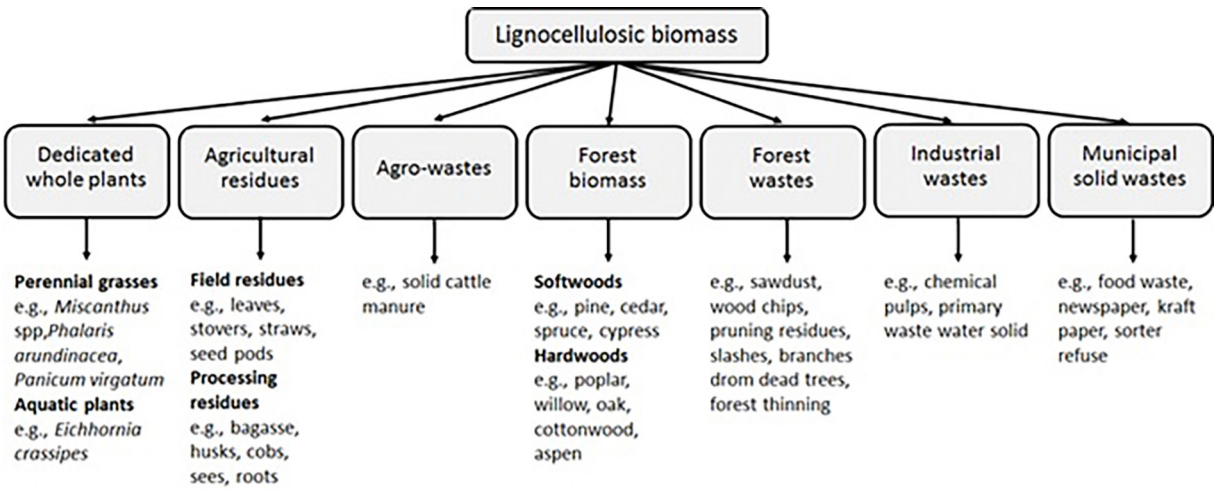
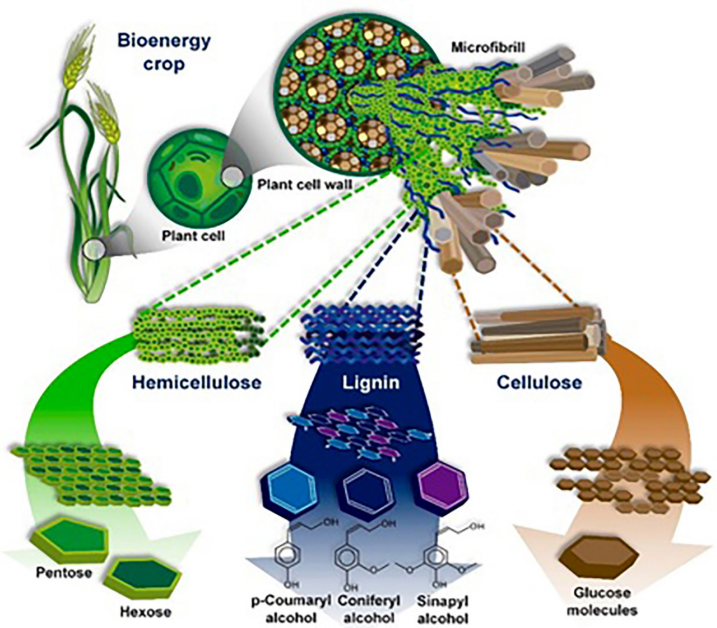


Fig. 2. Structure of lignocellulosic biomass [15]



The proportions of basic components differ depending on a type of the lignocellulose material (Tab. 1). The composition of biomass is significant as it affects the productivity of biofuels and their energetic efficiency [22].

Lignocellulosic biomass is one of the most abundant sources of bioenergy. Its global annual energetic potential is estimated at 100–270 EJ [16]; however, it is a material resistant to enzymatic hydrolysis what is determined by the structural factors, including crystallinity of cellulose and degree of its polymerisation, size of pores, volume and also, chemical factors, including the composition and the content of lignin, hemicellulose and acetyl groups [18].

Bioethanol from lignocellulosic biomass may be obtained by the thermo-chemical or biochemical conversion. In thermo-chemical process, the raw material is subjected to gasification and gas obtained from the synthesis is converted into ethanol with the application of *Clostridium ljungdahlii* bacteria. Production of cellulosic bioethanol by biochemical method is a complex, multistage process and it covers *inter alia*, preliminary treatment of raw materials, enzymatic hydrolysis, sugar fermentation and recovery of ethanol [23].

Table. 1. Composition of different lignocellulosic substrates [15]

Lignocellulosic substrates	Composition (% dry basis)		
	Cellulose	Hemicellulose	Lignin
bamboo stem	43.04	22.13	27.14
birch	40.1 ± 0.6	17.5 ± 0.2	24.2 ± 0.1
corn cob	42.0 ± 0.1	45.9 ± 0.9	2.8 ± 0.2
corn stalk	36.4 ± 0.1	30.3 ± 0.1	6.9 ± 1.4
corn stover	42.21	22.28	19.54
corn straw	49.3 ± 1.8	28.8 ± 1.4	7.5 ± 0.4
cotton stalk	41.6 ± 0.5	23.6 ± 0.4	23.3 ± 0.7
eucalyptus	52.07 ± 2.6	24.51 ± 1.1	25.2 ± 1.1
empty fruit bunch	34.9	26.64	31.1
giant reed	41.5 ± 2.6	20.5 ± 0.6	18.4 ± 1.4
grass	47.12 ± 3.2	36.01 ± 3.17	11.55 ± 0.3
maize straw	38.33 ± 0.8	29.76 ± 1.35	3..82 ± 0.5
meadow grass	41.28 ± 5.3	28.14 ± 3.2	30.14 ± 7.9
Miscanthus	36.3 ± 2.1	22.16 ± 1.9	22.55 ± 2.5
oat straw	35.0	28.2	4.1
oil palm empty fruit bunch	38.5 ± 1.9	26.1 ± 1.1	11.6 ± 1.6
pinewood	38.2 ± 0.3	24.1 ± 0.7	34.4 ± 0.3
poplar	46.0 ± 0.1	16.7 ± 0.1	26..6 ± 0.3
rice hulls	36.0	12.0	26.0
rice straw	37.8 ± 0.2	29.6 ± 0.7	14.8 ± 0.4
rye straw	36.5 ± 0.1	not reported	21.3 ± 0.1
sawdust waste	31.5 ± 1.3	26.1 ± 2.1	24.9 ± 1.7
sorghum straw	26.93 ± 1.2	32.57 ± 1.9	10.16 ± 1.8
spruce	24.7 ± 0.2	10.2 ± 0.1	35.0 ± 0.3
sugarcane bagasse	46.1 ± 0.7	20.1 ± 0.9	20.3 ± 0.6
sunflower stalk	34 ± 0.6	20.8 ± 0.8	29.7 ± 0.6
water hyacinth	36.84 ± 0.8	27.7 ± 0.2	10.7 ± 0.4
wheat straw	43.4	26.9	22.2
willow sawdust	35.6 ± 0.9	21.5 ± 0.9	28.7 ± 0.2

Preliminary treatment of lignocellulosic biomass

The basic problem consists in effective separation of sugars from lignocellulosic biomass. The preliminary treatment changes its structure and owing to this fact, the conversion of polysaccharides to fermentable sugars is possible [18]. The significant factor includes first of all removal of lignin, limiting the cellulose and hemicellulose hydrolysis in a great degree. The discussed processes utilize the methods which affect not only the content of lignin but also change a crystalline nature of cellulose and decrease the size of the particles of the initial material what results in rise of the level of lignocellulosic biomass digestibility [24]. After the preliminary treatment, cellulose is exposed, more available for cellulases and is hydrolysed quicker than that the untreated one [25].

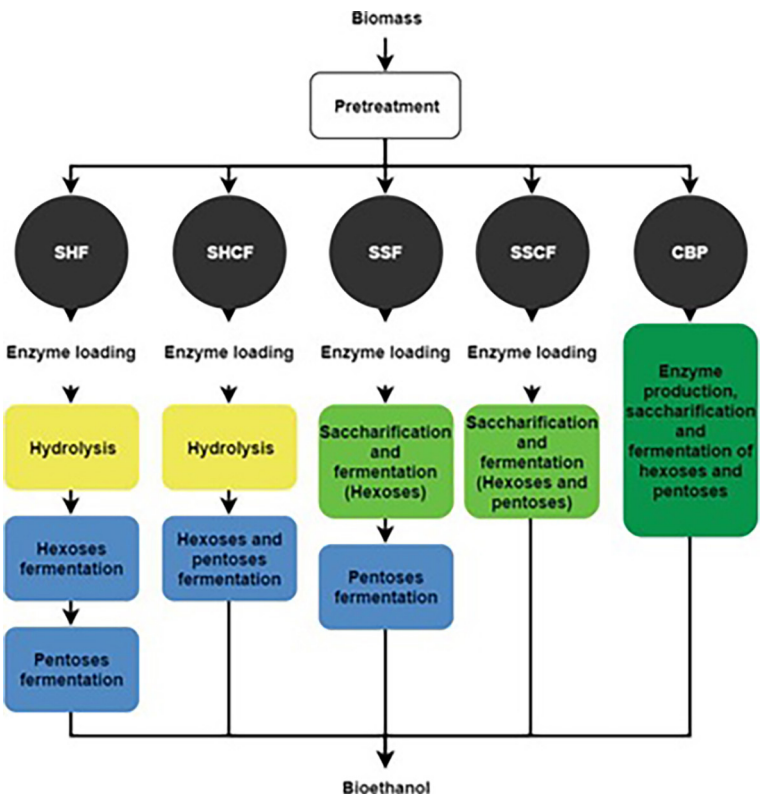
The features of ideal pre-treatment process:

- Obtaining of cellulose substrate sensitive to enzymatic hydrolysis,
- Minimum degradation of sugars or carbohydrates,
- Generation of minimum inhibitors and compounds toxic for microorganisms responsible for ethanol fermentation process,
- Low energy consumption in the process,
- The conditions of the process are favourable for lowering of the capital and operating costs,
- Inexpensive and recyclable chemicals used in the pre-treatment,
- The possibility of treating different types of biomass,
- Generation of by-products from lignin and hemicellulose, being suitable in various other industrial sectors,
- Scalability of the process, enabling its application in commercial purposes,
- A small negative impact on the environment [16].

Basic methods of preliminary treatment include as follows:

- Physical methods – they are employed with the aim to destroy a crystalline structure of cellulose, to decrease the size of the particles and to increase the area of surface of the raw material; they do not affect the chemical composition of the raw material; cellular walls are not subject to degradation; the significant structural changes do not occur,
- Chemical methods – they utilize chemical reagents, generally at the increased temperatures; they may cause a removal of hemicellulose by its dissolving or hydrolysis, removal of lignin (delignification) by destroying of the structures (depolymerisation and dissolving), liquefying of cellulose and preliminary hydrolysis [16],
- Physico-chemical methods – they employ water vapour explosion, combination of water vapour explosion and alkaline methods of the preliminary treatment of raw material in liquid anhydrous ammonia in the conditions of high temperature (90–100°C) and high pressure (1–5.2 MPa), application of CO2 which during water vapour treatment generated carbonic acid, facilitating hemicellulose hydrolysis: they use SO2 and acids at low temperatures to a partial dissolving of cellulose and catalytic technologies, based upon the oxidation processes [26],

Fig. 3. Processes for the second generation bioethanol production [32]



- Biological methods – they utilize lignolytic potential of certain microorganisms; owing to hydrolytic enzymes (oxidoreductases), microorganisms are able to decompose lignin effectively; the processes of decomposition may be conducted when cultivating microorganisms directly on the lignocellulose raw material or using enzymatic extracts [27].

After the preliminary treatment, the substrate is subjected to enzymatic depolymerisation. It is the most expensive stage due to a high cost of enzymes. In the obtained hydrolysate, C-5 and C-6 sugars are found which may be subjected to fermentation with generation of bioethanol [11]. In the process of ethanol fermentation, we may employ various modifications (Fig. 3), including separation of the process of enzymatic hydrolysis and fermentation [28] and run each of them separately in the optimal conditions (SHF method – separate hydrolysis and fermentation). Hydrolysis and fermentation may be conducted also together (SSF – simultaneous sacharification and fermentation). Sugars generated during hydrolysis are simultaneously fermented to ethanol. The studies confirm the effectiveness of the discussed technology of the 2nd generation bioethanol production from lignocellulose wastes [29]. In SSCF method (simultaneous sacharification and co-fermentation) not only sacharification and fermentation of hexoses but also fermentation of pentoses takes place [30]. In SHCF method (separate hydrolysis and co-fermentation), the processes of hydrolysis and fermentation run separately, whereas the fermentation of hexoses and pentoses occurs simultaneously. In CBP (consolidated bio-processing) method, we may combine production of enzymes, enzymatic sacharification and fermentation in one stage [31].

Lignocellulosic bio-refineries

Processing of lignocellulosic biomass in the so-called bio-refineries is economically justified; apart from the fuel, we may also obtain valuable bio-chemicals and biomaterials for application in other sectors of industry (Tab. 2). To produce them, the parts of biomass being not used directly in ethanol production, are first of all employed.

The high-value by-products may be obtained from the lignin, being separated in the earlier stage of the process (Fig. 4) and from hemicelluloses and C5 sugar subjected to a separate fermentation (Fig. 5). Additionally, some different energy carriers may be also produced (Fig. 6).

In 2017, there were 224 biorefineries acting in Europe, however only 43 were the second generation bio-refineries, utilizing, *inter alia*, non-consumption plants and bio-wastes. In the

Table. 2. Lignocellulosic biorefinery products [11]

Biofuels	Bioenergy	Food products	Biochemicals	Biomaterials
biodiesel, bioethanol and biomethane	steam power, electricity steam, syngas, heat, charcoal and lignin	sugar and substitutes, proteins, amino acids, gluten, protective colloids thickeners, emulsifiers and stabilisers	simpler hexose and pentoses, and their degradation products such as 5-hydroxy methyl furfural, glycerol, agrochemicals, fertilisers, sorbitol, phenols, coloured compounds, solvents, omega-3 fatty acids and biosurfactants	pulp and papers, PHB, activated carbon, bioplastics, bio-based epoxy, resin, cement, bioadhesives, bio-based polymers, bio-nanocomposites, etc.

Fig. 4. Conception of "lignin-driven" bioethanol based biorefinery [33]

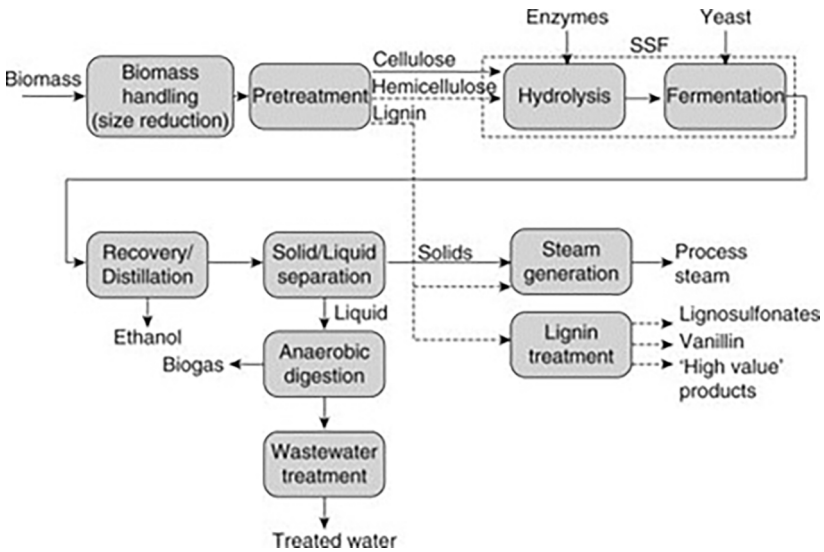


Fig. 5. Conception of "C5-driven" bioethanol-based biorefinery [33]

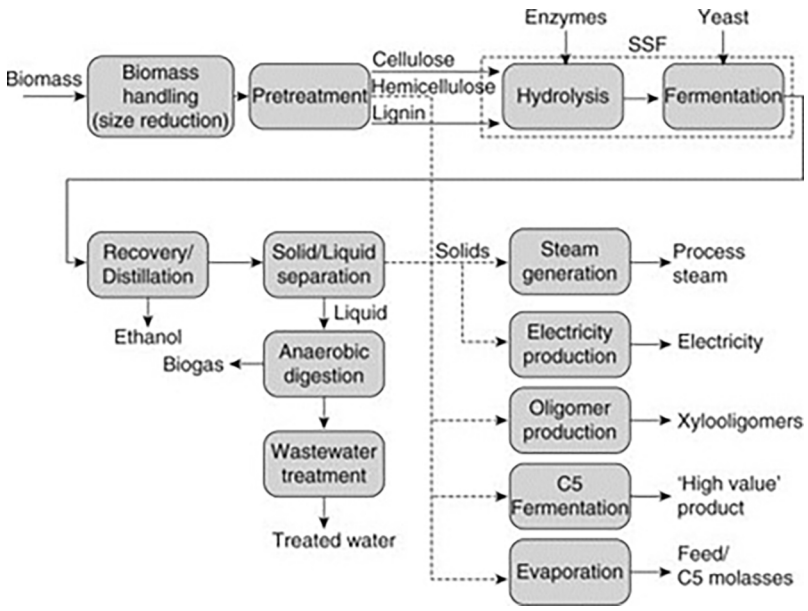
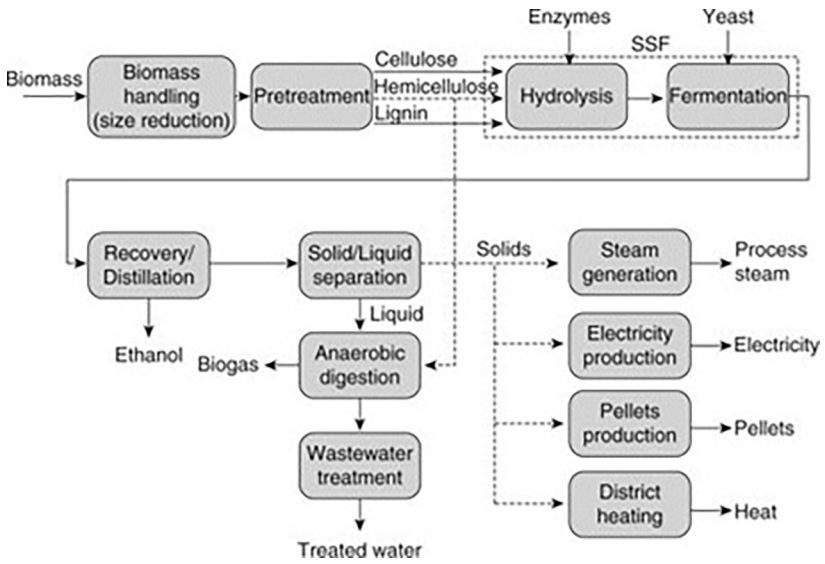


Fig. 6. Conception of "energy-driven" bioethanol-based biorefinery [33]



previous years, the EU finances a lot of the projects connected with the biorefining industry (Tab. 3), concerning the utilization of various fractions of biomass in the efficient and sustainable way [34]. Production of ethanol from cellulose materials is a promising technology which may help in energetic diversification and in decarbonisation of transport sector. Cellulosic bioethanol allows not only GHG emissions but has also a low ILUC coefficient connected with the indirect consequences of the changes in land utilization. Moreover, it is subjected to mechanism of double counting what means that the content of energy in the discussed biofuel is twice calculated in the total aim in respect of renewable energy in transport [35].

It is estimated that the investment costs on the plants of this type are found in the limits between 2570 EUR/kW and 3650 EUR/kW for ethanol production and it is dependent, *inter alia*, on the size of the plant, complexity of technology and location. The costs of raw material are dependent first of all on its type and availability in the site and are estimated at 10–20 EUR/MWh (50–100 EUR/tonne of dry matter) we should also add the costs of enzymes necessary for the hydrolysis process of order 15–30 EUR/MWh of the product and the remaining operating costs in amount of 13–18 EUR/MWh connected with the labour costs and purchase of media. As the discussed technologies are found in the stage of commercialization, there is a possibility of lowering the costs (Tab. 4) via optimization of the processes, integration with other technologies being advantageous for improvement of the effectiveness of the obtained by-products [36].

There are already a few plants in the world which produce cellulose ethanol in the commercial scale, e.g. Borregaard Industries AS in Norway (efficiency 16 kilo tonnes), Raizen Energia (36 k tons) and GranBio (65 k tons) in Brasil and POET-DSM Advanced Bio-fuels in the USA (75 k tons) [35].

Table 3. The selected projects, financed by the EU concerning utilization of lignocellulosic raw materials in biorefineries [34]

Project name	Biorefinery feedstock	Country coordinated in	Period	Total cost (€)
AgriChemWhey	Byproducts from dairy processing	Ireland	2018–2021	29 949.323
GRACE	Miscanthus or hemp varieties from marginal lands	Germany	2017–2022	15 000 851.21
SmartLi	Kraft lignins, lignosulfonates, and bleaching effluents	Finland	2015–2019	2 407 461.25
BIOSKOH	Lignocellulosic feedstock	Italy	2016–2021	30 122 313.75
BARBARA	Agri and food waste	Spain	2017–2020	2 711 375
AgriMax	Agri and food waste	Spain	2016–2020	15 543 494.56
PULP2VALUE	Sugarbeet pulp	Netherlands	2015–2019	11 428 347.50
GreenSolRes	Lignocellulosic residues or wastes	Netherlands	2016–2020	10 609 637.01
Dendromass4Europe	Dendromass on marginal land	Germany	2017–2022	20 442 318.75
YLFEED	Wood residues	France	2017–2020	14 976 590
GreenProtein	Vegetable residues from packed salad processing	Netherlands	2016–2021	5 546 519.99
PROMINENT	Cereal processing side streams	Finland	2015–2018	3 103 897.50
FIRST2RUN	Cardoon from marginal lands	Italy	2015–2019	25 022 688.75
Zelcor	Lignocellulosic residues from ethanol production, lignins dissolved during pulping process, and lignin-like humins formed by sugar conversion	France	2016–2020	6 710 012.50
STAR4BBI	Lignocellulosic feedstocks from forests and agriculture	Netherlands	2016–2019	995 877.50
BIOrescue	Wheat straw and agro-industrial waste	Spain	2016–2019	3 767 587.50
OPTISOCHEM	Residual wheat straw	France	2017–2021	16 376 816.83
US4GREENCHEM	Lignocellulosic feedstock	Germany	2015–2019	3 803 925
FUNGUSCHAIN	Mushroom (*Agaricus bisporus*) farming residues	Netherlands	2016–2020	8 143 661.25
POLYBIOSKIN	Food waste	Spain	2017–2020	4 058 359.38
ValChem	Woody feedstock	Finland	2015–2019	18 502 703.25
LIBBIO	Andes lupine from marginal lands	Iceland	2016–2020	4 923 750

Table 4. Potential costs of cellulosic ethanol production after reductions [36]

Process	Costs, EUR/MWh					
	Low cost feedstock: 13 EUR/MWh			High cost feedstock: 20 EUR/MWh		
	SGAB*	Future costs		SGAB*	Future costs	
		Pessimistic	Optimistic		Pessimistic	Optimistic
Investment cost EUR/kW output	(SGAB Low) 2,570	(SGAB-25%) 1,928	(SGAB-50%) 1,285	(SGAB High) 3,650	(SGAB-25%) 2,738	(SGAB-50%) 1,825
	Total production costs (EUR/MWh)					
Capital	42	32	21	60	45	30
Feedstock	33	33	33	50	50	50
Operating costs	28	25	22	48	27	24
Total	103	90	76	158	122	104

** Sub-Group on Advanced Biofuels*

Summing up

Lignocellulosic biomass is a material which may be successfully utilized as a raw material for production of the second generation bioethanol. Its manufacture is not dangerous to the food production and has a positive impact on the environment. The application of cellulose ethanol reduces energy consumption from traditional carriers so it is favourable for limitation of greenhouse gases' emission. Its production is, however, purposeful in biorefining processes where – apart from the biofuels itself – we may obtain many additional products, electric energy and heat. They constitute the value added and have a favourable effect on economic balance of the whole process.

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EVALUATION OF PROFITABILITY OF COMMERCIAL UNDERTAKINGS CONCERNING BIOGAS PRODUCTION IN AGRICULTURAL INSTALLATIONS

OCENA OPŁACALNOŚCI PRZEDSIĘWZIĘĆ KOMERCYJNYCH DLA PRODUKCJI BIOGAZU W INSTALACJACH ROLNICZYCH

***Summary**: In the paper, the economic aspects of the commercial undertakings of individual farmers in favour of biogas production in agricultural installations were presented. The evaluation of the profitability was carried out basing upon the investment model.*
The barriers to the development of biogas plant building in social, organizational, engineering and economic and legal contexts were described.
The operation of pilot biogas plant, implemented at the agricultural farm was presented. The experimental studies showed that the agricultural biogas plant reached more than 80% methane with the application of pork slurry. The tested cogeneration system in which the so-called biogas treatment at a low pressure was applied, allows the choice of energy-saving heat fittings what results in reliability of automation of the technological process.
The conducted considerations have revealed that investing in agricultural biogas plants may become the area of interest of investors – as individual farmers – possessing the infrastructure in a form of pig houses and the open lagoon where the pork manure has been stored until now.

***Keywords**: individual farm, pork slurry, agricultural biogas, mobile biogas plant*

***Streszczenie**: W artykule przedstawiono aspekty ekonomiczne w oparciu o model inwestycyjny dla ocena opłacalności przedsięwzięć komercyjnych realizowanych przez rolników indywidualnych na rzecz produkcji biogazu w instalacjach rolniczych.*
Opisano bariery rozwoju budowy biogazowni w kontekście społecznym, organizacyjnym, techniczno-technologicznym oraz ekonomiczno-prawnym.
Przedstawiono eksploatację biogazowni pilotażowej wdrożonej na terenie gospodarstwa rolnego wskazując na badania eksperymentalne biogazowni rolniczej osiągającej ponad 80% metanu przy zastosowaniu gnojowicy świńskiej. Testowany obecnie układ kogeneracji, w którym zastosowano tzw. uzdatnianie biogazu na niskim ciśnieniu pozwala na dobór energooszczędnej armatury ciepłowniczej, co przekłada się na niezawodność automatyzacji procesu technologicznego
Przeprowadzone rozważania wykazały, że inwestycje w biogazownie rolnicze mogą stanowić obszar zainteresowań inwestorów, jako rolników indywidualnych - posiadających infrastrukturę w postaci budynków chlewni oraz otwartej laguny, w której dotychczas magazynowano gnojowicę świńską.

***Słowa kluczowe**: gospodarstwo indywidualne, gnojowica świńska, biogaz rolniczy, biogazownia mobilna*

Introduction

Renewable energy sources (in Polish: OZE) have become more and more significant component in energetic balance of Poland, constituting a characteristics value of innovative and perspective economy. A special role in the mentioned process is ascribed to energy obtained from biogas, including agricultural biogas [1]. It is manifested in the governmental programme "Directions of development of agricultural biogas manufacturing plants in Poland", developed by the Ministry of Economy and adopted by the Council of the Ministers on July, 13, 2010 [9].

The implemented document in a necessary element of the planned process of establishing, in average, one agricultural biogas plant in each community annually up to 2020; it would utilize agricultural-origin biomass, with the assumption of having the appropriate conditions in the specified community to perform the discussed undertaking. The implementation of the assumptions of the programme is aimed at enabling the utilization of a real available potential of raw material for production of biogas which is present in agricultural by-products and the residues of agri-food industry. According to Curkowski et al. [1], the discussed potential is estimated at ca. 1.7 billion m^3 of the available biogas per year. We should bear in mind that in Poland about 14 billion m^3 of the natural gas are used in Poland annually while the individual users from the rural areas utilize ca. 500 million m^3 of gas.

The development of enterprises is indispensably connected with the skill of investing which is defined as a necessary condition of reproduction of resources in the economy whereas the structural changes in the economy must be an effective tool [11]. The development of the instruments the tasks of which is to evaluate the investment effectiveness has been observed. Therefore, the agricultural biogas plants are nowadays a stable source of electric energy production and more frequently, of heat. They are, simultaneously, one of the developmental technologies of electric energy production from the renewable

energy sources – hence, there is a necessity of conducting the thorough analyses on the level of investment decisions [10].

The most technically advanced biogas plants over the world have been constructed in Germany and Denmark for fifteen years. In the countries such as Austria, Switzerland and Sweden, the development of biogas plants is found at somewhat lower level [3]. In other countries, e.g. Spain, Italy, Belgium and the Netherlands, the first modern biogas-producing plants have been functioned for few years; the successive ones are found in the state of construction. In Europe, many countries are greatly interested in the development of biogas plants, especially Poland, Hungary, Lithuania, Great Britain and Ireland [8; 12].

According to the opinion of Renewable Energy Institute, the mean cost of building a bio-gas plant in Poland as calculated into 1.0 MW is ca. (15÷16) million PLN/MW. Financial model, based upon the calculations and the available materials assumes that the budget of building of bio-gas plant from the purchase of land until starting up the plant would be equal to 16.1 million PLN [10].

It was anticipated to obtain financing means in 2017 in a form of long-term credit. The model assumed that the investor would obtain the sum of 3.2 million PLN at the preferential conditions and, hence, he would obtain the cost of capital at the level of 3% during the whole crediting period. The remaining amount, i.e. 7.2 million PLN would be obtained when assuming the interest rate at the level of 7% in the first period and 6% since the moment of starting up the bio-gas plant. The payment of the interests would begin just at the moment of incurring the obligation; on the other hand, the capital in each of the credits would be paid since December 2018 for the period of 10 years. It was also assumed that in 2017, the investor would receive a decision on granting a subsidy for building of the biogas plant in the amount of 5 million PLN. The remaining sum, i.e. 0.7 million PLN would be the own contribution of the investor. The current expenses and a part of land purchase cost would be paid from the own means of the investor. Technology, premises, equipment and machines as well as infrastructure would be covered proportionally from the external financing sources. The system of co-generation together with the fermentation chambers and installations would be the most expensive element. They would constitute almost a half of total outlays. For the needs of appreciation, VAT tax was omitted. It was assumed that during the investment run, the investor would apply for VAT tax return during each period, so it would become neutral from the viewpoint of investment evaluation.

It was adopted for calculations that the biogas plant would work for 8000 h in the annual scale, that is, 334 days (91% of the whole year). Therefore, there is no much time left for downtime or maintenance work. Service of biogas plant requires at least one person, staying on its territory for the whole time. Many operations are mechanized; nevertheless, in the case of any failure, the immediate reaction is necessary.

A part of the electric energy as well as of heat will be used for process purposes. In the case of heat only 20% of the total heat production will be destined for sale. In the case of electricity, more than 90% of the produced electric energy will be destined for sale purposes. Setting up the biogas plant was planned for the beginning of 2008 so as to enable the implementation of 8000 work hours by the biogas plant during the whole year [10].

When considering the above model, we should expect the barriers to the development of the biogas plants.

Barriers to the development

Construction of biogas plants is undoubtedly a very big investment undertaking. The future investors are required to have considerable financial outlays, a good crediting capability and a wide knowledge in many domains which are mutually penetrating each other at the stage of planning and implementing the investment. Biogas plant, as being one of the methods for obtaining a green energy, may be the instrument effective in financial aspect. The conducted model analysis of building and operating the biogas plant has revealed that it is economically profitable investment. However, there is a very high risk of investing the means in this area. It must be considered at every stage of planning the investment as well as in the later period of its operation. Moreover, the biogas market is characterized by many barriers which must be considered throughout the whole analysis of the discussed enterprise. The attempts to systematize them bring their classification into four main areas: social, organizational, technical and technological, and legal-economic ones [5]:

1) Social barriers:
   - Negative perception of future investors by the inhabitants of the territories where the construction of the biogas plant is anticipated;
   - Concerns of the future investors in connection with a high instability of the sector;
2) Organizational barriers:
   - Lack of local plans for spatial development of the areas;
   - Lack of professional preparation of the officials for running the investments in a sector;
   - Organizational disintegration of the sector at the territory of the country;
   - The necessity of correlating the heat receipt and gas production, especially in the rural areas where there is no possibility to transfer heat (rural areas do not have the heat infrastructure),
   - Lack of the national research laboratories and support centres for the future investors,
   - Lack of reliable investment advisory activity;
3) Technical and technological barriers:
   - Temptation to invest in big biogas plants which bring higher profits and allow obtaining higher return rates from the involved capital,
   - The entities interested in building of small biogas plants do not receive a support on the market, lack of the institutions dealing with introduction of implementation of such small projects;
   - Lack of Polish engineering ideas which would allow adapting the biogas plants to our market and by this, to contribute to

lowering the costs of the investment,
- Initial unsuccessful attempts and the opinion on a high risk of such investment,

4) Legal and economic barriers:
- Lack of a stable support of OZE (Renewable Energy Sources) in the legislation,
- High capital barriers to the building of biogas plants,
- A strong position of energetic enterprises on the market and the necessity of complying to their requirements, being often too high for the farmers who would like to commence the discussed activity on the occasion of running agricultural farms,
- Bureaucracy, existing at the level of applying for support from the public means,
- A long period of return from the involved capital.

The experimental studies on agricultural biogas plants

Poland has a high potential of biogas: about 12% of energetic resources of biomass of the whole Europe, are found at the territory of our country. We are not able, however, to utilize it in an effective way. A lack of technological support from the leading scientific centres in Poland deepens a gap in this sector. The capital intensiveness plays the greatest role. High financial outlays in combination with a long period of return might change only when in Poland the production of particular components necessary for biogas plant building is conducted at the higher scale. In longer perspective the profits for the future investors have not been also specified. In spite of the fact that the Ministry of Economy has developed "Guidebook for the investors, interested in building of biogas plants" [6] which explained many doubts, still the gap on the market is recorded; it does not offer the ready solutions, especially for prosumer co-generation when using micro-biogas plant e.g. up to 40kWel. It is necessary to undertake the successive attempts and develop practical models of functioning for such innovative solutions.

The operation of pilot biogas plant, situated at the territory of agricultural farm in Ocieszyn (Photo. 1a) is one of the examples of the undertaken efforts. The installation for production of biogas, as implemented under the project BIOGAS&EE, financed by the National Centre of Studies and Development within BIOSTRATEG 1 programme, is managed by the Head of the Project, Grzegorz Wałowski, PhD, Eng. The solution of the problem was performed by the Institute of Technology and Life Sciences in Falenty and, more precisely, Department of Renewable Energies in Poznań; the cogeneration system with the so-called biogas treatment at a low pressure is tested at this moment. The biogas is directly supplied to the co-generator with the application of the elements of infrastructure of:
- American producer (Woodward) of automation systems, including advanced controller, throttles with electronic actuators, agitators, controllers of engine work to gas power generators and co-generation aggregates;
- German producer (Karl Dungs GmbH & Co. KG) of high-quality gas fittings, including filters, reducers, zero pressure regulators, integrated electro-valves with tightness control systems,
- Polish producer and distributor of energy-saving heating fittings for central heating system and water heater system (in Polish CWU) (WOMIX), including mixing valves together with drivers, complete systems of pump groups, automatics of heating installations [13].

Designing and building of a model of mono-substrate flow biogas reactor was implemented based on the inventory [7]. The fermentation tank is (cylindrical shape) is situated in vertical position and the bottom of the tank has a shape of cut cone with centrally situated drainage hole. The tightness of the fermentation tank is ensured by cover, closing the fermentor, together with the sealing element. The pilot production of biogas (Photo 1a) consisting of the systems: hydrodynamic agitation, heating, immobilization [15], with the use of pork slurry was situated at the territory of agricultural farm, possessing 1100 porkers managed on a slatted floor [14].

Fot. 1. Pilot biogas plant: a) site of biogas plant (a view [Photo by G. Wałowski] – from right: fragment of pig house, mono substrate flow rector for methane fermentation of pig slurry together with the installation for production of agricultural biogas, lagoon for post-fermentation product; b) adhesion bed, made from vertical pipes with coarseness of 80 µm, transported to the inside of fermentor – a view [Photo by G. Wałowski].

a)

b)

Inside the fermentation tank, there is a filling i.e. skeletal bed, made from vertical PVC pipelines, constituting the so-called "basket" (Photo 1b), the role of which is to increase the active surface for development of fermentative bacteria microflora [15].

Summing up

The investments in OZE (renewable energy) are long-term and require systematic and consequent action. What it is unprofitable at the present moment, it may become profitable in the perspective of few years. Many barriers which obstruct OZE development at each level may gradually decrease with the time. All barriers, including those psychological, social, legal, economic and political ones should be minimized or considerably reduced. Moreover, it is necessary to develop the effective instruments, which would promote and encourage investing in the discussed area. The support for the future investors and education of the society is the first step to contribute to increasing the interest in the discussed area among the potential investors. All mentioned activities must be coordinated at the central level as to ensure a full flow of information [10].

Economical profits resulting from the construction of biogas plant may be considered from the viewpoint of biogas producer and local community. For the producer, the sale of energy, certificates of origin, the so-called green certificates as well as other securities, heat and manure or post-fermentation biomass may constitute a source of income.

For community authorities, for example, the taxes paid by the biogas producer to the community authorities may be a measurable economic effect. A direct economic effect may be achieved by the local shops, owing to the sale of fertilizers, plant protection agents and fuels necessary for biomass production.

Also, a part of machines and equipment is purchased at the local market, especially those ones used in the current operation of the biogas plant (oils, greases, small spare parts, materials necessary for ensiling of biomass, etc).

Certain biogas plants deliver heat to the local users (houses, settlements or schools) at the competitive price as compared to the traditional sources. The biogas plant functions almost for the whole year, so it is a stable, constant and reliable heat supplier. The negotiations on the heat prices may be the important bargaining chip at the stage of social consultations. The signing of the long-term agreement, with the consideration of a stable price, would be a profitable solution for the both sides [4].

The conducted consideration has revealed however that investing in agricultural biogas plants may become the domain of interest of the investors; in spite of the fact that the mentioned investments are characterized by a high sensitivity, they bring the value added in a longer period of time. On the other hand, at the present investment costs, it is very important to have the investing support of the biogas plant construction; it would considerably allow abbreviating the period of return and by this, increase the interest of the future investors in building the biogas plants [10].

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THE ROLE OF ANALYTICAL DIAGRAMS IN THE PREPARATION OF METHODICAL PROCEDURES IN MODERN, CHEMICAL RESEARCH LABORATORIES

ROLA DIAGRAMÓW ANALITYCZNYCH W PRZYGOTOWANIU PROCEDUR METODYCZNYCH W NOWOCZESNYCH, CHEMICZNYCH LABORATORIACH BADAWCZYCH

Summary: *In correctly functioning chemical research laboratories, employing GLP (Good Laboratory Practice) principles, especially in accredited laboratories or those ones applying for the accreditation certificate, it is necessary – apart from the development of the policy of quality and systemic procedures – to prepare the methodological (analytical) procedures in a form, being consistent and comprehensible for the laboratory staff. The analytical diagrams, developed in a synthetic and transparent form, are a significant factor in the mentioned documents. In the present paper, the methods of constructing the analytical diagrams in the field of the studies on testing and materials for the determination of chemical composition of the isolated intermetallic γ' phases, when applying the technique of atomic absorption spectrometry (AAS), exposing the element form in the first case and a complex form with consideration of the specified dilutions of the analyzed samples (comprehensive analytical diagram) in the second case.*

Keywords: *analytical diagrams, isolates of γ' phase, atomic absorption spectrometry (AAS)*

Streszczenie: *W prawidłowo funkcjonujących chemicznych laboratoriach badawczych stosujących zasady GLP – Good Laboratory Practice, zwłaszcza w laboratoriach akredytowanych lub ubiegających się o certyfikat akredytacji, oprócz opracowania polityki jakości i procedur systemowych, konieczne jest również przygotowanie w zwartej i zrozumiałej dla personelu laboratoryjnego formie, procedur metodycznych (analitycznych). Istotnym czynnikiem w tych dokumentach są opracowane w syntetycznej i przejrzystej postaci diagramy analityczne. W niniejszej pracy przedstawiono sposoby konstruowania diagramów analitycznych w obszarze badań materiałoznawczych, do określania składu chemicznego wyizolowanych faz międzymetalicznych γ', stosując technikę atomowej spektrometrii absorpcyjnej [ang. atomic absorption spektrometry] (AAS), eksponując w pierwszym przypadku formę pierwiastkową, a w drugim kompleksową z uwzględnieniem konkretnych rozcieńczeń roztworów próbek analizowanych (ang.comprehensive analytical diagram).*

Słowa kluczowe: *diagramy analityczne, izolaty fazy γ', atomowa spektrometria absorpcyjna (AAS)*

Introduction

The increasing requirements connected with the integration with the European Union structures and stronger and stronger competition on the domestic market, including also that one between the research units, have brought about the necessity of guaranteeing the high quality of the performed tests and reliability of the obtained results by the research laboratories [1–3]. General requirements concerning the competences of the research and calibration laboratories cause that it becomes necessary to systematize the basic activities connected with the development and introduction of quality system in the field of research laboratories' management. The discussed topic is very complicated as it covers the management of the lab resources as well as the technical competences. The mentioned competences should be referred in particular to the laboratory staff and, more precisely to its qualifications and preparation to perform the specified tests or determinations, to laboratory rooms, satisfying the appropriate requirements for running the discussed tests, to the laboratory equipment with the analytical instruments and control-measuring devices and in the auxiliary equipment in respect of preparing the delivered samples to tests. Use of chemical reagents and standards, possessing the necessary certificates, the laboratory glassware of the appropriate grade etc. and, what is very important, development of the appropriate analytical methods together with their validation [4–11]. The mentioned areas of technical competences of the research laboratories constitute simultaneously the most important GLP (Good Laboratory Practice) principles.

In the present paper, when referring to the methodology of the tests, the methods of constructing the analytical diagrams in the extremely difficult area of the studies on testing and materials i.e. for determination of chemical composition of the inter-metallic γ' phase isolates with the application of atomic absorption spectrometry, have been presented [11–15].

Short characteristic of γ' phase

The creep resistance of multi-component nickel alloys is mainly determined by the presence of γ' phase, due to a complex of its very specific properties [15]. The choice of the chemical composition of the creep-resistant nickel-based alloys determines the amount of the γ' phase precipitates. In many cases, the volume fraction of the γ' phase precipitates in the structure of nickel superalloys is up to 68%. Depending on the amount of alloying constituents added to nickel alloys and their final content in these alloys, and on the applied variant of alloy heat treatment, the chemical composition of the γ'-Ni_3(Al, X) phase, where X = Ti, Ta, Nb, can vary in a very wide range of values. This is due to the fact that cobalt can replace nickel, while titanium, niobium and tantalum can occupy the position of aluminium in the ordered γ' phase lattice. Molybdenum, chromium and iron can replace both aluminium and nickel in the Ni_3Al compound [15]. Typically, in the precipitates of γ' phase, the content of from five to ten metal elements is determined.

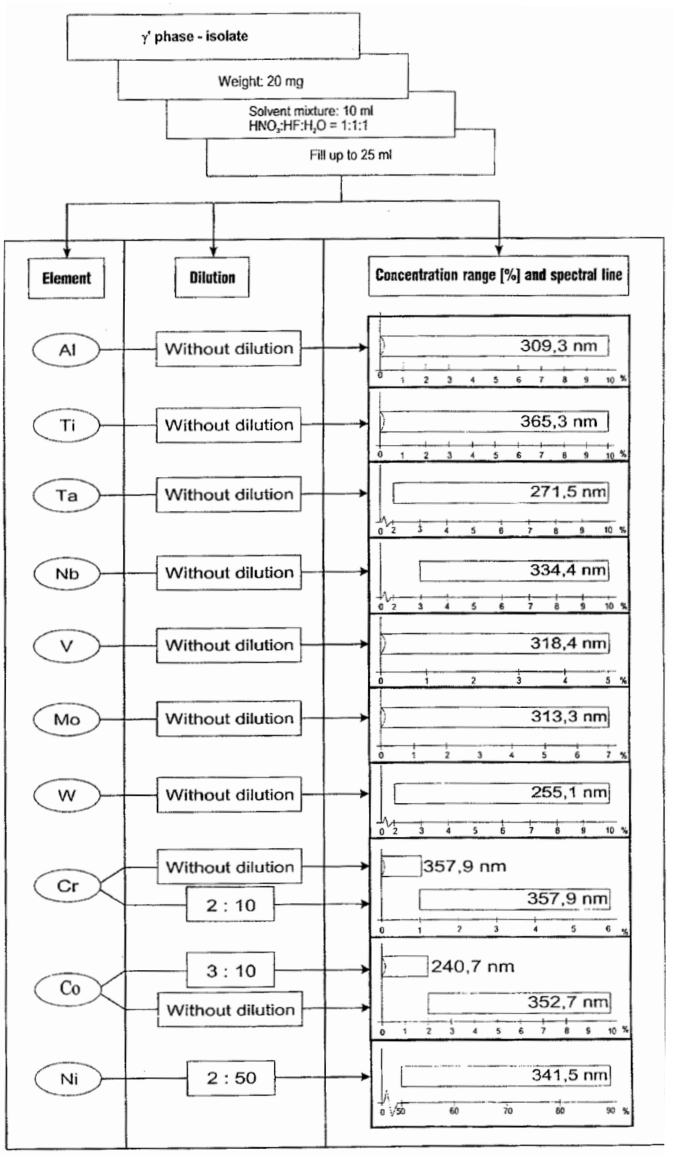
The ways of constructing the analytical diagrams

A high number of the grades of multi-component alloys on the basis of nickel and their comprehensive and widely varying chemical composition determine the chemical composition of the intermetallic γ' phase isolates. Hence, it is difficult to specify univocally the ranges of occurrence of the particular components in the γ' phase isolates. The following intervals of the concentration of the elements, as present in the γ' phase composition, have been adopted with a certain approximation:

Al – up to 10%,
Ti – up to 10%,
Nb – from 3 to 10% (Fig. 2 illustrates even the range from 2%),
Ta – from 2 to 10%,
Co – up to 10%,
Cr – up to 6%,
Mo – up to 7%,
V – up to 5%, and
W – from 2 to 10%.

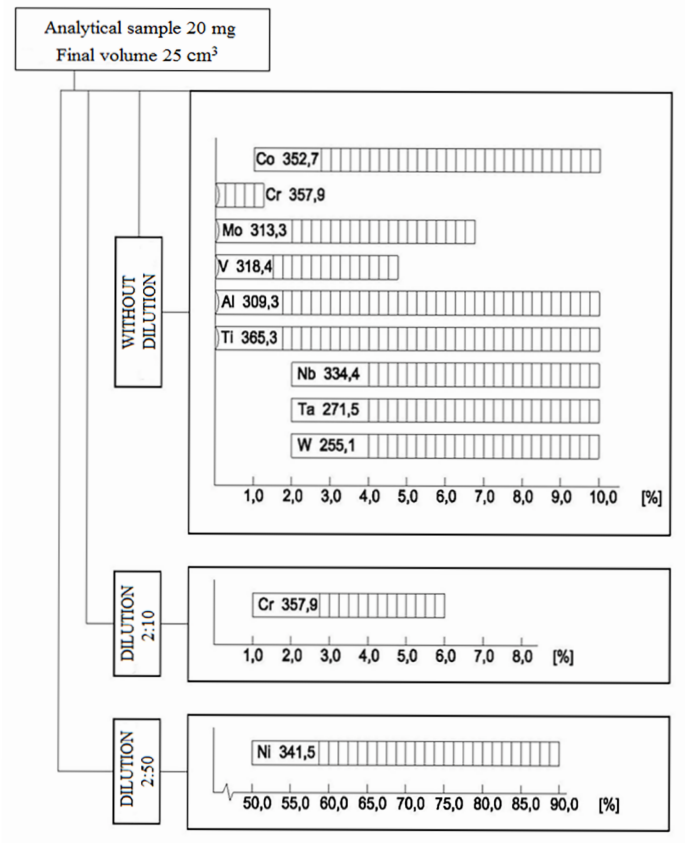
To determine the content of the particular metallic elements, the technique of atomic absorption spectrometry (AAS) was chosen. The choice of the mentioned above method (AAS) was performed based upon its numerous advantages, including, *inter alia*, sensitivity of determinations, selectivity, accuracy and precision. When commencing the preparation of the analytical diagrams, it was considered that in the γ' phase isolates, the contents of 5–10 metallic elements, occurring in relatively wide range of concentrations, should be determined; therefore, the discussed schemes contained such date as weighing of the sample (isolate), final volume of the sample's solution, size of the necessary dilutions and the employed analytical lines together with the corresponding concentration ranges. Two types of the analytical diagrams were developed; they are presented in Fig. 1 and 2. The both discussed diagrams were performed with the consideration of the same concentration ranges of the particular metallic elements, present in the composition of γ' phase isolates. The analytical diagram of the elements, as shown in Fig. 1 was developed when assuming the method for determination of the particular elements, occurring in the γ' phase isolates as the initial point. On the other hand, the complex analytical scheme, as illustrated in Fig. 2 was performed when basing on the thoroughly calculated variants of the dilutions of the sample solutions (γ' phase isolates) and the employed spectral lines. The transparency of the both analytical diagrams is their common and significant feature which enables a quick and appropriate decision of the laboratory staff in relation to the selected effective method of analytical procedure, depending on the expected chemical composition of the analyzed γ' phase isolates. Apart from the analytical schemes, the analytical procedure should contain the method for preparation of the samples and standard solutions.

Fig. 1. Analytical diagram for the analysis of γ' phase isolates by AAS method



Source: own development.

Fig. 2. The comprehensive analytical diagram for determination of γ' phase chemical composition by AAS technique [15]



Preparation of samples (isolates) and standards

Chemical composition of the γ' phase precipitates is determined during analysis of the γ' phase isolates. Various reagents and extraction conditions are used to isolate and extract the γ' phase from multi-component nickel alloys [11-15]. In studies carried out at the Silesian University of Technology [54,56], the γ' phase was isolated by anodic dissolution in a reagent containing 20 ml $HClO_4$, 50 ml HNO_3, 1000 ml CH_3OH, at a current density of 0.1 A/cm² and temperature ranging from 0 to 5°C.

The method of determining the content of metallic elements in the γ' phase isolates using atomic absorption spectrometry was described in detail in [11-15]. The 20 mg weighed portion of the isolate was placed in a 100 ml Teflon beaker, adding 10 ml of the digesting mixture (HNO_3: HF: H_2O = 1: 1: 1) and heating the whole gently on a heating plate until complete dissolution of the isolate. Then 10 ml of HCl were added and the contents of the beaker were carefully evaporated to dryness. This operation was repeated to determine cobalt content in the γ' phase isolate. The beaker walls were then rinsed with a small amount of water and 2 ml of concentrated hydrochloric acid and 1 ml of concentrated hydrofluoric acid were added. The solution was heated to dissolve the salt, boiled, cooled to room temperature and transferred quantitatively to a 25 ml graduated flask. Then 0.2 g of ammonium fluoride was added, water was added to the mark and the whole was mixed thoroughly.

Taking into account numerous inter-element effects that occur during analysis of γ' phase isolates [15], synthetic standard reference solutions were prepared in parallel with isolate samples by adding varying amounts of base standard reference solutions of all determinants occurring in γ' phase to cover the expected concentrations of these elements. The total mass of metals in each reference standard should be constant and equal to 20 mg. To maintain the same conditions during preparation of standard reference solutions, the order of the individual operations must be the same as when preparing the test sample solutions, i.e. evaporating with hydrochloric acid, adding a certain amount of hydrofluoric acid and ammonium fluoride, and supplementing with water to 25 ml. The blank samples were all reagents used in the analysis. The detailed measuring parameters for the determined elements are given in Tab. 1.

Table 1. Operating parameters

Element	Measuring range %	Analytical Line, nm	Slit, nm	Flame	Type of flame[1)]	Burner height, mm	Lamp current, mA[2)]	Integration period s	Linear working range, µg/cm³	Supplementary information
Cr	5-40	357,9	0,7	C_2H_2-N_2O	R	8	25	3	10	
Co	0-30	240,7 352,7	0,2	C_2H_2-Air C_2H_2-N_2O	U	5	30	3	6 500	
Al.	0,5-7	309,3	0,7	C_2H_2-N_2O	R	6	25	3	80	
Ti	0-5	365,3	0,2	C_2H_2-N_2O	R	6	36	3	150	add. $AlCl_3$ to 1000 µg Al/cm³
Mo	0-12	313,3 317,0	0,7	C_2H_2-N_2O	R	7	30	3	60 80	
Nb	0,5-7	334,4	0,2	C_2H_2-N_2O	R	5	36	10	900	
Ta	0,5-6	271,5	0,2	C_2H_2-N_2O	R	5	36	10	1000	add. 0,1 M NH_4F
W	0-11	255,1 400,9	0,2 0,7	C_2H_2-N_2O	R	7	36	10	1400 500	
V	0-2	318,4	0,7	C_2H_2-N_2O	R	6	36	3	100	add. $AlCl_3$ to 1000 µg Al/cm³

[1)] R – reducing, O – oxidizing [2)] Lamps Intensitron

Summing up

The both discussed diagrams contain the same amount of information, however being presented in somewhat different graphic form, necessary for the correct choice and correlation of the analytical parameters, serving for determination of the content of the particular elements in intermetallic γ' phase isolates, with the application of atomic absorption spectrometry. The detailed results of chemical analyses of γ' phase isolates are found in the papers [11–15]. When taking into consideration the problem range of the present article, it does not seem purposeful to cite them again. It should be stressed that the use of the so-prepared analytical diagrams by the laboratory staff makes the work in the laboratory throughout the whole measuring cycle decidedly more systematized; it allows also avoiding the unnecessary losses of time for additional calculations with the aim to prepare correctly the dilutions of the samples' solutions as well as to make the appropriate choice of spectral lines [15, 16]. They may be also helpful in the appropriate preparation of synthetic standard solutions in order to calibrate the absorptiometer (photocolorimeter). Additionally, the analysis of the specified quantitative data, as contained in the developed analytical diagrams, facilitates considerably the performance of the validation of the employed analytical method.

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#GAMIFICATION IN OCCUPATIONAL HEALTH AND SAFETY (OHS) TRAININGS

#GRYWALIZACJA W SZKOLENIACH BHP

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MANAGER OF OHS, ENVIRONMENTAL PROTECTION AND PROPERTY PROTECTION
FOR ALL COMPANIES OF PHILIPS MORRIS INTERNATIONAL IN POLAND

The trainings in occupational health and safety matters have been considered as being deadly boring for many years; such opinion is dating back to the period of the implementation of the only one reasonable method of education: the teacher speaks and the pupils listen. A label of the most boring trainings which, alas, are obligatory, confirms only the existing stereotype. If the trainers were able to fill a room only with the volunteers, being really interested in a given matter, it would be possible to expect the improvement of the quality of training. Meanwhile, their compulsoriness and lack of control gives a luxury of a high frequency, often of a low quality, to many trainers, instructors and specialists in occupational health and safety (in Polish: BHP).

What is the aim of OHS training? First of all, it serves creation of awareness of appropriate behavior and consequence of its absence. Therefore, apart from legal knowledge, we speak about the influence on people and on their behavior. And now, the first difficulty in BHP teaching appears: change management. The successive one includes their obligatory content. The preparation of attractive form of education in respect of legal rules or other, not very interesting elements of "framework programmes of education" requires creative approach and effort. As we know, the market does not like empty space and where it is necessary, a product appears. More and more companies which offer service in the field of OHS begin to suggest better prepared trainings. However, the educational offer in respect of soft skills, managerial training, IT training or, simply, cooking courses remains still more attractive in a form of knowledge transfer as compared to the training work health and safety. Therefore, it is important to make the discussed training more attractive by a change of their form. One of such elements is #gamification, which apart from dynamics in teaching, and effect on the rate of knowledge assimilation, introduces innovativeness in instruments and methods as well as competition as motivating and mobilizing factor.

Is it therefore possible to run interesting training in big companies? Can we make the subject of OHS training interesting for generation of millennials? Will the knowledge concerning the appropriate protecting rules be transmitted to the employees in an understandable way?

The answer is yes but under the condition of applying three most important elements of effective training in respect of safety and implementation of changes in culture of organization safety. The description of the mentioned elements is given below.

Innovative #simplification

Carl Friedrich Gauss, a genial German mathematician, physicist and astronomer lived at the turn of the 18th century. In spite of the fact that he is considered as one of the outstanding scholars in the field of science in history, he is not so recognized as Archimedes or Newton. However, most of us will remind him when looking at normal Gauss distribution. We should also remember him due to another reason. Let us move to Germany of 1784 when seven years' old Carl Friedrich attended school. A teacher of mathematics, being deprived a greater engagement in his profession, gave a mathematic task to his pupils which should

Fig. 1. Carl Friedrich Gauss (1777-1855) – German mathematician, physicist, astronomer and geodesist [1]

make the children busy and give him at least one hour of rest. The pupils were asked to give the sum of arithmetic progression from 1 to 100 what may be written, in the simplest way, as 1 + 2 + 3 + ... + 98 + 99 = 100 = … After few minutes, contrary to expectations, a young Gauss gave the correct result of the discussed adding. Although being unaware of his operation, he based only upon his imagination and simplified a laborious counting owing to a simple rule which he had noticed. When combining into pairs the numbers1 and 100, 2 and 99, 3 and 98 and so on, he obtained 50 pairs with sum of 101, therefore, (1+100) + (2=99) + … = 101 x 50 = 5050. To-day it is contained in the programme for the fourth class of elementary school.

Let us come back to the question about effective training in health and safety of work. It is not seldom case that ***the mentioned above trainings***, being instructed to the external companies, ***are the tiring "talking shops" or confabs*** (in Polish the so-called "nasiadówki") ***for the participants*** when the fragments of Work Code or other legal regulations are read aloud. The transmission of knowledge is implemented in professional language, being very well understandable for instructor who does not seek for the way of access to the trained listeners. Such methods are especially disliked by the persons, employed as blue-collar workers. They are treated quite often as a day which may be spent sitting or even sleeping and it is not necessary to stay at the machine or dig with spade.

Simplification of training in the field of safety, the mandatory and the additional ones, aiming at such shaping of our listeners and furnishing them with such knowledge and skills that they could protect their life, should be commenced from the contents of the transmission and the language of the transmission.

Carl Friedrich Gauss, as performing the mathematic operation in non-obvious was, should be the inspiration for all persons who develop the trainings in respect of safety. Similarly as Gauss, we have to seek for the methods of abbreviating the time period necessary for assimilation of the knowledge. The effectiveness of the method is measured by the level of knowledge which was acquired by a student!

The knowledge does not mean, however, everything. We must also answer the question whether the educated persons would change the possessed knowledge into appropriate behavior? It is affected by the successive factor of correct training, that is, #leadership.

The engaged and reliable # leadership

Thyssen Krupp Gerlach (TKG) from Homburg near Frankfurt is one of the known magnates of manufacture of components for the companies of automotive sector. In 2010, the number of accidents at work in the mentioned company was equal to 20 per million of the hours worked and the work environment was faced with the problems of noise, vibrations, high temperature and dusting. The management of the company began to perceive the negative effects of low culture of safety and in February 2011, they invited the consultants of DuPont company for cooperation, asking them to help to analyze the existing situation and improve the state of occupational health and safety. After the performed analysis, it was revealed that on the Bradley's diagram (Fig. 2) the highest management of TKG placed the status of its organizational culture by one degree higher than it was in a real situation.

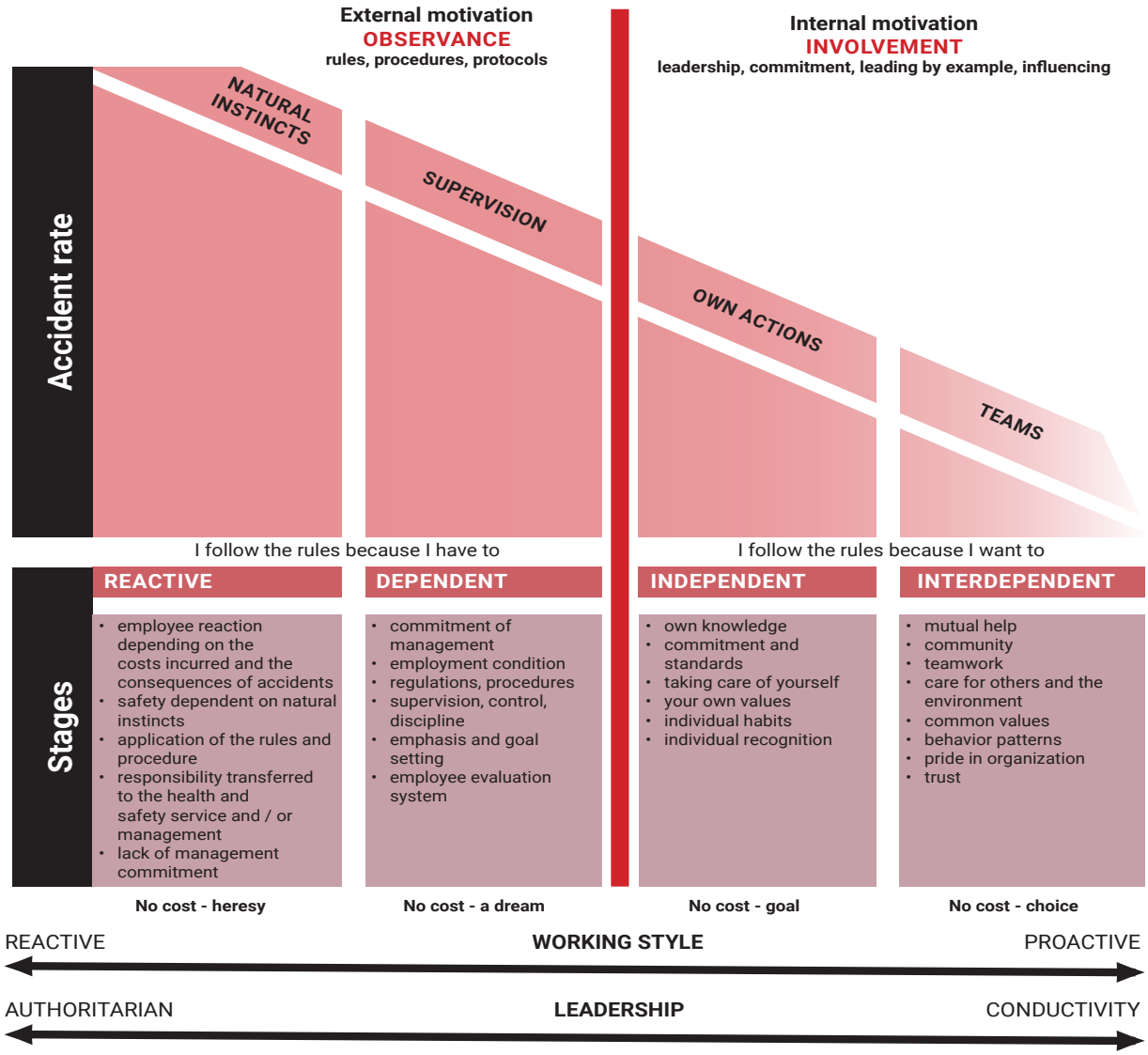
When analyzing more deeply the data, it was observed that there are also encountered good behaviours of the employees which may be strengthened and also such ones which lead to dangerous situations and damages. The management of TKG undertook immediately the corrective action. They utilized the suggestion that they should at first focus on "quick win". One of such actions included declaration of safety rules for the management the members of which signed as a proof of their engagement. The mentioned principles were widespread and gave a distinct signal to the staff: the engagement of the highest level of the management is the first and most important step towards the improvement of safety at the workplace. Although TKG on the Bradley's curve was still found on the side "I observe it because I have to", the involvement of the management caused their passage from reactive stage into dependent one.

During three years, the number of accidents at work in TKG dropped to the level of 0.1 accidents per one million of the hours worked. Ten principles of safety were published and introduced into life. Every month, sixty five managers of the highest level conducts the talks with the employees aiming at identification of the threats, increase of awareness, improvement of standards of safety and motivation of the staff to work in the way consistent with the mentioned standards. The discussed meeting are also aimed at recognizing the correct behaviours and positive changes, and strengthening the safety of work as everyday element of running the business[2]. ***And, also, in the discussed case it has been revealed to be true that owing to good advices the road is long and owing to examples – short and effective.***

Coming back to the question whether the principles of safety, as being effectively assimilated during the training, will be immediately employed in practice by our workers, we may decisively answer that self-discipline will be proved in a certain degree but only a reliable and engaged leadership will guarantee a full success.

Let us remind once again the initial question: what purpose the trainings in occupational health and safety serve for? If their task is to generate the awareness of appropriate behaviour and of the consequence of their absence and the protection of the employee alone, and if we already know what a role of the involved superior is, we are faced against a new challenge, i.e. change management. We all know it from our experience. We seldom react with enthusiasm when someone expects we will change our behaviour. Especially, in the case when it requires a big concentration and change of our habits. The change in behaviour is never a quick process. Different people pass through it in a different rate what causes that the superiors have to tackle with a given situation when a part of organization has already approved and introduced the change, a part is just doing it and the last group still seeks the reason, sense and justification of it as those people discard any change as a rule.

Fig. 2. Bradley's diagram, as developed by DuPont company (Source: DuPont)



The reliable and engaged leadership may help in change of behaviours. The training plays also a significant role. However, the expectation of the results to come after training based exclusively upon the lectures is condemned on defeat, critics and discarding. #gamification seems to be helpful in this problem.

The adapted #gamification

What does the word "#gamification" mean? It is, *inter alia*, the method of teaching which introduces activation of the participants by game and competition simultaneously. Although love of competition cannot be a factor, motivating all participants in the same degree, many persons participate in the game for a pleasure of competing, without the mindset to gain a necessary victory. In the case of training, conducted by the method of #gamification, the win is an effectiveness of assimilating the required knowledge in reality and not taking the place on the podium.

If we speak about effectiveness, it is worthy to mention the rewarding. Construction of good association with the subjects of training by consequent appraisal of the participants during the training as well as by the end of it should be a good guideline for the instructors. Even the examination may occur to be nice if well prepared team feels the fun during its passing, owing to the previous multiple checking of the knowledge of the participants by the instructor; it guarantees the easiness of obtaining the credit.

Frightening with the examination in order to obtain the attention of the listeners is ineffective as compared to rewarding their professional success after each finished problem module. The reward may be an appraisal or may have a substantial form, depending on the available resources.

Although a triangle of effectiveness, as developed by Edgar Dale (referred to in article in version of 1969) has as many followers as opponents (due to certain inaccuracies and utilization of highly estimated percentage data), it may be

Fig. 3. Triangle of effectiveness of memorization by E. Dale

THE TRIANGLE OF REMEMBERING EFFICIENCY		
after two weeks we usually remember		way of involvement
90% of what we say and do	by doing the actual action	active
	simulating real activities	
	performing a drama	
70% of what we say	giving a lecture	
	taking part in the discussion	
50% of what we hear and see	watching the actual action	passive
	watching the show	
	looking at the exhibit and its presentation	
	watching a movie	
30% of what we see	watching pictures, photos	
20% of what we hear	listening to speech	
10% of what we read	reading	

trusted on the intuition on the background, when filtrating the data from the diagram through our own experiences when we learn by various methods. If we could absolutely believe Dale, it could be – with regret – stated that only 10% of the readers of the present paper would remember it after 2 weeks and perhaps would utilize the contained herein suggestions.

In #gamification, the activation of the participants and encouraging them to, de facto, self-education is the most important factor. "Give a fish to a hungry man – you will feed him for one day; give him a fishing rod – you will feed him for the whole life", the known sentence says. In the questions of training in respect of safety, the mentioned above saying is most adequate.

Teaching the adults on safety seems to be senseless. All know that electric current "kicks" and you may fall down the stairs after losing equilibrium if we do not keep the trail. So really, all-knowing and (pseudo) aware adults twist their ankles on the stairs or are subjected to electric shock. Therefore, their familiarization with the rules, principles and good practices must have an empiric form.

There are many possibilities of changing the training conducted in a form of lecture into #gamification, being limited probably more by imagination of the instructors than by the indispensable sources for its conducting.

The trainers who do not have the experience with #gamification, may begin from the application of the methods, employed in other domains of training such as work on "post-it" and then, discussion and classification of answers. Another easy method consists in distribution of the divided material among the participants and encouraging each of them to teach "his" part of material to the remaining persons. It is also possible to describe some exemplified situations, specific of a given profession, of case study type and encourage the discussion in groups what was mistakenly performed, where to seek the correction and

Fot. 1. Board game "Leadership in respect of safety" for managers and leaders in Philip Morris Polska SA.

how to remedy the repeated occurrence of the problems.

Where can we find the inspirations for more attractive teaching? At the beginning, I suggest the simplest and universally available games. The board games which are very popular now not only among the children and young people ***may be*** – with a good will and even small imagination – ***utilized in running the OHS trainings***. Let us take the simplest examples: "Mushroom picking" or "Ladders and snakes". The participants, as divided into particular teams, move on the board and stop only at the specially marked fields, and implement the professional tasks. They may include the tasks connected with the initial as well as periodical training. Being equipped with the appropriate materials, they implement the "task" in order to go on. When teaching the remaining teams, they learn in the most effective way. Another excellent and a very cheap solution includes traditional and known "Play on words" (in Polish: Kalambury) or game "Tabu". The task of the trainer is to adapt the entries to a profile and profession of the participants.

If the employee has more financial means, he may buy ready-to-use board games, teaching the selected aspects in the field of safety such as "Memory", "Wheel of Fortune", or puzzles, being available e.g. in offer of the Malopolska company "TAMgram"[4].

In #gamification, we may utilize computer games, e.g. applications in mobile phones and also, the excellent instrument, teaching the correct observation within the frames of risk evaluation, that is, goggles 3D (VR). The built-in scene in the goggles present the image in the dimension of 360 degrees which transfers the trained person to virtual warehouse, manufacturing area or office where there are programmed inconsistencies to be discovered by a player. The level of difficulty should depend on the level of the knowledge of the participants. Simulation allows full focusing on a given subject, its "experiencing" and in effect, rising emotions; the players keep up the memorized elements of knowledge in the field of safety. It is worthy to mention e.g. the interesting training in VR technology by VR Premium company in cooperation with BHP Życie[5].

Gabe Zichermann[6] is known as one of the greatest followers of gamification (that is, inter alia, utilization of video games in teaching). In his addresses during the TED conferences, he arguments that #gamification (game-competition) may be utilized not only by the companies but also in teaching those persons, who are not able to engage in traditional teaching (by lecture method) in classes. Zichermann discards the argument that the addictive environment of video games does not teach the appropriate type of attention. He argues with the thesis that gamification is, as a rule, harmful, or that it is simply a fashion; he indicates the positive results of #gamification, employed outside the entertainment sector although he admits that it is not a technology without defects. He tries to convince that #gamification may be transmitted to internet banking system,

Fot. 2. The example of mailing concerning the principles of safety, as prepared by Time4 company for Philip Morris Polska Distribution

charity organizations or another sector. System of rewarding (known from video games) may encourage even the holders of gym room tickets to participate regularly in the discussed meetings. All depends on the way of designing # gamification so as to make it addictive and to affect the change of attitude, e.g. encourage to frequent participation in the sports' club classes.

The games which employ web applications are best tested among the office population. They are especially effective when an enterprise increases safety culture and wants to remind the mentioned problems to the employees, affecting the permanent changes in awareness and behaviour. Such example may be found in trainings in the field of introducing golden principles among the administration workers, implemented in a form of quiz which comes to the receivers by e-mail at internal mailing system and is systematically implemented according to the plan, for instance every two weeks for each principle.

Additionally, the trainings being developed as mobile applications may be uploaded into any number of mobile devices such as tablets. When having a sufficient number of the devices, we may carry out the trainings and quizzes in groups, with the support of trainer in the sites, being most comfortable for the participants, what is especially significant in training of blue-collar working groups. Free-of-charge, generally available mobile applications for conducting the knowledge tests may perfectly supplement the attractive training in the field of safety, transforming the exam into quiz and, owing to it, creating a positive association with OHS.

Fot. 3. The example, showing how the training may be combined with quiz and the knowledge may be transferred in the interesting way.

If training is interesting, it means undoubtedly BHP training.....

In many big companies, visible positive effects of modern training are already visible. For instance, good results are obtained owing to consolidated approach in all affiliates (plants) of the same company. It facilitates generation of a high culture of safety. In the companies with the appropriate approach to BHP problems (treating them as the elements of management and improvement of the company and not as the unwanted necessity), we may observe a lower number of accidents, including especially those heavy ones. Of course, it cannot be achieved without engagement of people and financial means.

The changes in occupational health and safety trainings are unavoidable. The discussed sector must follow the changes in the contemporary education and teaching shall never stop to be the most important element of building the responsibility for safety. It is wonderful if we have successes in this domain when saving human life and health. And it is not true that we have to employ external companies in order to improve the standard of training; we may (even we have to!) try our own efforts and imagination.

All this indicates that we approach the exciting future of trainings which will become so interesting that the employees themselves will wish to participate in them!

Sources

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Gamification with hashtag and other important terms

(read: hashtag) – as given by blog widzialni.pl, according to official definition in Vocabulary of Polish Language, it is "word or phrase, preceded by sign # facilitating finding and grouping of elements". Commonly speaking, hashtags are internet road signs owing to which we are able to localise easily discussions, posts and contents connected with a given subject. Owing to symbol # situated at the beginning of a word, the phrase adopts a form of active link and aggregates all threads concerning a specified subject. It is enough to click a desired hashtag and we will see the entries in which a given entry has appeared[1]. Searching covers only one internet service, therefore hashtag cannot be connected with the news from another service[2].

#Gamification (English word – the definition was invented by the founder of Bunchball company, Rajat Paharii). At present business, it is recognised as the easiest and most effective method for employment of the workers. Gamification is based upon the techniques, utilized by designers of games, used for engagement of players in order to motivate them to the expected behaviour or activity. # Gamification does not create anything new, it consists in strengthening of the existing experience via application of motivating techniques which make that the games are so addictive. Especially in on-line versions, the immediate return information encourages the players to react to the challenges, undertaking action, generally speaking to further activity and involvement in the successive stages of the game. From among the major techniques of gamification, the most known are as follows: definition of goals, passing the levels up, gaining the scores, gaining the trophies, cooperation in teams, construction of community or individual competition. # Gamification motivates via promise of being the best one in virtual dimension or via substantial rewarding[3].

Bradley's curve – it is a diagram which refers to the state of advancement of safety culture of a given organization with the utilization of the number of cases to illustrate the maturity of the company. The discussed state of advancement is described by four stages of development on which there are the employees and the management of the company found. The first one is the most primitive in understanding of importance of the safety aspects of the company; it is REACTIVE stage, where the rate of accidents in the highest and safety is not managed practically by anybody. Avoidance of injuries is rather more a problem of luck than of the existing system for health and life protection. The procedures, if any, are only on paper and the management thinks that safety is a duty of OHS (Occupational Health and Safety) service. The second stage, being called DEPENDENT one, apart from natural instincts protecting the employees, includes the supervision to the process. The company still remains on the side: "I observe the principles because I must" but we may already refer to practising the procedures or written safety principles which are introduced under the force, however the superiors begin to pay attention to their observing. INDEPENDENT stage of safety culture development moves the employees above the most difficult threshold of the will to behave in consistency with the principles which protect us because it is good for us. The employees represent own good habits, irrespectively of their supervision, they have their own systems of values which motivate them to safe work. The stage Co-DEPENDENT is a dream of every specialist in OHS. "I observe the rules because I want to" means that the aware and motivated personnel take mutual care and creates a thoughtful community. Good practices of giving a friend's advices are implemented and the accidents do not almost appear.

[1] https://www.widzialni.pl/blog/hastag-co-to-jest-i-gdzie-jest-uzywany/

[2] https://pl.wikipedia.org/wiki/Hashtag

[3] https://www.bunchball.com/gamification

XXVI INTERNATIONAL SCIENCE CONFERENCE

"INTENSIFICATION PROBLEM WITH LIVESTOCK PRODUCTION ACCORDING TO UE STANDARDS INCLUDING ENVIRONMENTAL PROTECTION AND ALTERNATIVE RENEWABLE SOURCES PRODUCTION INCLUDING BIOGAS"

INSTITUTE OF TECHNOLOGY AND LIFE SCIENCES

On 16th September 2020 in Institute of Technology and Life Science in Falenty has performed ***XXVI International Science Conference*** under ages of Agriculture and Rural Development Ministry ***„Intensification problem with livestock production according to UE Standards including environmental protection and alternative renewable sources production including biogas"***. Conference was available online due to Network Expert.

In the conference many issues were brought concerning sustainable development about plant and live stock production, removable energy sources. Conference has started with training of UE research programs and innovation grants. In this module were two lectures delivered by Ms Bożena Podlaska represented National Contact Point for Research Programs of the EU and Mr Łukasz Kurek represented National Research and Development Center.

Next sessions has presented innovative solutions in agricultural production including livestock production, and renewable energy obtaining with rural infrastructure.

W XXVI International Science Conference has 115 participants from Poland, Russian Federation, Belarus and Latvia representing institutions:

- Koszalin University of Technology,
- Higher School of Agribusiness in Lomza,
- West Pomeranian University of Technology in Szczecin,
- Warsaw University of Life Science - SGGW,
- Warsaw School of Economics (SGH),
- Kazimierz Wielki University in Bydgoszcz,
- Univeristy of Agriculture in Krakow,
- Poznań University of Life Science,
- The National Research Institute of Animal Production,
- West Pomeranian Chamber of Agriculture,
- University of Life Sciences in Lublin,
- Institute of Plant Protection, National Research Institute, Field Experimental Station in Białystok,
- Ministry of Agriculture and Rural Development,
- National Research and Development Center,
- Wielkopolska Agricultural Advisory Center in Poznań,
- BELAGROMECH, Minsk, Belarus,
- GNU VNII Kormov names V.R. Viliamsa, Moscov, Russia (Animal Feed Institute),
- RUNIP "IMSKH NAN Belarusi", Minsk, Belarus (Institute of Power Engineering),

- Latvian University of Agriculture, Jelgava, Latvia,
- GNU NIISH Agricultural Scientific and Research Institute, Kirov, Russia,
- FGBNU FANC North East names N.V. Rudnickiego, Kirov, Russia,
- State Engineering and Economics Institute in Knyaginino, Russia,
- De Heus,
- TESTMER Warszawa S.A.,
- WOLF System Sp. z o.o.,
- Lely East Sp. z o.o.

On The conference 25 lectured were delivered, 10 posters, including 12 speeches in foreign languages (English and Russian).

Co-organizers of the congress:

- Department of Renewable Energy Sources Engineering, West Pomeranian University of Technology in Szczecin,
- Higher School of Agribusiness in Lomza,
- Department of Organization, Management and Production Engineering, SGGW,
- Univeristy of Agriculture in Krakow.

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Media patronage:

- Polish Technical Review Magazine,
- Internet Journal B2B „Teraz Środowisko",
- Interactive TV AgroNews.com.

Submited papers by International Science Conference participants, three monographers were issued in printed and electronic version:

1. Monografia pt. „Innowacyjne technologie pozyskania energii odnawialnej", pp. 190.
2. Monography. „Innowacyjne rozwiązania w produkcji rolnej ze szczególnym uwzględnieniem chowu zwierząt", pp. 370.
3. Monography. „Проблемы интенсификации животноводства с учетом охраны окружающей среды и производства альтернативных источников энергии, в том числе биогаза (Problems of intensification of animal production including environment protection and alternative energy production as well as biogas)", pp. 111.

We are grateful Co-organizers, Sponsors, Patrons and Participants for active part in the Conference!

Material prepared by the conference organizer

THE XXXIII[RD] EDITION OF THE COMPETITION
NUMERUS PRIMUS INTER PARES

SOCIETY OF CULTURE AND HISTORY OF ENGINEERING

The multiannual tradition of the Competition Numerus Primus inter Pares is to summarize the its editions during the ceremonies, being the finals of the initiatives of the Federation of engineering Associations NOT, addressed to the young generation. And it happened, as usually, this time. The awarding of diplomas to the laureates of the XXXIII[rd] Competition Numerus Primus had place in September, 25[th] 2020 in Warsaw House of Engineer NOT during the termination of the Competition Young Innovator, organized for the pupils of primary schools, lyceums and vocational technical schools.

The purpose of the competition Numerus Primus was to determine the best (in the field of popularization of knowledge and technical culture) number of technical periodical journal and popular – technical magazine from the previous calendar year. The discussed competition is organized by the Society of Culture and History of Engineering, the member of Federation SNT NOT.

The Jury of the Competition Numerus Primus inter Pares, headed by Prof. Czesław Waszkiewicz, PhD, Eng., appreciated highly the professional and graphic level and the editorial form of all submitted periodicals and, after a thorough evaluation

Fot. 1. The plaque Numerus Primus is received by Mirosław Usidis – the editor-in-chief of "Młody Technik" (from right: Prof. Czesław Waszkiewicz – the Chairman of the Jury, Mirosław Usidis – the Editor-in-Chief of MT, Ewa Mańkiewicz-Cudny – the President of FSNT-NOT, the editor Janusz M. Kowalski – the secretary of the Jury of the Society)

decided to grant the awards as follows:

In the group of the journals, popularizing science and technology:

- A title of Laureate – "Numerus Primus inter Pares" – goes to number 2/2019 of the Journal ***MŁODY TECHNIK*** (eng. The Young Technician), editor: AVT Company,

In the group of the specialist periodicals:

- A title of Laureate – "Numerus Primus inter Pares" – goes to number 4/2019 of the journal ***"TECHNIKA ROLNICZA – OGRODNICZA – LEŚNA"*** (eng. "Agricultural, Gardening and Forestry Engineering"), editor: Sieć Badawcza Łukasiewicz – Przemysłowy Instytut Maszyn Rolniczych (eng. Industrial Institute of Agricultural Machines"), Poznań

Jury awarded also the prize to number 7/2019 of the scientific-technical monthly: ***ELEKTROINSTALATOR***, editor SIGMA-NOT Company.

Developed by Janusz M. Kowalski

Fot. 2. The distinction is received by (from the right): Tomasz Charążka – editor-in-chief of "Elektroinstallator" magazine, Anna Rybacka-Dybcio – the Vice-President of Editorial House SIGMA-NOT, Prof. Czesław Waszkiewicz – the President of the Jury, Ewa Mankiewicz-Cudny – the President of FSNT-NOT, editor Janusz M. Kowalski – the secretary of the Jury of the Society of Culture and History of Engineering

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