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SCIENCE AND INDUSTRY IN A COUNTRY OF CHANGES

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IN THE MILL AND BAKERY**

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QUALITY CONTROL OF RAW MATERIALS IN THE MILL AND BAKERY

KONTROLA JAKOŚCI SUROWCÓW W MŁYNIU I PIEKARNI

Summary: From the point of view of the quality of the finished product, which is bread or other products, the quality of the raw material is strategically important. In the case of the milling industry and bakery, this raw material is grain, usually wheat or less often, rye. The technological value of the grain is a function of many different factors such as a variety, the size and profile of fertilization, agrotechnical and climate conditions during the growing season or the conditions of harvesting and storage. Knowledge about the quality of grain, including its humidity or chemical composition is crucial to assess its suitability for bakery or confectionery purposes. Chemical composition of wheat grain, and above all the quantity and quality of wet gluten often determine the usefulness of such grain and its price at the purchase point. The grain quality assessment methods include the assessment of such features as moisture content, glassiness and bulk density in the healing state. In the case of flour, its baking value is crucial, as in the case of grain, the quantity and quality of gluten, as well as the falling number or sedimentation indicator, as well as the results of water absorption measurement using farinograph. Farinograph, as well as the extensograph, are used to analyze the rheological properties of the dough made from the tested flour. The rheological features of the dough determine the quality of final products. In addition, a fermentograph and alveograph are used to assess the baking value of flour. In the present paper, the review and the characteristics of commonly used methods and devices to assess the quality of grain and baking flour were carried out.

Keywords: grain, flour, baking value, farinograph, extensograph, fermentograph, alveograph

Streszczenie: Z punktu widzenia jakości wyrobu gotowego jakim jest chleb lub inne wypieki strategicznie ważna jest jakość surowca. W przypadku branży młynarskiej i piekarskiej surowcem tym jest ziarno, najczęściej pszenicy lub rzadziej żyta. Wartość technologiczna ziarna jest funkcją wielu różnych czynników jak odmiana, wielkość i profil nawożenia, warunki agrotechniczne i klimatyczne w czasie okresu wegetacji czy też warunki zbioru i przechowywania. Wiedza na temat jakości ziarna, w tym jego wilgotności czy składu chemicznego jest kluczowa do oceny jego przydatności na cele piekarskie czy cukiernicze. Skład chemiczny ziarna pszenicy, a przede wszystkim ilość i jakość glutenu mokrego niejednokrotnie decydują o przydatności takiego ziarna oraz jego cenę w punkcie skupu. Metody oceny jakości ziarna obejmują ocenę takich cech jak wilgotność, szklistość oraz gęstość w stanie usypowym. W przypadku mąki jej wartość wypiekowa kluczowe są, podobnie jak w przypadku ziarna ilość i jakość glutenu, a także liczba opadania czy wskaźnika sedymentacji, jak również wyniki pomiaru wodochłonności przy użyciu farinografu. Farinograf podobnie, jak i ekstensograf stosowane są do analizy właściwości reologicznych ciasta wytworzonego z badanej mąki. Cechy reologiczne ciasta decydują determinują jakość wyrobów gotowych. Oprócz tego do oceny wartości wypiekowej mąki jest wykorzystywany fermentograf oraz wiskograf. W pracy dokonano przeglądu oraz charakterystyki powszechnie wykorzystywanych metod i urządzeń służących ocenie jakości ziarna i wartości wypiekowej mąki.

Słowa kluczowe: ziarno, mąka, wartość wypiekowa, farinograf, ekstensograf, fermentograf, alveograf

Introduction

Cereal products are an important component of everyday human diet as they are the main source of energy and of simple and complex carbohydrates. According to the guidelines of Pyramid of Healthy Nutrition and Physical Activity, developed at the Institute of Food and Nutrition for adult persons, cereal products should be the component of majority of meals. It is important to utilize most frequently the products resulting from the so-called whole grain milling. The cereal products coming from such milling are more abundant in nutrients; they contain more vitamins, especially from B group, certain mineral compounds and dietary fibre. The last one plays also a prebiotic function in human body [1]. It is just the high content of fibre in the mentioned products and by this, its high level in the diet which is especially important in preventing the non-infectious diet-dependent civilization diseases [2]. The assortment of dietary fibre-rich products includes, *inter alia*, whole meal bread

(dark bread, graham), whole meal brown pasta and, also, grits (incl. buckwheat and barley) and flakes (*inter alia* from oats). The second important problem is the accessibility of cereal products for the persons suffering from celiac disease or gluten intolerance. The results of the conducted studies indicate that the frequency of consumption of gluten-free cereal products among the persons with the celiac disease is high. The mentioned above products have a key importance in composing their diet [3]. During the recent years, we have observed a considerable decline in consumption of bread and cereal products in Polish households. According to the newest data of the Chief Statistical Office (GUS) in 2021, the average monthly consumption per person was equal to 5.17 kg. On the other hand, in the years 2015 and 2011, it was 6.09 and 6.70 kg, respectively [4].

The direction of development of cereal sector may be determined by many factors, including prices of raw materials and manufacturing costs, nutrition trends, level of export of the grain and cereals products. In the light of the mentioned

problems, it should however be the search for new food products based on cereal grain and pseudo-cereals and their products which would satisfy the needs of the consumers, with the special care of their quality and safety. In the present paper, the review of the methods for control of the quality of the grain, intended for milling and of the methods employed in the quality control of the raw materials used in milling and bakery production.

Control of the quality of the grain destined for consumption purposes

The commercial quality of the wheat grain is dependent on many factors, *inter alia*, on variety, weather condition during the period of plants' vegetation and grain harvesting as well as on the region of cultivation. The commodity assessment of the wheat grain in respect of the content of protein, gluten, density of the grain in bulk (loose) state and the falling number indicates the differentiation of the wheat grain depending the season of the grain's harvesting and climate-cultivation region [5, 6]. Rye is less differentiated in its varieties in respect of the technological quality of the grain [7]; climate conditions during the cultivation have a big importance for the quality of the grain [8]. The wheat grain-collecting points determine the quality parameters, their minimum level and also precise the methods of the tests according to the direction of the destination. The quality discriminants may be classified into the following groups: 1: specifying general properties of the grain (flavour, appearance, gloss, degree of maturity), 2: specifying the storage suitability (contamination presence, humidity or presence of pests), 3: connected with the health safety of the grain and 4: characterizing technological value [9].

The quality of wheat grain is determined by many parameters which inform about its milling and baking quality. The milling value of the grain is evaluated, *inter alia*, on the grounds of such qualities as density in loose (bulk) state, glassiness, protein content, gluten content and, also, the content of ash in the grain and in the flour, obtained from the discussed grain [10]. In the opinion of Dziki and Laskowski [11] hardness is the most important property of wheat grain. The mentioned parameter has an enormous impact on milling, and, in particular, on conditioning (technological treatment), disintegration and sieving (screening) and by this, on the properties of the obtained flour [10]. The methods for measurement of the cereal grain hardness have been improved for many years; we may classify them as technological ones and endurance tests [12].

The humidity of cereal grain is one of the most important parameters deciding on its suitability for long-term storage. It is also significant from the viewpoint of the preparation of the grain to milling due to energy consumption during the disintegration process as well as effect on the quantity and quality of the milling products. The measurement of the grain humidity, depending on the needs and accessibility of technical support, may be performed by different methods. On the market there are available mobile hygrometers for measuring of the grain humidity; they are, most frequently, compact and precise

devices allowing determination of humidity of the whole grains. NIR analyzers are equipped with sensors with the matrix of LED diodes, emitting radiation in near infrared (NIR). The humidity of material is measured on the grounds of radiation intensity [13]. Contrary to classic filter analyzers and those scanning with a mobile monochromator, the modern instruments employ stationary monochromator and light-sensitive element composed of 256 linearly situated InGas detectors (Diode Array) with the sensitivities, corresponding to energies obtained in the range of NIR 950-1650 nm. The applied technology and utility solutions enabled elimination of the basic inconvenience of classic NIR technology i.e. form of analyzed substance as it may analyze the samples in such form as they have, without preliminary milling or homogenization [14]. The humidity of the grain may be also determined by laboratory methods by the measurement of the mass loss during drying of the samples and with the application of moisture balances.

The commodity evaluation of the grain includes, *inter alia*, determination of the grain density in loose state; the mentioned test is carried out using manual or automatic, mechanical, electric or electronic measuring devices for determination of the mass of hectoliter. The density of cereal in loose state is also called the specific weight or volume weight. The discussed parameter is a ratio of cereal mass of the full container and its volume, under the closely specified conditions; it is expressed in kg per hectoliter (kg/hl) [15]. The popular densitometers for the grain include, *inter alia*, the equipment intended for the determination of the grain density in the loose state of cereals, using 1-litre measuring container [16].

The weight of 1000 grains is a parameter which determines the quality of the grain and the level of filling with reserve substances what affects its suitability for food industry [17]. The market automatic devices with programmer, being called counters of the grains are destined for counting of the grain as well as counting out the required number of the grain. Hence, they find a special application in cereal laboratories, cereal cultivation points and scientific -research units [18].

The glassiness of the wheat grain is the important parameter of its suitability for the consumption purposes [16]. The glassy grains are characterized by a compact structure of endosperm and higher content of protein compounds, including gluten proteins [19]. The determination of the grain glassiness may be carried out by the methods of visual evaluation, using pharintome. The mentioned device is used for cutting of the grain and evaluating its cross-section appearance; grey and glossy cross-section is typical of the glassy grains. The application of diaphanoscope consists in overexposure of the grain; glassy grains transmit more light and during the test, they are brighter [20].

The parameters deciding about the technological value of the grain, according to the destination, includes as follows: protein content, the quantity of the washed out wet gluten, indicator of Zeleny's sedimentation, and falling number [21]. The mentioned tests may be performed with the use of equipment or device which allow a quick classification of the grain lot, e.g.

in respect of the suitability for production of specific flours or production of milling mixtures. The content of total protein may be determined using NIR analyzer [14]. The determination of the level of wet gluten is carried out by the method of washing out with the application of mechanical equipment, e.g. Perten Glutomatic System [22]. ICC (No. 155) standards and PN-EN ISO 21415-2:2015-12 are employed [23, 24]. Zeleny's sedimentation index is a measure of the quality of gluten proteins [20]. The falling number is commonly used quality parameter for determination of the activity of amylolytic enzymes in wheat and rye grains [25]. The mentioned determination is carried out using the equipment for determination of the falling number by Hagberg-Perten method, e.g. instruments for determination of the falling number by Sadkiewicz Instruments (Bydgoszcz, Poland) or Falling Number by Perkin Elmer Inc. (Waltham, USA). The determination of the falling number is performed according to the requirements of the following standards: ICC/107/1 [26], AACc 56-81.03 [27], ISO/DIS 3093 [28] and Polish standard PN-EN ISO 3093:2010 [29].

The grain which comes to the mill is directed, after the previous preparation, to milling. As it is followed from the conducted studies [30, 31], the unitary energy of the grain disintegration is dependent on glassiness, density at the loose state and ash content in the grain. Gradually with the increase in glassiness and loose density, the unitary energy of disintegration is increased. Index of disintegration effectiveness is increased together with the increase in glassiness, loose state density and weight of thousand grains and is decreased together with the increase in the ash content in the grain. Glassiness is a feature affecting the stronger impact on energy consumption at disintegration as compared to density at the loose state and ash content and gluten content. As it was revealed in the studies of the wheat grains [32], the energy consumption of the disintegration of the discussed species of grain is more strongly connected with the glassiness of the grain than with the gluten content.

The studies on the baking value of flour

The content of ash in the flour is the basis of the flour classification, to the particular types [33, 34]. The determination of the ash content in the flour is carried out by the method of the sample's combustion in the muffle furnace [35, 36]. The mentioned method is time-consuming and highly energy-consuming. To satisfy the needs of bakers and millers, Polish scientists have developed the method for determination of the flour whiteness, using the whiteness meter [37]. The whiteness meter is destined for measurements of light reflection coefficient of the flour samples and other food products. The established value of the mentioned reflection indicator enables qualification of the sample in accordance with the requirements set in the standards. The whiteness of the flour is determined by the brightness of the colour, i.e. the degree of its brightening or darkening; its componential elements include brightness and degree of yellow colour [37, 38].

Baking value of the flour is most frequently specified as the set of features, characterizing its behaviour in the process of dough preparation and during baking. The baking value of the flour is also connected with the considerable differences in its chemical composition and physicochemical properties of the particular components, and, especially of gluten. The methods employed in evaluation of the baking value are classified into two groups: indirect and direct. The indirect methods include chemical and physical methods [20-39]. The tests carried out by the chemical methods cover determination of protein content and other components of the flour. The tests of the quantity and quality of gluten and of sedimentation index have a great importance [23, 24].

The methods of the flour quality based upon the chemical analyses and determination of the quantity and physical properties of gluten obtained from the dough do not give the complete information about the baking value of the examined flour. The chemical tests are supplemented with the examination of physical properties of the dough produced from the mentioned flour. In the research and industrial laboratories, there were introduced many devices, serving for the examination of the physical properties of the dough; they were employed in testing of the behaviour and physical properties of the dough during the process of its mixing (agitation), fermentation etc., in the conditions similar to those in the industrial manufacturing process [20, 30].

Methods of evaluation of the rheological properties of the dough

The methods for the evaluation of the rheological properties of the dough gain more and more application in the qualifying assessment as well as in relation to the requirements set before the producers of wheat flour. The chemical tests of the flour are supplemented with tests of the physical properties of the dough made of it. Specialized laboratory equipment is used to test the behavior and physical properties of the dough, while maintaining test conditions similar to industrial conditions [20, 39].

Most often, the analysis of the physical properties of the dough during its production is performed with the use of a farinograph [20]. **Farinographic analysis** is based on the measurement of the resistance posed by the dough during mixing and analysis. The flour water absorption and dough parameters (dough stability, dough development time, softening) are determined. Farinograph may be employed in the tests of the flour coming from laboratory milling and of the commercial flours obtained from the wheat grain [40]. The newest constructional solutions of farinograph with strain gauge electronic dynamometer allow a very accurate evaluation of the characteristics of the resistance revealed by the dough during its kneading process. Additionally, there is available the automatic station, feeding water to the kneader (mixer) of the farinograph, with the own temperature-controlled container for water and volumetric system of its dosing [41] what additionally improves the accuracy of the measurements.

Supplementing the data obtained in the farinographic analysis on the quality of flour is the **extensographic analysis**. The resistance of the dough during its tearing is determined using an extensograph. In addition, it also gives the opportunity to study the effect of fermentation process conditions (time and temperature) on dough stretching [20]. It is a tool for control of the produced flour, allowing ensuring the constant quality of the product in accordance to the individual requirements of the customer. The results of the analysis enable the evaluation of the effect of additives, e.g. oxidizing elements such as ascorbic acid, or enzymes, on the flour also in a function of relaxation time. It facilitates the control and ensures the optimal rheological properties of the flour [42, 43]. It may be very useful in optimization of manufacture of the dough obtained with the application of health-promoting additives in production process of the enriched bread.

Alveograph is another device that is used to test the dough. It is used in the study of viscoplastic properties of dough made of wheat flour. The **alveographic analysis** is performed using the international reference method, determining the alveographic values (resistance, stretching ability, elasticity and baking strength) [44, 45]. Apart from the mentioned above methods, the method of alveographic assessment belongs to the most frequently employed methods for evaluation of the rheological properties of the dough, produced from the wheat flour. It consists in the examination of the resistance of the dough sample during its even blowing up. The parameters of the dough as determined using alveograph are the basis of the quality classification systems of the wheat grain and wheat flour in such countries as, *inter alia*, France, Spain, Italy and Argentine. The alveographic assessment gains more and more wide application also in other countries, e.g. in Poland. Based upon the differentiation of alveographic parameters in the studies of wheat flours, the results of the analysis are helpful in evaluation of the direction of utilization of a given flour, e.g. for production of bread, rolls or pastry products [45].

The ability of producing and retaining gases during the fermentation of the dough and baked product is the important issue from the viewpoint of assessing the quality of the flour [40]. Examination and registration of flour and yeast fermentation properties are performed using a laser fermentograph. **Fermentographic analysis** makes it possible to determine the ability of flour to retain CO₂ produced during dough fermentation, as well as to determine the gas-producing capacity of flour [46, 47]. It may be also employed in optimization of the manufacture of the dough with the additives, e.g. abundant in biologically active compounds.

The baking capacity of the flour is dependent on the properties of gelatinization of starch and activity of enzymes (α -amylase) [20, 48, 49]. Amylolytic activity of the wheat and rye flour is the component of their baking value and is determined by the same methods as in the case of the grain meal [26–28]. **Amylograph** is a specialized instrument for measurement and recording of characteristics and properties of starch gelatinization in the flours, depending on time and temperature [50], including the

initial and final temperature of gelatinization, maximum viscosity of the glue, produced from the flour suspension.

The rye dough does not generate gluten net what results also from the presence of a high quantity of pentosans in the rye grain. They have the capacity of creating very viscous solutions. High enzymatic activity if the rye grain is connected with its high sensitivity to sprouting during harvesting and storage. Due to this reason, the moderately low level of α -amylase activity is the main requirement in relation to the quality of the rye grain. Also, due to the same reason, baking value of the rye flour is characterized, first of all, on the grounds of the falling number and amylographic parameters of the flour suspension. The discussed methods are focused on the evaluation of the starch properties, its ability to swell and gelatinize and on the susceptibility to effect of amylolytic enzymes and assessment of the activity of amylases, present in the flour [51, 52].

Tested baking is a direct method for evaluation of baking value of flour. Baking may be classified according to the site of performance and, consequently, also the scale into: laboratory (performed in laboratory conditions) and industrial (carried out in a bakery) [20]. The industrial test baking is the last stage of the studies, allowing the complex assessment of baking value of the flour and deciding on its optimum direction of utilization [53].

Bibliography

- [1] Instytut Żywności i Żywienia, <https://ncez.pzh.gov.pl/wp-content/uploads/2021/03/piramida-dla-doroslych-opis866.pdf> (dostęp online: 14.02.2023)
- [2] Kołodziejczyk P., Michniewicz J. 2018. Ziarno zbóż i produkty zbożowe jako źródła błonnika pokarmowego. *Żywność. Nauka. Technologia. Jakość*, 3 (116), 5-22.
- [3] Czerwińska D., Kołtajis-Dołowy A., Trębska J. 2018. Częstotliwość spożycia wybranych bezglutenowych produktów zbożowych wśród osób chorych na celiakię. *Problemy Higieny i Epidemiologii*, 99, 58-63.
- [4] Główny Urząd Statystyczny, Bank Danych Lokalnych, <https://bdl.stat.gov.pl/bdl/start> (dostęp online: 14.02.2023)
- [5] Gąsiorowski H. (Ed.). 2004. *Pszenica: chemia i technologia: praca zbiorowa*. Państwowe Wydawnictwo Rolnicze i Leśne, Poznań, Polska.
- [6] Szafranska A. 2019. Wpływ wybranych czynników na jakość ziarna pszenicy zbieranego w Polsce. *Przegląd Zbożowo-Młynarski*, 63(1), 26-30.
- [7] Gąsiorowski H. 1994. *Żyto – chemia i technologia*. Państwowe Wydawnictwo Rolnicze i Leśne, Poznań, Polska.
- [8] Bushuk W. 2001. Rye: production, chemistry, and technology (No. Ed. 2). American Association of Cereal Chemists, St. Paul, USA.
- [9] Waraczewska Z. 2022. Wiadomości Rolnicze Polska. Jakość handlowa ziarna pszenicy – co jest oceniane i jakie są minimalne wymagania. <https://www.wrp.pl/jakosc-handlowa-ziarna-pszenicy-co-jest-oceniane-i-jakie-sa-minimalne-wymagania/> (dostęp online: 13.02.2023)
- [10] Stępniewska S. 2016. Wartość przemiałowa ziarna wybranych odmian pszenicy ze zbiorów z lat 2012-2014. *Acta Agrophysica*, 23(1), 75-87
- [11] Dżiki D., Laskowski J. 2005. Wheat kernel physical properties and milling process. *Acta Agrophysica*, 6(1), 59-71.
- [12] Frączek J., Kaczorowski J., Ślipek Z., Horabik J., Molenda M., 2003. Standaryzacja metod pomiaru właściwości fizyczno-mechanicznych roślinnych materiałów ziarnistych. *Acta Agrophysica*, 92, 47-72.

- [13] Tomkiewicz D. 2009. Budowa i działanie czujnika wilgotności ziarna zboża wykorzystującego promieniowanie w zakresie bliskiej podczerwieni. *Inżynieria Rolnicza*, 13(6), 309-314.
- [14] <https://www.perkinelmer.com/pl/category/benchtop-nir-analyzers> (dostęp online: 14.02.2023)
- [15] PN-EN ISO 7971-3:2019-03. Ziarno zbóż. Oznaczanie gęstości w stanie zsypanym, zwanej masą hektolitra. Część 3: Metoda rutynowa.
- [16] <https://instytut-sadkiewicza.pl/product/gestosciomierz-1l/> (dostęp online: 15.02.2023)
- [17] Mitek M., Słowiński M. 2006. *Wybrane zagadnienia z technologii żywności. Technologia zbóż*. Wydawnictwo SGGW, Warszawa, Polska.
- [18] <https://instytut-sadkiewicza.pl/product/licznik-ziaren/> (dostęp online: 15.02.2023)
- [19] Cacak-Pietrzak G., Ceglińska A., Haber T. 1999. *Cechy fizyko-chemiczne ziarna wybranych krajowych odmian pszenicy. Pamiętnik Puławski*, 118, 35-43
- [20] Jakubczyk T., Haber T. (Eds.). 1983. *Analiza zbóż i przetworów zbożowych: praca zbiorowa*. Wydawnictwo SGGW-AR, Warszawa, Polska.
- [21] Stępniewska S. 2015. Wartość technologiczna ziarna wybranych odmian pszenicy. *Acta Agrophysica*, 22(1), 103-114
- [22] <https://www.perkinelmer.com/pl/category/glutomatic-system> (dostęp online: 14.02.2023)
- [23] PN-EN ISO 21415-2:2015-12. Pszenica i mąka pszenna. Ilość glutenu. Część 2: Oznaczanie glutenu mokrego za pomocą urządzeń mechanicznych.
- [24] ICC Standard No. 155. Determination of Wet Gluten Quantity and Quality (Gluten Index ac. to Perten) of Whole Wheat Meal and Wheat Flour (*Triticum aestivum*).
- [25] Szafrńska A. 2016. Liczba opadania – wskaźnik oceny aktywności alfa-amylazy. *Przegląd Zbożowo-Młynarski*, 60(4), 36-39.
- [26] ICC No. 107/1 Determination of the Falling Number according to Hagberg – as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour.
- [27] AACC Method 56-81.03. Determination of Falling Number.
- [28] ISO 3093:2009. Wheat, rye and their flours, durum wheat and durum wheat semolina. Determination of the falling number according to Hagberg-Perten.
- [29] PN-EN ISO 3093:2010. Pszenica, żyto i mąki z nich uzyskane, pszenica durum i semolina. Oznaczanie liczby opadania metodą Hagberga-Pertena.
- [30] Cacak-Pietrzak G., Gondek E., Jonczyk K. 2013. Porównanie struktury wewnętrznej oraz właściwości przemiatowych ziarna orkiszu i pszenicy zycznej z uprawy ekologicznej. *Zeszyty Problemowe Postępów Nauk Rolniczych*, 574, 3-10.
- [31] Warechowska M. 2014. Wybrane właściwości fizyczne ziarna zbóż a energochłonność rozdrabniania. *Agricultural Engineering*, 18(1), 239-249.
- [32] Laskowski J., Różyło R. 2003. Influence of gluten content and wheat glassiness on the wheat grain grinding energy. *Acta Agrophysica*, 2(97-3), 589-596.
- [33] PN-A-74022:2003. Przetwory zbożowe. Mąka pszenna.
- [34] PN-A-74032: 2002 Przetwory zbożowe. Mąka żytnia.
- [35] PN-EN ISO 2171:2010. Ziarno zbóż, nasiona roślin strączkowych i ich przetwory. Oznaczanie zawartości popiołu metodą spalania.
- [36] AACC Method 08-01.01. Ash – Basic Method.
- [37] Woźnicka K., Sadkiewicz J. 2010. Wdrażanie energooszczędnych mierników bieli mąki w młynarstwie. *Inżynieria i Aparatura Chemiczna*, 49(5), 132-133.
- [38] <https://instytut-sadkiewicza.pl/product/miernik-bieli/> (dostęp online: 14.02.2023)
- [39] Jurga R. 2012. Wartość wypiekowa mąki pszennej. *Przegląd Piekarski i Cukierniczy*, 60(5), 14,16.
- [40] PN-EN ISO 5530-1:2015-01. Mąka pszenna. Fizyczne właściwości ciasta. Część 1: Oznaczanie wodochłonności i właściwości reologicznych za pomocą farinografu.
- [41] <https://www.brabender.com/en/product/farinograph-ts/> (dostęp online: 15.02.2023)
- [42] Zawadzki K. 1999. Ekstensograf – aparat do kontroli jakości wypiekowej mąki pszennej – stosowany w UE. *Przegląd Zbożowo-Młynarski*, 43(6), 39-41.
- [43] <https://www.brabender.com/en/product/extensograph-e/> (dostęp online: 15.02.2023)
- [44] Dziki D., Laskowski J. 2003. Ocena właściwości reologicznych ciasta przy wykorzystaniu konsystografu i alweografu. *Acta Agrophysica*, 82, 23-32.
- [45] Szafrńska A. 2020. Zastosowanie alweografu do oceny jakości mąki pszennej. *Przegląd Piekarski i Cukierniczy*, 68(1), 10-13.
- [46] <https://instytut-sadkiewicza.pl/product/fermentograf-laserowy/> (dostęp online: 15.02.2023)
- [47] Sadkiewicz K., Sadkiewicz J. 2005. Przydatność badan właściwości fermentacyjnych mąki i drożdży w technologii piekarskiej. *Ekologia i Technika*, 13(5), 167-169.
- [48] Rothkaehl J. 2000. Ocena stopnia aktywności alfa-amylazy przy zastosowaniu amylografu. *Przegląd Zbożowo-Młynarski*, 44(12), 21-23.
- [49] Szafrńska A. 2016. Ocena amylograficzna mąki pszennej i żytniej. *Przegląd Zbożowo-Młynarski*, 60(5), 24-28.
- [50] <https://www.brabender.com/en/product/amylograph-e/> (dostęp online: 15.02.2023)
- [51] Kot M., Słowik E. 2012. Wartość wypiekowa mąki żytniej. *Przegląd Zbożowo-Młynarski*, 56(12), 19-21.
- [52] Szafrńska A. 2011. Ocena wartości wypiekowej mąki żytniej. *Postępy Nauki i Technologii Przemysłu Rolno-Spożywczego*, 66(4), 5-18.
- [53] Mielcarz M. 2009. Próbný wypiek laboratoryjny – ostatnie ogniwo sprawdzania jakości mąki. *Przegląd Zbożowo-Młynarski*, 53(9), 22-24.

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MINIMIZATION OF MOTION RESISTANCE IN PROSUMER WIND POWER PLANT

MINIMALIZACJA OPORÓW RUCHU W PROSUMENCKIEJ ELEKTROWNI WIATROWEJ

Summary: By their very nature, prosumer wind farms must be installed in the vicinity of human settlements. These locations have very limited wind energy resources due to limited installation heights, terrain obstacles, tall trees and buildings. All solutions that increase their energy efficiency are of particular importance for this type of power plant. The article describes the selected design solutions of turbine rotors with a vertical axis of rotation that enable the improvement of the efficiency of prosumer power plants. A new design solution for the bearing of the power plant shaft was suggested. High durability, low noise, ease of use and safety of use characterize it. This bearing system ensures the minimization of movement resistance, in particular at start-up, which means that the power station can operate effectively at low wind speeds.

Keywords: prosumer wind farms, wind energy resources, energy efficiency, minimization of motion resistance, power plant

Streszczenie: Ze swej natury prosumenckie farmy wiatrowe muszą być instalowane w pobliżu osiedli ludzkich. Lokalizacje te mają bardzo ograniczone zasoby energii wiatrowej ze względu na ograniczone wysokości instalacji, przeszkody terenowe, wysokie drzewa i budynki. Szczególne znaczenie dla tego typu elektrowni mają wszelkie rozwiązania zwiększające ich efektywność energetyczną. W artykule opisano wybrane rozwiązania konstrukcyjne wirników turbin z pionową osią obrotu, które umożliwiają poprawę sprawności elektrowni prosumenckich. Zaproponowano nowe rozwiązanie konstrukcyjne łożyska wału elektrowni. Cechuje go wysoka trwałość, niski poziom hałasu, łatwość obsługi i bezpieczeństwo użytkowania. Taki układ łożysk zapewnia minimalizację oporów ruchu, w szczególności przy rozruchu, co sprawia, że elektrownia może efektywnie pracować przy niskich prędkościach wiatru.

Słowa kluczowe: prosumenckie farmy wiatrowe, zasoby energii wiatrowej, efektywność energetyczną, minimalizacja oporów ruchu, elektrownia wiatrowa

Introduction

Prosumer power plants are designed mainly to meet the electricity demand of the users themselves, with the transfer of only the excess of generated energy to the general power grid. In the case of water or wind power plants, respectively small amounts of water or winds with limited speed are used.

Prosumer wind farms are subject to numerous environmental restrictions, as they are most often installed on buildings or in the close vicinity of residential areas. Wind conditions in these zones are often limited due to numerous terrain obstacles, tall trees and buildings. Additional restrictions follow from building regulations and the need to maintain as quiet running as possible and safety of use. The height of the installation on buildings is limited by regulations (in Poland it is currently 3 m above buildings).

Similar limitations apply when wind turbines are placed on towers in the close vicinity of human habitation [1, 8, 7].

The aforementioned limitations mean that solutions allowing for the fullest possible use of available wind energy are of particular importance. In particular, efforts should be made to minimize own motion resistance so that low-speed winds can be used and the power plant start-up is carried out at low wind speeds.

This paper presents the design solutions of the power plant elements that aim at the decrease in the start-up resistance and assuring lowest noise generation and security of its use. The requirements of minimum costs of construction and exploitation of wind power station are considered.

Turbine rotors of wind turbines with a vertical axis of rotation and improved functional properties

In the field of various designs of prosumer wind power plants, turbine rotors with a vertical axis of rotation are most often used. Their main advantage includes simple design and the ability to work regardless of the direction of the wind. Compared to the rotors with a horizontal axis, especially large wind farms, they have lower energy efficiency and a relatively large axial load [2]. The lower efficiency of rotors with a vertical axis of rotation is due to the fact that the blades of the rotors have to move "upwind" (against the direction of the wind) during part of their rotation, which absorbs part of the energy obtained on the active part of the rotation of the rotor.

The rotors of wind turbines with a vertical axis of rotation can be relatively easily modified in order to obtain more generated

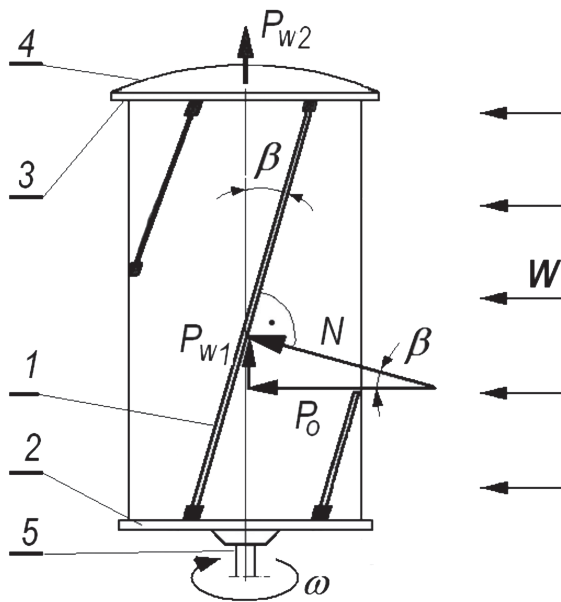


Fig. 1. Scheme of a wind turbine rotor with a vertical axis of rotation and helical blades and an aerodynamic design

power. These modifications usually have an extensive character and consist in increasing the working surface of the rotors. Enlarging the dimensions of the rotors encounters many limitations. The increase in the diameter of the rotors increases the active surface of the blades, but leads to a decrease in rotational speed and causes a significant increase in the weight of the rotors, which increases the bearing resistance. It is more effective to increase the length of the blades. With the increase in the height of the rotors, their energy efficiency improves, because the share of the unfavourable action ("escape") of the air stream at the blade ends decreases. An increase in the length of the blades, on the other hand, increases the susceptibility to generating vibrations, especially in the case of winds of variable speed.

In these cases, there are the aforementioned restrictions in the regulations and the increasing in bending moment acting on the shaft of the power plant, because the arm of the resultant wind pressure force is increased.

In the described situation, design solutions that improve the efficiency of rotor operation without excessive increase in their size become more important.

For prosumer applications, the height of rotors with a vertical axis of rotation can be advantageously assumed to be about 2 ÷ 4 times of the diameter, especially when using the rotor design modifications described below.

Instead of straight blades that are oriented parallel to the axis of rotation of the rotor, it is advisable to use skew or helical blades, which is schematically illustrated in Fig. 1. With the appropriate inclination of the blades at an angle in the range $\beta = 10^{\circ}\div 20^{\circ}$, the acting force for each blade as a result of wind pressure N decomposes into a horizontal component $P_0 = N \cos \beta$, causing the rotor torque, and a vertical component $P_{w1} = N \sin \beta$ acting upwards. The P_{w1} component acts in the direction of unloading the shaft bearing with forces reducing its axial load. On the longitudinal

load of the shaft bearing with the vertical axis of rotation consists of the weights of the rotor itself, the shaft, which is usually long, and the weights of all moving parts mounted on the shaft. The apparent reduction of the aforementioned weights as a result of the force P_{w1} causes the reduction in the resistance to rotor movement, which is desirable, especially during start-up. It is particularly advantageous to use blades with a helical shape, because then it is possible to effectively increase the spatial stiffness of the blades without increasing their mass. Greater stiffness of the blades eliminates susceptibility to vibrations and noise generated especially when the wind speed changes.

An additional advantage of slanted, and even more preferably helical, blades is their increased degree of coverage, analogous to the helical teeth of the gear wheels. It then becomes possible to reduce the number of blades, which further reduces the weight of the turbine wheel.

Discs 2 and 3 (Fig. 1), to which the blades are attached, transfer the torque to the shaft 5. It is best to use standard expansion rings to secure the discs to the shaft, ensuring a strong, backlash-free disconnection, transferring a large torque and longitudinal forces [4]. The use of standard expansion rings to connect discs 2 and 3 to the shaft, and to connect all other rotating elements to the shaft, allows the use of a section of a thick-walled pipe in metallurgical condition as a shaft, i.e. without the need for machining the shaft. Expansion rings compensate for metallurgical deviations in making thick-walled pipes. This is of particular importance when the users themselves build prosumer wind farms.

The discs in which the ends of the blades are embedded, in particular the upper disc 3, may be equipped with tops 4 convex upwards (Fig. 1). The crown 4 with an aerodynamic profile causes the flowing wind to cause a lifting force P_{w2} in accordance with Bernoulli's law as a result of the difference in air velocity above and below the crown 4. The lift force, P_{w2} , reduces the axial load on the shaft bearing by acting with the wind pressure component P_{w1} .

In total, a significant reduction in the longitudinal load on the shaft bearing is obtained, the greater the higher the current wind speed. This is especially desirable during the start-up of the power plant, because the resting resistances are definitely increased.

With the increased height of the rotor, it is advisable to use a stacked arrangement of blades. An example of such a rotor configuration with a 3-tier arrangement of blades is shown schematically in Fig. 2. The individual stages of the blades are made with an angular displacement in relation to the blades of the adjacent stage.

This displacement shall be equal to the angle pitch of the blades on each floor divided by the number of floors. In the example in Fig. 2, it is $120^{\circ}/3=40^{\circ}$ (Fig. 2 cross section A-A). Such an arrangement of blades allows reducing their number; moreover, shorter blades can be made lighter while maintaining sufficient rigidity. This assures further reduction in the thrust load on the shaft bearing. Intermediate discs 4 and 5 can also be mounted on the shaft by means of expansion rings. Thanks to this, the torque from the rotor to the shaft is transmitted in a graduated manner. This provides the possibility of reducing the cross-section of the shaft in the upper zone of the rotor, which reduces its weight, reducing

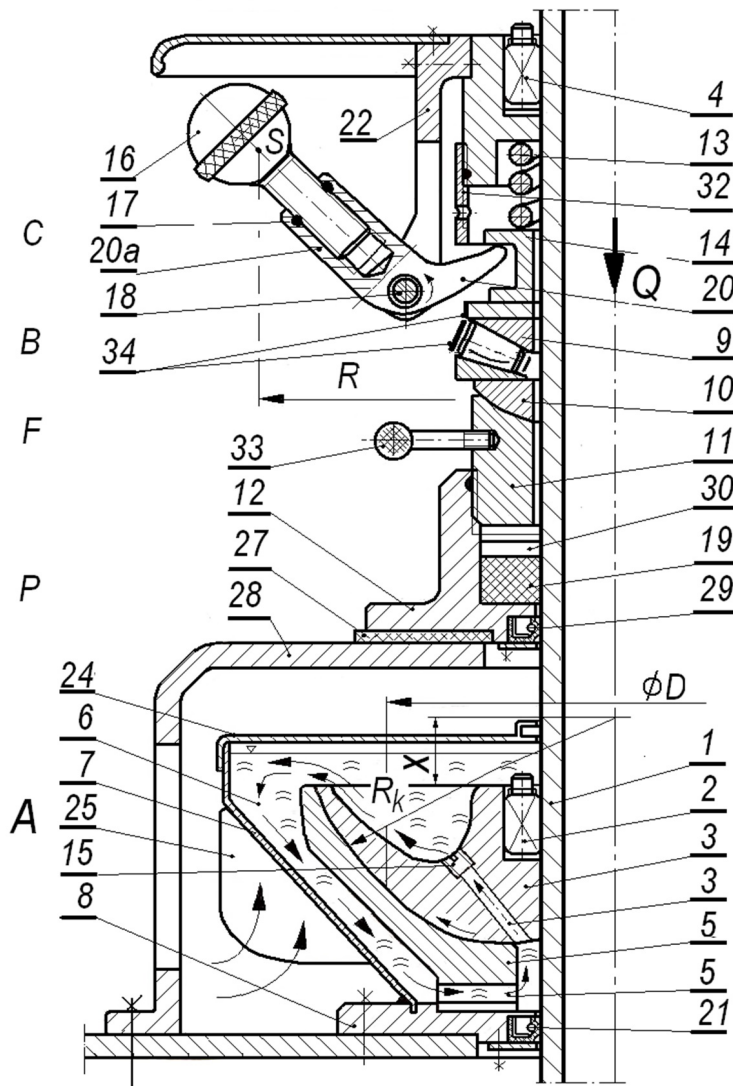


Fig. 4. Combined bearing of a wind turbine shaft with vertical axis of rotation, consisting of the main sliding bearing A with hydrodynamic lubrication, the rolling bearing B supporting the start-up and run-out and the transverse journal bearing P (laterally stabilizing the wind turbine shaft)

The bearing system consists of the following components:

- A- main journal bearing with hydrodynamic lubrication operating only at a sufficiently high rotational speed to ensure smooth lubrication,
- B- supporting rolling bearing operating only during start-up and slowing down,
- C- sub-assembly for switching the load between bearings B and A,
- F- sub-assembly of initial clearance adjustment in journal bearing A,
- P- radial journal bearing which transversely stabilizes the shaft of power plant.

per or brass casing 7 with external vertical cooling ribs 25. Base of the journal bearing 8 is seated in a rigid console 28.

At rest, the full bearing load Q is carried by the supporting rolling bearing 9 which is spherically supported by the ring 10. The self-aligning spherical ring 10 is supported by on the adjustment sleeve 11 connected with a fine-thread to the base 12 fixed on the ceiling of the building or lower landing, preferably by means of a vibration damping pad 27. The rolling bearing 9 transfers the load Q as a result of the pressure of the sliding sleeve 14 resting on the compression spring 13, which is mounted in the housing 4 fixed on the shaft 1 with the expansion ring 2.

The start-up of the entire power plant system is carried out only with the participation of the rolling bearing 9, because there is a predetermined clearance in the slide bearing. As the rotation-

al speed of the system increases, the inertial weights 16 mounted on pins 18 cause increasing pressure on the sliding sleeve 14 through the levers 20. This generates a gradual smooth loosening of the starting load of the rolling bearing 9 combined with the transfer of the load to the main slide bearing A, in which, due to the slip of journal 3 after bushing 5, hydrodynamic lubrication develops. In the final stage of start-up, the supporting rolling bearing 9 is fully unloaded and stops, and the full load Q is carried by the main journal bearing A under hydrodynamic lubrication conditions.

The spherical form of the journal 3 makes, that the journal bearing A transfer, apart from the main thrust load Q , also the transverse load of the shaft 1 resulting from, among others, wind pressure on the turbine wheel mounted on the upper part of the shaft. In the journal bearing, there is an intensive circulation of the lubricant, shown by the arrows in Fig. 4. The lubricant flows through the holes 5a to the input side of the bearing, located in the vicinity of the shaft, moves in a spiral in the zone of cooperation of the pin 3 with the sleeve 5 and, under the action of centrifugal force, flows into the housing 7, lifting heat generated in the bearing. After cooling, the lubricant returns to the input side of the bearing, which is favoured by the gravitational change in its density.

The journal 3 acts as the impeller of a centrifugal pump due to the radial or helical grooves made on the working surface of the journal.

Appropriately shaped grooves in journal 3 facilitate the formation of numerous wedges, ensuring smooth lubrication in the main slide bearing, even at reduced rotational speed. The rotational speed at which the described load switching from the auxiliary rolling bearing to the main sliding bearing A takes place, is controlled by changing the radius R of rotation of the centre of mass S of weights 16 by turning the threaded connection these weights in the openings of the control levers 20a. The ring 17 made of high-friction material serves to stabilize the set position of the

weights S_1 . Turning the weights 16, preferably in the number of three evenly spaced, should be performed equally for all weights, maintaining full balance of the subassembly C.

In the extreme position, the levers 20 rest against the adjustable stop sleeve 32 that serves to eliminate the generation of vibrations in the load switching system. An additional radial journal bearing 19 is used for transverse stabilization of the long shaft 1. A self-lubricating porous bushing 30 lubricated with plastic grease and applied during bearing assembling may be used as bearing 19.

In order to ensure that the entire bearing system operated as described, it is necessary to properly pre-adjust the bearing, which is done by subassembly F. When stationary, preferably before flooding the journal bearing with lubricant, it should be en-

sured that in the main journal bearing A, there was a clearance, of a size close to the thickness of the lubricating film at the nominal rotational speed occurring at the average wind speed. Ignorance of this quantity is not a significant obstacle. It is necessary to turn the lever 33 in such a way as to determine the position in which dry contact begins in the bearing A. The symptom is then a strongly increased resistance to rotation of the shaft 1. Then, turn the lever 33 in the direction of lifting the sleeve 11 so as to obtain a situation in which the journal bearing A will be completely unloaded, and a small load will be taken over by the supporting rolling bearing 9. The signal will be a significant decrease in the resistance to rotation of the shaft. It is desirable to increase this slight clearance by a small fraction of a millimetre using the angle of rotation of the fine thread of the adjusting sleeve 11 relative to the base 12. After bearing A has been flooded with lubricant, the entire system can be started up. The described activity is performed once, with any correction that may occur during operation, for example, with a significant difference in thermal elongation of the elements of the control bearing system.

Then, proceed to adjusting the C subassembly so that the load is switched at the assumed lowest possible rotational speed ensuring proper operation of the journal bearing. The load switching should be smooth, without the breaks. When the bearing run out occurs, e.g. when the power plant is stopped or the wind speed decreases significantly, the described load switching system works in the opposite direction and the final bearing run out takes place only with the participation of the rolling bearing 9.

The described run of bearing operation with proper adjustment causes that the slide bearing A operates only in conditions of full hydrodynamic lubrication, while the supporting rolling bearing 3 works only for short periods of time at start-up and run-out. Thanks to this, a very high durability of the elements of bearing system is obtained, and the start-up takes place with significantly reduced resistance to motion, i.e. it can take place already at the minimum wind speed.

Operational control of the operation of load switching system in both directions can be carried out by visual observation of contrasting axial stripes 34 located on the cage of the rolling bearing 9 and the sliding sleeve 14. The use of a stroboscope allows for accurate measurement of the rotational speed of switching the load between bearings A and B.

The described bearing of the prosumer wind power plant with vertical rotation is characterized by high noiselessness, because the supporting rolling bearing works for a short time and at a moderate speed of rotation. However, the journal bearing A, operating in conditions of full hydrodynamic lubrication, is practically noiseless.

The proportions between the transferred axial load Q and the transverse load can be adjusted by the appropriate selection of the radius R_k of the spherical journal 3 and the size X of the position of its upper edge. The possibility of using a sufficiently large average slip diameter D in the slide bearing A allows the use of a lubricant with the lowest possible viscosity to lubricate the slide bearing. It positively reduces the bearing resistance to the motion and improves the overall energy efficiency of the entire system

wind power plant, thanks to which it can effectively use even limited wind conditions.

Final remarks

Restrictions on the conditions for installing prosumer wind turbines mean that their users often have very limited possibilities of using energy. Therefore, any measures to increase their effectiveness are of great practical importance

The article describes selected design solutions for wind turbines with a vertical axis of rotation that allow to improve the efficiency of the wind turbine, which can be used by the users themselves at the design stage as well as during the modernization of already operated installations. Such possibilities are created by the use of helical or other blades of turbine rotors, a stacked arrangement of blades, the aerodynamic top of the rotors and blades with high flexibility. These solutions can be used separately or in various combinations, contributing to a significant improvement in the operational properties of wind turbine rotors.

Particular attention was paid to the new design of the power plant shaft bearing system with a vertical axis of rotation.

This bearing system is characterized by particularly high durability, high noiselessness, and increased safety of use and practically maintenance-free. Of particular importance are the limited resistance to motion of the described bearings system, which enable the power plant to operate at low wind speeds.

The dissemination of the described solutions in the design of prosumer wind farms can be a significant contribution to the development of distributed energy based on RES (Renewable Energy Systems).

Bibliography

- [1] Ackerman T.: Wind power in power systems. John Willey and Sons. Chichester. 2009.
- [2] Lubośny Z.: Wind farms in the power system. WNT, Warsaw. 2006. (in Polish)
- [3] Olszowiec P.: Wind energy. Electro technical News. No. 77. 2021. (in Polish)
- [4] Mikuła J., Mikuła S., and Strzelecki S.: The concept of a pro-consumer hydro power plant with a special bearing for the main shaft. Polish Technical Review. Year. 1. 2022.
- [5] Wegner Wind turbine noise. Springer Berlin. 1916.
- [6] Zagubień A., Wolniewicz K.: Domestic sources of low-frequency noise. Environmental Protection Yearbook, No. 19, 2017. (in Polish)
- [7] Regulation of the Minister of Environment of 14.06. 2007 on acceptable noise measurements in the environment. Journal Laws of 22.01. 2014 item 112. (in Polish)
- [8] Jasiński A. W. and others: Wind farms in the human environment. Monograph. No. 178. Ed. Polish Academy of Sciences, Committee of Environmental Engineering, Lublin. 2022. (in Polish).

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NEW DEVELOPMENTS IN METHANE FERMENTATION AND AMMONIA EMISSION TO OBTAIN BETTER ENVIRONMENTAL CONDITIONS FOR LIVING IN COUNTRY SIDE AREA

NOWE ROZWIĄZANIA W FERMENTACJI METANOWEJ I EMISJI AMONIAKU W CELU UZYSKANIA LEPSZYCH WARUNKÓW ŚRODOWISKOWYCH DO ŻYCIA NA OBSZARACH WIEJSKICH

Summary: Research results indicate the growing ammonia concentration in the air and the necessity to undertake the work aimed at the change of the mentioned situation, using different solutions. University of Maryland (USA) undertook the study of global ammonia concentrations in the air over the most productive agricultural regions in the world. Acidification of animal slurry has proved to be an efficient solution to minimize NH_3 emissions in-house, during storage, and after soil application, as well as to increase the fertilizer value of slurry, without negative impacts on other gaseous emissions. This solution has been used commonly in Denmark, and its efficiency with regard to the minimization of NH_3 emissions has been documented in some studies. Slurry acidification technology gives many advantages from the point of view of soil fertilization and also the limiting of ammonia emission. Acidification reduced NH_3 emission from the stored slurry to less than 10% of the emission from untreated slurry, and the NH_3 emission from the slurry employed on the field was reduced by 67%. Of course it requires providing the safety procedures to avoid a direct contact of farm workers with harmful activity of the acid. Reducing the loss of nitrogen from agriculture has a key meaning for reduction of eutrophication of the Baltic Sea. Most of the airborne eutrophication to the Baltic Sea comes from the ammonia emissions, and in the BSR almost all ammonia emissions come from livestock manure. Annual deposition of ammonia nitrogen to the Baltic Sea has been increasing during the recent years and was greater in 2012 than in 1995. While emissions are decreasing slightly in some countries, HELCOM Baltic Sea Action Plan calls for a reduction of 118.000 tonnes of nitrogen annually to the Baltic Sea, and the Revised Gothenburg Protocol (2012) calls for ambitious reductions in ammonia emissions from all BSR countries. Slurry acidification also affects solid/liquid slurry separation efficiency positively; DM is higher, N lower and P higher in the solid fraction. A combined treatment should efficiently prevent gaseous emissions, increase fertilizer value of slurry and reduce transport and energy costs. The pH level of 5.5- 6.4 is not very acidic, and no more acidic than rain water, which has a normal pH range from 4.5 to 8.5. Biogas experiments show the possibility of utilization of slurry with high dry matter content in biogas production.

Keywords: new technology, slurry acidification technology, ammonia emission, environment protection, biogas production

Streszczenie: Wyniki badań wskazują na rosnące stężenie amoniaku w powietrzu i konieczność podjęcia pracy nad zmianą tej sytuacji przy zastosowaniu różnych rozwiązań. University of Maryland (USA) podjął się badania globalnych stężeń amoniaku w powietrzu nad najbardziej produktywnymi regionami rolniczymi na świecie. Zakwaszanie gnojowicy zwierzęcej okazało się skutecznym rozwiązaniem minimalizującym emisję NH_3 w gospodarstwie, podczas przechowywania i po zastosowaniu doglebowym, a także zwiększającym wartość nawozową gnojowicy bez negatywnego wpływu na inne emisje gazowe. Rozwiązanie to jest powszechnie stosowane w Danii, a jego skuteczność w zakresie minimalizacji emisji NH_3 została udokumentowana w niektórych badaniach. Technologia zakwaszania gnojowicy daje wiele korzyści z punktu widzenia nawożenia gleby, a także ograniczenia emisji amoniaku. Zakwaszenie ograniczyło emisję NH_3 z magazynowanej gnojowicy do mniej niż 10% emisji z gnojowicy nieoczyszczonej, a emisja NH_3 z gnojowicy stosowanej na polu została zmniejszona o 67%. Oczywiście wymaga to zapewnienia procedur bezpieczeństwa, aby uniknąć bezpośredniego kontaktu pracowników rolnych ze szkodliwym działaniem kwasu. Ograniczenie strat azotu z rolnictwa ma kluczowe znaczenie dla ograniczenia eutrofizacji Morza Bałtyckiego. Większość eutrofizacji przenoszonej drogą powietrzną do Morza Bałtyckiego pochodzi z emisji amoniaku, a w BSR prawie wszystkie emisje amoniaku pochodzą z obornika zwierzęcego. Roczna depozycja azotu amonowego w Morzu Bałtyckim wzrosła w ostatnich latach i była większa w 2012 r. niż w 1995 r. Podczas gdy emisje w niektórych krajach nieznacznie spadają, Bałtycki Plan Działania HELCOM zakłada redukcję o 118 000 ton azotu rocznie do Morza Bałtyckiego oraz zrewidowany protokół z Göteborga (2012) wzywa do ambitnych redukcji emisji amoniaku ze wszystkich krajów BSR. Zakwaszenie gnojowicy wpływa również pozytywnie na skuteczność separacji gnojowicy ciało stałe/ciecz, DM jest wyższy, N niższy, a P wyższy we frakcji stałej. Połączona obróbka powinna skutecznie zapobiegać emisjom gazów, zwiększać wartość nawozową gnojowicy oraz obniżyć koszty transportu i energii. Poziom pH 5,5-6,4 nie jest bardzo kwaśny i nie bardziej kwaśny niż woda deszczowa, która ma normalny zakres pH od 4,5 do 8,5. Doświadczenia biogazowe wskazują na możliwość wykorzystania gnojowicy o wysokiej zawartości suchej masy do produkcji biogazu.

Słowa kluczowe: nowa technologia, technologia zakwaszania gnojowicy, emisja amoniaku, ochrona środowiska, produkcja biogazu

Introduction

Ammonia in the gaseous state is a natural part of the nitrogen cycle in nature, but excessive concentration harms plants and lowers water and air quality. In the lowest atmosphere, the

troposphere, ammonia reacts with nitric and sulfuric acids to form nitric-containing particles, adding to the air pollution. Researchers from University of Maryland (USA) undertook the first long-term study of global ammonia concentrations in the air over the four most productive agricultural regions in the world.

application, as well as to increase the fertilizer value of slurry, without negative impacts on other gaseous emissions.

Figure 1 shows two concrete tanks staying side by side, one is for fresh slurry and the other for acidified slurry. These two concrete tanks are equipped in one mixer and one pump, which can be moved very easily from one tank to the other, depending on the requirements. Fresh slurry from the right tank is pumped to the left tank, where acidification occurs. Acidification process is controlled by pH meter. When process is completed, acidified slurry is taken by a tanker using discharge pipe RB.

Analysis of different storage tanks and acidification systems was provided. Also, the economic analysis concerning possible usage of acidified slurry on different crops as corn, wheat, grass etc. was carried out. Costs of energy as electricity, gas, petrol etc. were taken into consideration. Technical documentation of two concrete tanks was elaborated. To provide acidification process in the mentioned two tanks, a special automated system was elaborated. The main elements of the discussed system are: pump, mixer, pH meter, temperature meter. When slurry achieves a proper pH value then it is pumped to the tanker with trailing hoses, which will spread the acidified slurry on the field plots to provide farther experiments. After analysis of different "in storage" systems present on Danish market, there was chosen one of the systems, which can be suitable for the Polish animal herd sizes and possibility of safe acid delivery on the farm, where acidification process will be provided. This system contains the following main elements: the main frame with power transmission taken from PTO of the tractor, slurry

mixer, acid pump, which delivers acid from the truck with acid to the area of slurry mixer activity, pH meter, which can check when proper PH level of slurry is achieved.

Biogas experiment concerning slurry fermentation with high dry matter content

Figure 2 shows a schematic diagram of the device, which allows to examine the individual elements of the technological process that determines the fermentation, and allows to conduct substrate fermentation studies, determine their physical and chemical characteristics, and further determine the characteristics of the fermentation process, the quality and quantity of obtained biogas and quality of digestive residues. The question of constructing a station for the production of biogas, mainly from the substrate in the form of mixture of manure, organic waste and vegetable matter was presented. The test bed according to the embodiment shown on figure 2 has a substrate fermentation vessel 1, cooperating with the pre-fermentation tank 2 and the final fermentation tank 3. The substrate fermentation tank, the pre-fermentation tank and the final fermentation tank are equipped with an insulating protective layer 5 heated by heating mantle 4. The biogas produced in these tanks is transported via lines 2 to biogas tank 24 and then to the cogeneration unit 30. During transportation to the reservoir 24, the biogas is subjected to dehydration in the trap 25 and desulphurization in the desulphurizer 26.

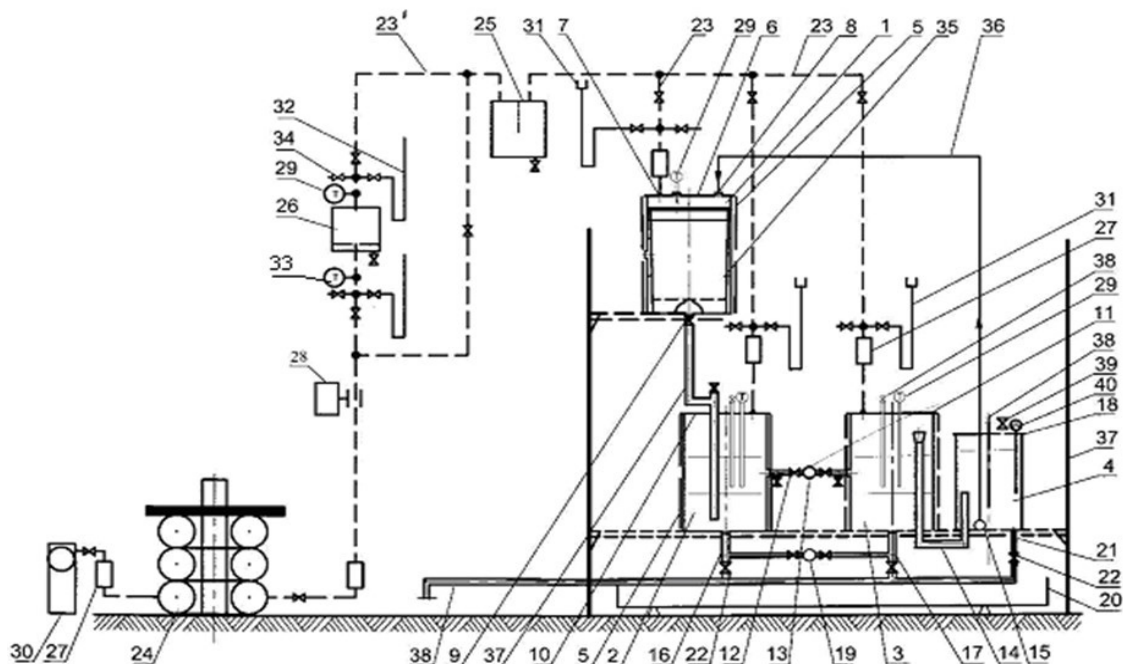


Fig. 2. Scheme of a stand for biogas recovery from substrates up to 12% of dry matter content

1 - substrate flushing tank; 2 - pre-fermented tank for rinsed organic matter; 3 - tank for final organic matter fermentation; 4 - overflow tank; 5 - external thermal insulation; 6 - tank cover; 7 - biogas feeding pipe; 8 - drain hose for rinsed organic matter; 9 - shut-off valve; 10 - tank cover; 11 - tank cover; 12 - pump; 13 - mixing pump; 14 - siphon funnel; 15 - suction-discharge pump; 16 - drain-mixing pipeline; 17 - drain-mixing pipeline; 18 - tank cover; 19 - mixing pump; 20 - bath; 21 - drain pipe; 22 - liquid organic drainage valves; 23 - biogas discharge line; 24 - biogas tank; 25 - biogas trap; 26 - biogas desulphurization; 27 - flame breaker; 28 - biogas counter; 29 - thermometer set; 30 - cogeneration unit; 31 - safety valves; 32 - biogas pressure indicators; 33 - thermometer set; 34 - biogas sampling valves; 35 - openwork basket for solid substrate; 36 - transport pipeline for rinsed organic matter; 38 - sampling slots from chambers; 39 - filler insert; 40 - liquid level indicator (Romaniuk et al., 2013)

Test results concerning fermentation process using slurry with high dry matter content

Average evaluation process parameters of fermentation mixtures tested at substrates' dry matter content equal to 10% are presented in table 1.

Table 1. Average evaluation process parameters of fermentation mixtures tested at substrates' dry matter content equal to 10% (Myczko et al., 2015)

Process parameters of fermentation mixture	OS ZPE 15/15 sample 10%	PC (OS WD) ZPE 15/15 sample 10%	ST (OS WD) ZPE 15/15 sample 10%	OP ZPE 15/15 sample 10%	PC (OP WD) ZPE 15/15 sample 10%	ST (OP WD) ZPE 15/15 sample 10%	OP ZPE 15/15 sample 10%	PC (OP WD) ZPE 15/15 sample 10%	ST (OP WD) ZPE 15/15 sample 10%	K0 - inoculum
pH-H ₂ O initial	7,28 ±0,07	7,32±0,07	7,31 ±0,07	7,16 ±0,07	7,20 ±0,07	7,20 ±0,07	6,94 ±0,07	6,95 ±0,08	6,94 ±0,07	7,02 ±0,07
TEMP. COMPENSATION in lab. temp.: 20,5°C	28,2°C	26,1°C	26,9°C	25,6°C	27,8°C	25,1°C	24,6°C	26,8°C	26,1°C	31,1°C
Dissolved oxygen O ₂ *	0,18 [mg/l]	0,02 [mg/l]	0,06 [mg/l]	0,11 [mg/l]	0,02 [mg/l]	0,09 [mg/l]	0,13 [mg/l]	0,02 [mg/l]	0,08 [mg/l]	0,02 [mg/l]
Alkaline buffer potential LKT/OWN*	4,16	4,68	2,94	4,31	4,53	3,12	4,33	4,14	2,06	0,08
Loading of the fermentation mixture with dry organic mass	4,54% dev ±0,14 68,93% dm ±2,07	2,60% dev ±0,05 69,51% dm ±2,08	3,57% dev ±0,07 67,86% dm ±2,04	4,51% dev ±0,14 68,95% dm ±2,07	2,53% dev ±0,05 69,57% dm ±2,09	3,47% dev ±0,10 68,71% dm ±2,06	4,20% dev ±0,13 69,13% dm ±2,05	2,49% dev ±0,05 67,47% dm ±2,02	3,34% dev ±0,07 69,39% dm ±2,08	2,68% dev ±0,04 67,61% dm ±1,9
Number of fermentation days	52	4	54	52	4	56	56	4	58	14
Biogas yield SPM**	62,49 ±5,03 NI/kg dev	44,77 ±3,58 NI/kg dev	17,20 ±1,38 NI/kg dev	66,90 ±5,35 NI/kg dev	46,06 ±3,68 NI/kg dev	29,84 ±2,39 NI/kg dev	56,79 ±4,54 NI/kg dev	20,44 ±1,64 NI/kg dev	28,34 ±2,27 NI/kg dev	0,88 ±0,07 NI/kg dev
Content CH ₄ NH ₃ H ₂ S	53,6% 23,6 ppm 128 ppm	46,8% 12,3ppm 113ppm	51,3% 20,2% 22ppm	55,1% 18,4 ppm 216 ppm	48,8% 18,5ppm 125 ppm	50,5% 12,2ppm 24 ppm	50,7% 8,7 ppm 34 ppm	43,6% 4,7 ppm 30 ppm	50,3% 4,0 ppm 22 ppm	51,6% 2,56 ppm 9 ppm

* Results of dissolved oxygen and alkaline buffer potential were obtained by the method beyond the scope of accreditation

** The result of the biogas yield is the net amount of gas from the test sample, the result of biogas yield from the inoculum is given for orientation

Control test K0 – Inoculate methane fermentation bacteria. Lab conditions: temp. of 21.6–22.5°C, moisture. 38.9–41.6%, pressure: 1007.0–1013.0 hPa; Total drying time: 60 hours, total roasting time: 10 hours

Influence of slurry acidification on the chosen materials

To study an effect of the influence of acidic slurry on produced standard concrete samples measuring 15x15x15 cm, made from two grades of concrete C25/30 and 30/37 in an amount of 66 pieces, was carried out. As a medium, there was taken aggressive slurry acidified to a pH of 5.5. All samples after construction by

the company Hydrobudowa were subjected to a process of care and maturation for a period of 28 days under the conditions specified in the standard. Then the samples were placed in an acidified slurry, normal slurry and water. Time storage of the samples in different media was set at 6 months, 12 month and 18 month. The samples will be subjected to the strength tests of concrete and, selectively, to microscopic examination of

SEM. The endurance test shall be a subject of three samples, of which the average value is calculated. The reference point is obtained compressive strength of concrete samples after 28 days of ripening and comparison with the results of the strength tests and microscopic one, conducted on the samples stored in various media for different periods of time. For laboratory tests on the effects of acidic slurry on reinforcing steel, prepared in the laboratory Hydrobudowa, the samples of concrete with embedded reinforcement were used. In the samples with dimensions 4x4x16 cm of amount 33 pieces there is placed a rod of diameter 6 mm, protected by a concrete layer with a thickness of 2 mm, 7 mm and 17 mm. The samples were placed in the media: acidified slurry, normal slurry and water. The samples will be kept for a period of 6 months, 12 months and 18 months. The measure of the impact of the corrosive action of acidic slurry will be the toughness of the samples on strength when bending. The survey will be carried out on a strength testing machine. The samples will be also a subject to macroscopic evaluation. The reference point will be the reaching of breaking strength of the concrete samples after 28 days of ripening and macroscopic evaluation of steel reinforcement. The results will be compared with the results from the research samples stored in different media for different periods of time.

Acidification of slurry is spontaneously changed, therefore, the monitoring of the level of acidity of pH and temperature was introduced.

Development of market equipment involved in slurry acidification

Mobile acidification equipment could be suitable for acidifying the slurry in storage system during mixing just before spreading. Such equipment could be invested by the farmer. Mobile equipment implies that the cost can be shared if the same equipment is used on several farms. The service could also be hired from a contractor, under the conditions that there is a contractor in the neighborhood providing this service.

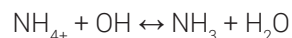
Figure 3 shows the equipment, which will be delivered by ORUM Co. from Denmark.



Fig. 3. Orum Semden's "in storage" acidification system at work (farm in Denmark)
Source: ORUM Co promotion material 2017

The described professional equipment can have a big influence on farmers' interest in large size of animal herds in Poland.

Just to explain why ammonia evaporation does not exist, it can be explained by drawing the following equilibrium in slurry between ammonium salt and ammonia gas:



At pH = 6.4 all mineralized N is found as ammonium, and no evaporation takes place.

In Denmark, the slurry should after lowering the pH <6 be spread within 24 hours according to the rules. As the spreading season lasts for longer time, this could mean a period of several weeks per year. Economical calculations are needed to compare which solution is most profitable for individual farms. When hiring the service of acidification, the technology will be available also for smaller farms. Also, if surplus storage volume is needed because of foaming when adding acid, may make the alternative non-profitable compared to the other two alternatives.

Description of processes when adding sulphuric acid to slurry is presented below:

NH_3 (ammonia) + H⁺ = NH_{4+} (ammonium)

NH_3 = gas – may evaporate NH_{4+} = salt – does not evaporate)

H_2SO_4 (sulphuric acid) = Hydrogen - Sulphur-Oxygen = Sustainable

The concept of reducing slurry pH to get lower nitrogen losses to the air relies on the equilibrium between NH_4 and NH_3 , what is presented in figure 4.

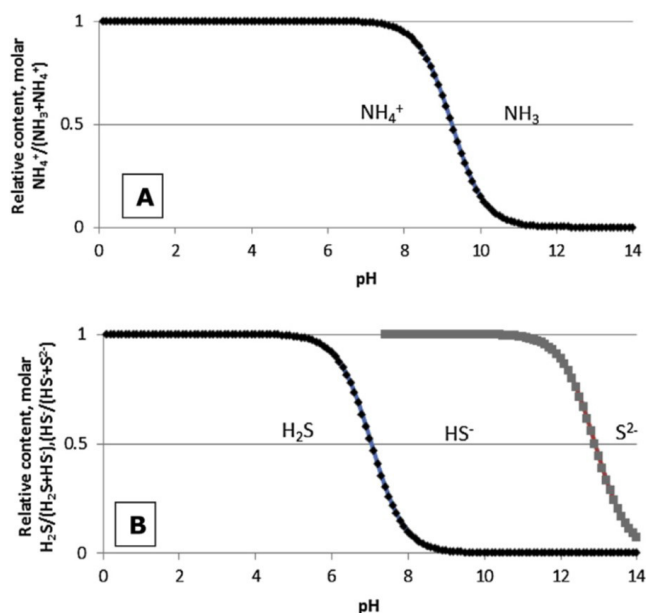


Fig. 4. Effect of slurry pH on its relative content of NH_{4+} (A) and H_2S (B)
Source: David Fangueiro 2015

Conclusions

Acidification reduces NH_3 emission from pig houses by 70% compared with the standard housing treatment. Little loss was

observed from the stored slurry, and the NH_3 emission from the applied slurry was reduced by 67%. In consequence, a 43% (S.E. 27%) increase in mineral fertilizer equivalent (MFE) was measured in the field studies. The slurry acidification system is the approved Best Available Technology (BAT) in Denmark. The pH level of 5.5- 6.4 is not very acidic, and no more acidic than rain water, which has a normal pH range from 4.5 to 8.5.

Slurry acidification technology gives many advantages from the point of view of soil fertilization and also the limiting of ammonia emission. Of course it requires providing the safety procedures to avoid a direct contact of farm workers with the harmful activity of the acid. But in the case of good acidification technology, which does not allow having a direct contact either in the storage area or in the field with the acid, this job is rather safe while fulfilling the procedures.

Besides it, the discussed acidification impacts positively on other slurry treatments such as solid - liquid separation or composting; upon the use of a non-sulphur containing additive, it may also impact positively on biogas production. Nevertheless, the acidification of slurry might induce higher losses by leaching, due to solubilisation of mineral elements.

Acidification of animal slurry has proved to be an efficient solution to minimize NH_3 emissions in-house, during storage, and after soil application, as well as to increase the fertilizer value of slurry, without negative impacts on other gaseous emissions.

References

- [1] BalticManure. http://www.balticmanure.eu/en/news/acidification_of_slurry_and_biogas_can_go_hand_in_hand.htm.
- [2] Biocover A/S, 2012. Vera Statement. http://www.veracert.eu/-/media/DS/Files/Downloads/Artikler/VERA_erklaering_2012_okt_enkeltside.pdf (accessed 07.05.14).
- [3] Fangueiro, D., Ribeiro, H., Vasconcelos, E., Coutinho, J., Cabral, F., Treatment by acidification followed by solid-liquid separation affects slurry and slurry fractions composition and their potential of N mineralization. *Bioresour. Technol.* 100 (20), 4914-4917 2009.
- [4] Fangueiro D., Surgu, S., Coutinho, J., Vasconcelos, E., 2013. Impact of cattle slurry acidification on carbon and nitrogen dynamics during storage and after soil incorporation. *J. Plant Nutr. Soil Sci.* 176, 540-550.
- [5] Fangueiro D., Surgu, S., Napier, V., Menaia, J., Vasconcelos, E., Coutinho, J., Impact of slurry management strategies on potential leaching of nutrients and pathogens in a sandy soil amended with cattle slurry. *J. Environ.Manag.* 146, 198-205, 2014.
- [6] Chadwick D., Sommer S., Rhorman R., Fangueiro D., Cardenas L., Amon B., Manure management: Implications for greenhouse gas emissions. *Animal Feed Science and Technology* 166, 514-531, 2011.
- [7] Fangueiro D., Hjorth M., F Gioelli. Acidification of animal slurry—a review. *Journal of environmental management* 149, 46-56, 2015.
- [8] Fangueiro D., Bermond A., Santos E., Carapuça H., Duarte A. Heavy metal mobility assessment in sediments based on a kinetic approach of the EDTA extraction: search for optimal experimental condition. *Analytica Chimica Acta* 459 (2), 245-256, 2002.
- [9] Fangueiro.D, Bermond A., Santos E, Carapuça H., Duarte A., Talanta A.. Kinetic approach to heavy metal mobilization assessment in sediments: choose of kinetic equations and models to achieve maximum information. 66 (4), 844-857, 2005.
- [10] Fangueiro D., Pereira J., Coutinho J., Moreira N., Trindade H. NPK farm-gate nutrient balances in dairy farms from Northwest Portugal. *European Journal of Agronomy* 28 (4), 625-634, 2008.
- [11] HELCOM. 2013. Revised nutrient targets. <http://www.helcom.fi/baltic-sea-action-plan/nutrient-reductionscheme/targets>.
- [12] Maryland University, 2017. "Geophysical Research Letters".
- [13] Myczko et al., 2017. Biogas experiments using slurry with high dry matter content.
- [14] Interreg EU - Baltic Sea Region - Baltic Slurry Acidification Project 2016-2019.
- [15] Project number BIOSTRATEG1/269056/5/NCBR/2015 from 11.08.2015.
- [16] Romaniuk et al., 2017. Patent concerning biogas production using slurry with high dry matter content.
- [17] Mielcarek-Bocheńska P., W. Rzeźnik. Ammonia emission from livestock production in Poland and its regional diversity, in the years 2005–2017, PAN, 2018

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PRESERVATIVES IN FRUIT JAMS

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Summary: The modern human diet is the subject of research and interest for a large group of specialists. The unlimited capabilities of synthesising new chemical substances and the far-reaching changes in legislation create a space for expanding the list of permissible food additives. Despite the research conducted on new substances, the consumers are afraid that not all additives are sufficiently safe. This is frequently due to lack of access to objective and scientifically-verified information. The most concern is caused by the use of multiple additives in the same food product, which increases the risk of their accumulation in the human body. The objective of this paper is to discuss preservatives added to jams. It involves a discussion of the technological process and indicates the moment that a given preservative is added, showing photographs and findings from an experiment conducted on a single type of jam. The experiment was conducted under domestic conditions.

Keywords: jam, experiment, food additives, technology, consumer

Streszczenie: Dieta współczesnego człowieka to przedmiot badań i zainteresowania dużej grupy specjalistów. Nieograniczone możliwości syntezy nowych substancji chemicznych i daleko idące zmiany w ustawodawstwie dają pole do rozszerzenia listy dopuszczalnych dodatków do żywności. Pomimo badań nad nowymi substancjami istnieje obawa konsumentów, że nie wszystkie dodatki do żywności są wystarczająco bezpieczne. Jest to często wynikiem braku obiektywnych i potwierdzonych naukowo informacji. Najwięcej obaw budzi stosowanie wielu dodatków w jednym produkcie spożywczym, a to zwiększa ryzyko ich kumulacji w organizmie człowieka. Założeniem artykułu jest przybliżenie jakie substancje konserwujące pojawiają się w dżemach. Przedstawienie procesu technologicznego i wskazanie momentu kiedy dana substancja konserwująca jest dodawana oraz przedstawienie zdjęć i wniosków z doświadczenia jakiemu poddano jeden rodzaj dżemu. Doświadczenie to wykonano w warunkach domowych.

Słowa kluczowe: dżem, doświadczenie, dodatki spożywcze, technologia, konsument

Introduction

The use of additive substances with food in Poland is governed by the Regulations of the Minister of Health [1]. Food additives have been divided into five groups according to their technological function. The first group includes substances which keep food from spoiling (preservatives, antioxidants). The second group comprises sensory compounds (aromas, colourings). The third group consists of the additives that affect the product's structure (thickening and gelling agents). The fourth group facilitates food production (enzymes). The last, fifth group, covers enriching, functional and bioactive substances (vitamins and probiotics) [2].

Jam production technology

Jams intended for consumption serve as tasty additions to meals and are used as an ingredient by the confectionery industry. The ancillary substances are sugar and food acid, which are added to ensure the appropriate gelling conditions. Also, citric acid is typically used. The gelling agents used include pectins with an average gelling speed. The first stage involves cooking the product, which is carried out in vacuum evaporators.

The preliminary actions may differ depending on the raw material used. If fresh or pasteurised fruit is used, sugar syrup is first produced in the evaporator and the fruits are added afterwards. The second stage of cooking takes around 20 to 25 minutes and involves saturating fruits with sugar. This is conducted in a vacuum of 0.8–0.9 atm and the temperature inside the evaporator should be 60–65°C. Towards the end of the cooking process, the jam is heated to 95–100°C, while the negative pressure in the evaporator is gradually decreased. Then, the product is held at the mentioned temperature for around 5 minutes for sterilisation purposes. The third stage of cooking consists of adding a gelling agent, as well as potential deacidification and preservation. While the gelling agent is being added, the jam must be continuously stirred. After the extract reaches the required level of gelling, a solution of citric acid is added and, after being stirred for a short time, the product is bottled immediately. It is very important to observe the specified jam cooking temperatures after adding pectins, because each time the range is exceeded by 10%, the gel forming ability of pectins drops by 15–20%. The jams are then placed and sealed in boiled and dried packaging where they are pasteurised. Pasteurisation is performed at 85°C for 5 minutes. After leaving the pasteuriser, the product should not be warmer than 40°C

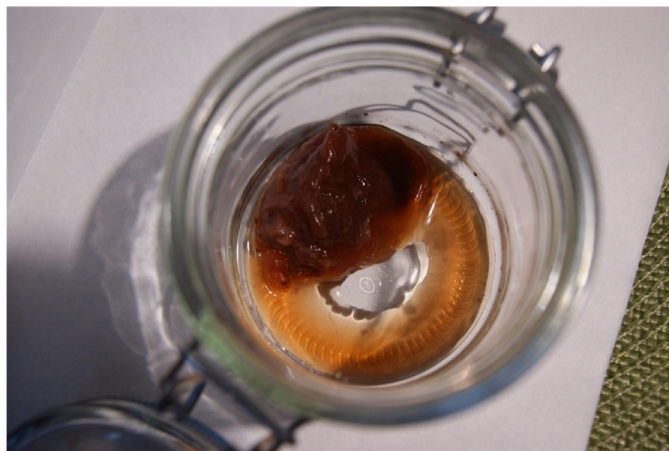
Popular preservative food additives

Food additives are used in the production process of jam. These are defined as substances not normally consumed as food and not typically being food ingredients, but used during production for technological purposes. The FAO/WHO Expert Committee on Food Additives determined the acceptable daily intakes (ADI) for those substances. This value is weighed in $\text{mg} \times \text{kg}^{-1}$ of human body weight and means the overall amount of substances that can be taken in by the human body from all sources during the day without causing harm. The most popular additives are preservatives and antioxidants. Two main groups of preservatives are used to preserve foods and these are classified according to the methods of obtaining them, i.e.: antiseptics, which are simple compounds that may have their equivalents in nature and antibiotics, which are compounds produced by microbes. The addition of acids to food products is aimed at modifying their flavour and preventing the growth of bacterial flora [3]. Acids and acidity regulators can be added to food products in accordance with the *quantum satis* principle (in Latin: as much as needed, the amount which is enough). This means that a given substance is used in the lowest amount necessary to achieve the appropriate technological effect, as per the good manufacturing practice prepared as a part of the FAO/WHO Codex Alimentarius. Lactic acid E-270 – prevents the growth of microbes, citric acid E-330 – facilitates the gelling of pectins, sodium sorbate E-201 – prevents fungal growth, but is not effective against bacteria, potassium sorbate E-202 – a pH-dependent preservative, starch syrup – obtained from starch hydrolysis to glucose and by-products, guar gum E-412 – used to increase the stickiness of the food product, sucrose – obtained from sugar beets or sugar cane using industrial treatment processes [4].

Experiment with strawberry jam

To determine whether preservatives affect fruit preserves, three 280 g jars of strawberry jam were purchased. A spoonful of each jam was then placed in three separate test tubes. Two of these remained open and one was sealed. The samples were stored in a household pantry in a temperature that did not exceed 10°C for a period of seven days. Sugar-free organic jam was placed in the sealed test tube number 1. On tasting, the product had a slightly sour flavour, a not-too-firm consistency, dark colour and visible pieces of fruits. It was made with 35g of fruit per 100g of the product, with added lemon juice made from concentrate. Sample 2, as open, contained jam with added sucrose. It was made of 35g of fruit per 100g of the product. In addition, the ingredients include guar gum, gelling agent, citric acid and sugar. This jam was very sweet, had a pleasant smell, it did not contain any pieces of fruits, it had a firm consistency and the colour of a fresh ripe strawberry. The last test tube contained sample 3, which was a low-sugar jam made of 36g of fruit per 100g of the product. Pectins and lemon juice were used as additives. The product had a uniform texture with the colour

of a highly ripe strawberry and a pleasant smell, moderately sweet. The samples were observed for seven days. The pantry used in the experiment is located in a cellared building with a constant temperature and has no access to sunlight. The



Sample 1. Juice formed at the bottom and the jam itself acquired a watery consistency



Sample 2. The jam became stuck to the bottom of the jar and acquired a slightly bitter smell



Sample 3. The jam became stuck to the bottom of the jar and changed its colour to dark brown

described conditions reduced the pace of changes occurring within the products. The first sample to deteriorate – as early as on the third day of the experiment – was sample 1, which had no added preservatives. The other two samples remained intact for seven days, but their consistency and colour would not attract a potential customer. The experiment has demonstrated that preservatives do have an influence on product lifetime, but this is not without consequence to our health.

Summary

To conclude, we should pose the question whether food additives are indeed harmful to human health. Not long ago, we used to store food in herbs or salt to prevent bacterial growth, or in dark cellars, protected from light. Dried and long-fried fruits could be found in every household pantry. Meanwhile, civilisational progress necessitated the use of preservatives. Manufacturers are not eager to produce foods with short expiry dates or shelf life. Chemical substances have been identified that are better and more effective than traditional methods of preserving food products, while improving their quality and attractiveness. Processing allows us to keep food products available regardless of their growth season. Frozen fruits are one example. Processing increases a product's shelf life. It also improves product safety when e.g. high temperatures are used to eliminate harmful bacteria. Organic food advocates constantly struggle with the manufacturers of foods containing chemical preservatives. However, the latter frequently make the claim that natural origin is no guarantee that food is not

harmful. For instance, it can be polluted with pesticides. The most common ailments and disorders caused by excessive consumption of various food additives include gastric problems, food allergies, and deficiencies of important nutrients, problems with their digestion and absorption, diabetes and many others. As the experiment shows, preservatives serve their purpose well, but only under specific conditions. If we open a jar of jam and leave it on the shelf next to some baked goods, in a few days the bacteria will begin to grow inside regardless of the fact that the product's expiry date is two years. The product was opened and exposed to all kinds of external factors. No preservative is enough to guarantee that a product is healthy.

Bibliography

- [1] Regulation of the Minister of Health of 22 November 2010 on permissible additives (Journal of Laws of 2010 No. 232, item 1525);
- [2] Cyran-Szczegielniak D., Janicki B., Roślewska A., Stanek M., Stasia K., „*Food Additives*”, WU Bydgoszcz, 2015;
- [3] Andrejko D., Andrejko M., „*Food contaminants. Sources and impact on the human body*”, Wydawnictwo Uniwersytetu Przyrodniczego Lublinie, 2009;
- [4] Rutkowki A., Gwiazda S., Dąbrowski K., „*A Compendium of Food Additives*”, WNT Wa-wa 2013;

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SPÓŁKA Z OGRANICZONĄ
ODPOWIEDZIALNOŚCIĄ**
Dzięki temu WYDAWNICTWO CZASOPISM I
KSIĄŻEK TECHNICZNYCH SIGMA-NOT SPÓŁKA Z
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THE 29TH EDITION OF PLEBISCITE FOR THE TITLE OF GOLDEN ENGINEER

29 EDYCJA PLEBISCYTU O TYTUŁ ZŁOTEGO INŻYNIERA

– *The solemn summing up of the XXIXth edition of the plebiscite for the title of Golden Engineer was the meeting of the people who have the feet firmly fixed on the ground, the people who have occurred to be very necessary at difficult time, especially those wise who should be distinguished* – Roman Czajarek, the leading journalist, Honorary Golden Engineer PT, engineer, MSc, graduate of Szczecin University of Technology stated.

Mr R. Czajarek reminded that the mentioned event, as being organized by 157 year old Technical Review, was connected this year with the celebration of the International Day of Engineer for the Sustainable Development, being called the International Day of Engineer.

The ceremony which was traditionally held at Warsaw House of Technician (3.03.2023) was opened by Ewa Mańkiewicz-Cudny, the President of the Federation of Engineering Associations of the Chief Technical Organization (NOT). She informed that this year, the celebration of the International Day of Engineer for the Sustainable Development, organized under the motto: *“Engineering Innovations for the more active world”* was commenced by unveiling the monument (March, 2, 2023 in Warsaw) of Piotr Stanisław Drzewiecki, Eng, the creator of the associative movement of engineers, constructor of the House of Technology (in Polish: Dom Technika, WDT) built in 1905, the outstanding engineer, the first President of Warsaw after regaining the independent own state in 1918.

The President of FSNT-NOT greeted all participants of the ceremony, including the special guests: Andrzej Dera, the secretary of the state at the Chancellery of the President of the Republic of Poland and Wojciech Murdzek, the secretary of the state at the Ministry of Education and Sciences and the partners, and



the persons, representing the patrons of the discussed event, together with whom the International Days of Engineer (IDE) are organized: Prof. Dr hab. Teofil Jesionowski, Eng. – the Chairman of the Conference of Rectors of Polish Universities of Technology, Rector of Poznań University of Technology; Prof. Jerzy Barglik, the President of Engineering Academy in Poland; Prof. Dr hab. Michał Kleiber, Eng., the President of Polish Committee of UNESCO. The President Ewa Mańkiewicz-Cudny reminded that the UNESCO was the patron of IDE which was established in 2019.

The guests of the International Day of Engineer were as follows: prof. Dr hab. Krzysztof Zaremba, Eng, Rector of Warsaw University of Technology; prof. Dr hab. Jan Szmidt, Eng, Honorary Chairman of the Conference of Rectors of Polish Academic Schools, “Diamond Engineer of PT (*“Technical Review”*); Prof. Dr hab. Maciej Żylicz, the President of Foundation in Favour of Polish Science; Prof. Dr hab. Marcin Palys, the Chairman of the Main Council of Science and Higher Education; Prof. Dr hab. Bogusław Smólski, Eng, the Chairman of the Committee of Electronics and Telecommunication of PAN; Marek Kłoczko, the President of Polish Economic Chamber; Stefan Kamiński, the President of Polish Economic Chamber of Electronics and Telecommunication;



Polish celebration of the International Day of Engineer gathered many participants

Prof. Dr hab. Sławomir Cieślak, Eng, the President of the Association of Polish Electric Engineers; Prof. Dr hab. Maria Kaszyńska, the Chairwoman of Polish Association of Construction Engineers and technicians; Eng. Jerzy Klimczak, MSc, the President of the Association of Engineers and Technicians of Chemical Industry; Vice-Presidents of FSNT-NOT: Stefan Góralczyk and Kamil Wójcik; Jerzy Rożek, the President of 118 years-old WDT; Martyna Jachimowicz, the editor-in-chief of Technical Review (Polish: Przegląd Techniczny); the Management of the Publishing House of SIGMA-NOT; the President Magdalena Borek-Daruk and Vice-President Anna Rybacka-Dybcio.

HIGHLIGHTING THE ROLE OF ENGINEERS

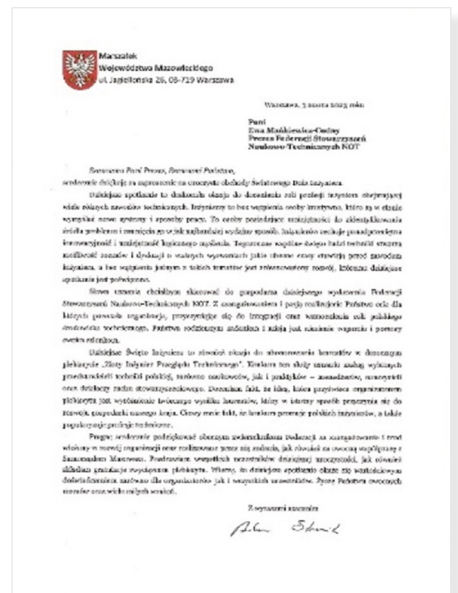
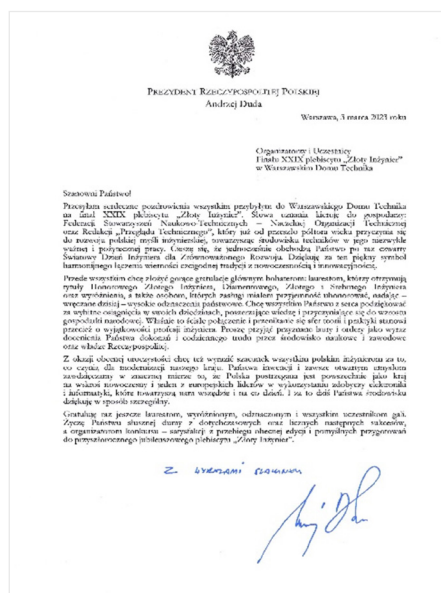
– It is only four years when the International Organization of Engineering Organizations together with UNESCO has celebrated the International Day of Engineer for the Sustainable Development whereas already 29 years ago, the "Technical Review" stated that during the system transformations, the engineers were somewhat left behind.... We do not need, however, to convince anybody that they played the important role; they are playing it now and will play it in the future all over the world. It is true not only in aspect of constructing, designing, producing, ecology and also in social aspect as engineering "went thorough" our lives. We recognised, therefore, that engineers deserve to have their own holiday. We decided it will be the day of the ceremony of summing up the Plebiscite for the title of "Golden Engineer" – Ewa Mańkiewicz-Cudny said in her inauguration speech.

I do not need to convince the participants of this meeting about the role of engineers, but I would like their achievements to be also appreciated as it is in the case of artists, writers and painters. A beautiful picture is signed but who constructed a beautiful bridge of our building? Let's take care of our creators, let the creators of engineering to be found in the history, let their achievements be signed i.e. known. Polish engineers have the huge achievements and have contributed to the world progress, for example Pawel Baran, co-creator of Internet or Mieczysław Bekker, the creator of moon vehicle.

We should also help the young people, let them chose the profession of engineer which is creative and giving a lot of possibilities.

Our patron is Stanislaw Staszik who said that idea or concept is a "fancy of human mind until it is employed in practice".

– Today, many specialists, social activists consider that to do in order to limit the negative consequences of bad or inappropriate application of many things. Each thing may be used for the good of man or his harm. It is not dependent on the creator of this thing but on every individual man as well as on values which we believe in. Are we able to limit ourselves? The moment came to think about it; the engineers are doing their best to make their work serve the good and could reverse the unfavourable phenomena, accompanying our development since the times of the successive industrial revolutions.



The letters sent by Andrzej Duda, the President of the Republic of Poland, and by Adam Struzik, the Marshall of the Mazovian Voivodeship



During the ceremony, the Minister Andrzej Dera handed the state distinctions to Ewa Mańkiewicz-Cudny, the President of FSNT-NOIT and Prof. Dr hab. Adam Wiśniewski, Eng, the former secretary general of the Academy of Engineering in Poland

The engineers try to do it as, according to the Staszic motto, "be useful for the nation". But when Staszic was saying his words, Poland did not exist. Today we have our country independent. All our laureates are useful for the nation" – the President of FSNT-NOT stressed.

Then, the Minister Andrzej Dera, the secretary of the State at the Chancellery of the President of the Republic of Poland, read out the letter of the President, directed to the participants of the ceremony. The successive point of the program included the state distinctions. It was led by Robert Broszkowski from the Bureau of Distinctions and Appointments of the Office of the President of Poland; the awards were handed by Andrzej Dera. **Ewa Mańkiewicz-Cudny**, the President of FSNT-NOT since 2002, the editor-in-chief of the "Technical Review" in the years 1989-2021, was honoured with the Commander's Cross of the Order of Polonia Restituta for the outstanding merits in promoting and popularization of Polish technical idea and for the contribution to the development of innovativeness of Polish economy. **Prof. Dr hab. Adam Wiśniewski, Eng.**, the former secretary general of the Academy of Engineering in Poland was decorated with the Officer's Cross of the Order of Polonia Restituta for the outstanding merits for development of mechanical engineering, for the achievements in the scientific-research and didactic activity and popularization of Polish scientific thought all over the world. He is a creator of the only Polish military patent utilized abroad: reactive armour ERAWA (Explosive Reactive Armour Wiśniewski Adam) in 1986, tested in tanks T-72 and in 1992 – PT-91(today, they are fighting at Ukraine).

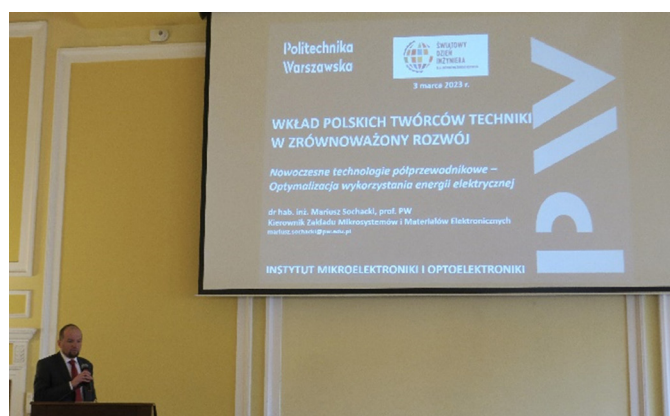
Ewa Mańkiewicz-Cudny expressed the words of gratitude to the President for the awarded distinctions and to the Academy of Engineering in Poland which applied for them. Then, Wiesław Kołodziejcki, the President of the Mazovian Fund of Credit Guarantees, read out the letter of the Marshall of the Mazovian Voivodeship, Adam Struzik.

PRESENTATIONS

The series of the lectures was commenced by Dr hab. Mariusz Sochacki, Eng., Professor of Warsaw University of Technology (PW), the Head of the Department of Technology of Microsystems and Electronic Materials at the Microelectronics and Optoelectronics Institute of Warsaw University of Technology. He presented the lecture "Contribution of Polish creators of engineering to the sustainable development. Modern semiconductor technologies – optimization of electric energy utilization".

The lectured paid attention to the contemporary social challenges that is, the sustainable development and the increasing demands concerning the systems of processing with a high efficiency. The key role will be played by power electronics, the driving force of which is motorization industry. The heart of the electric car is the power electronics converter, constructed from the electronic components, utilizing silicon carbide (SiC) or gallium nitride (GaN).

Prof. Dr hab. Piotr Wolański, Eng, from Institute of Heat Engineering, Faculty of Power and Aeronautical Engineering of Warsaw University of Technology (PW), Łukasiewicz Research Network – Institute of Aviation, and the Honorary Chairman of the Committee of Space and Satellite Studies of PAN (Polish Acad-



emy of Sciences) delivered a very interesting lecture: "Achievements of Polish Space Science". He commenced from historical outline of the contribution of Poles to the development of space studies. Then he presented the examples of the contemporary Polish achievement in the discussed domain, such as e.g. development of module for feeding the camera CaSSIS (Colour and Stereo Surface Imaging System) in the Centre of Space Studies of Pan which sent the first images of Mars planet surface in 2016.

THE LAUREATES TAKE THE FLOOR

The Laureates of the 29th edition of the Plebiscite for the title of "Golden Engineer of Technical Review" received the diplomas and statuettes from the hands of Ewa Mańkiewicz-Cudny, Martyna Jachimowicz and Andrzej Dera and Wojciech Murdzek.

Prof. Dr hab. Teofil Jasionowski, Eng., the „Diamond Engineer” expressed the words of gratitude in behalf of the Laureates; he wished them not only development in the field of engineering but also humanism as all engineers are humanists, knowing better or worse mathematics. If we want to control, compete and create the strong economy, let's invest in education. The future generations will be like the engineers' education, so I address the decision-makers to not forget about building the strong economy and strong engineering because the new generations are our pride. As being a person who has to deal with the university, I can say that the greatest pleasure for me is to open the doors to the young peoples who want to study not easy disciple, i.e. engineering sciences; they will be building the better future, so let's make the good.

The distinctions of the "Honorary Golden Engineer" have been handed over since the 10th edition to the persons who have a diploma of engineer but they were successful in completely different domains and are known from these "non-technical" achievements. The mentioned title is also given to the persons who do not have technical education but have contributed to the development of engineering in the outstanding way.

Jan Krzysztof Ardanowski, this year's Laureate, after having received the diploma, said that the future of the agriculture, the domain being especially important for human nutrition and solution of the problems, standing before our Globe, will be determined by the scientific-research in the solutions which can be introduced and implemented by the engineers. There are many problems, but the domain of the engineers is a precision agriculture, utilizing the satellite data and drones. Food production is significantly affected by reasonable management of water what can be helped by the hydro-engineers. We have also a lot to in respect of bioengineering. We have good agriculture and let's try to do our best as not to weaken it as the humanity needs food.

Aleksandra Bednarek, the youngest person, honoured with this title, ended her short words of thanks with her favourite quotation, coming from Patrick Süskind, German writer and screenwriter: "Aim at the Moon, because even if you don't strike a target, you will be among the stars".

During the couloirs meetings, she told me that her dream is to reach the Crown of Oceans – the swimming equivalent of

The distinguished engineers of 2022:

Dr hab. Artur Jerzy Badyga, Eng,
Prof. of PW; Eng. Arkadiusz Kanigowski,
MSc, Eng. Paweł Kapusta,
MSc, Eng. Jarosław Kuba,
MSc, and Eng Marek Stolarski MSc.

Silver engineers of 2022:

Prof. Dr hab. Anna Boczkowska,
Eng, Dr hab. Andrzej Katunin, Eng.,
Professor of Silesian Univ. of Technology,
Dr Bożydar Neroj, Eng,
Eng. Krzysztof Ozdarski, MSc,
Eng. Roman Weglicki, MSc,
Beata Wittman MSc (received by Alicja Walecka)

Golden Engineers of 2022:

Dr hab. Włodzimierz Adamski, Eng,
Eng. Tomasz Dębicki, MSc,
Dr Sławomir Jasiński, Eng.,
Eng. Andrzej Niechwiej, MSc,
Dr Adam Rylski, Eng,
Prof. Dr hab. Piotr Wolański, Eng,
Eng. Lech Żak, MSc.

Honorary Golden Engineers of 2022:

Eng. Jan Krzysztof Ardanowski, MSc,
Eng. Aleksandra Bednarek, MSc,
Dr Robert Perkowski

Diamond Engineer of 2022:

Prof. Dr hab. Teofil Jasionowski, Eng.



Honorary Golden Engineers of 2022: Eng. Jan Krzysztof Ardanowski, MSc,
Eng. Aleksandra Bednarek, MSc, Dr Robert Perkowski



The distinguished engineers of 2022: Dr hab. Artur Jerzy Badyga, Eng, Prof. of PW; Eng. Arkadiusz Kanigowski, MSc, Eng. Paweł Kapusta, MSc, Eng. Jarosław Kuba, MSc, and Eng Marek Stolarski MSc.



Silver engineers of 2022: Prof. Dr hab. Anna Boczkowska, Eng, Dr hab. Andrzej Katunin, Eng., Professor of Silesian Univ. of Technology, Dr Bożydar Neroj, Eng, Eng. Krzysztof Ozdarski, MSc, Eng. Roman Weglicki, MSc, Beata Wittman MSc (received by Alicja Walecka)



Golden Engineers of 2022: Dr hab. Włodzimierz Adamski, Eng, Eng. Tomasz Dębicki, MSc, Dr Sławomir Jasiński, Eng., Eng. Andrzej Niechwiej, MSc, Dr Adam Ryński, Eng, Prof. Dr hab. Piotr Wolański, Eng, Eng. Lech Żak, MSc.



Diamond Engineer of 2022: Prof. Dr hab. Teofil Jesionowski, Eng.

the Crown of Earth, that is, the conquest of 7 most important water passages in long-distance swimming all over the world. – Two-three persons are swimming simultaneously at the comparable rate, they are accompanied by the boat so it is necessary to be patient and wait for the answer from the Federation, dealing with the organization of such passages via the La Manche Channel (CS&PF). At the end of 2017, I was informed that I could swim in ... 2021. And on 21, July, I crossed ca. 43 km during 13 h and 18 min. And now I am waiting for the answer from the Association, organizing the crosses via the Strait of Gibraltar, being more than twice narrower but characterized by considerably stronger currents on which the temperature of water is dependent. I think I will be able to try to cross it in 2024. –

Of course, I wish it to her in behalf of the readers of PT. I would like to add that after having crossed the La Manche Channel Aleksandra Bednarek got the Triple Crown of Open Water Swimming: the Triple Crown in swimming in open waters because earlier she passed Katalina Channel and went around Manhattan Island by swimming.

Robert Perkowski stated that for him, as manager, the received distinction was very important because engineer is someone who even if wants to fly among the clouds or approximate the stars, he must firmly stay on the earth. It is so because his decisions are based on the rules of physics, on everything what causes that the implemented undertakings are more real. And, therefore, the manager with engineering spirit is simply better.

Wojciech Murdzek commenced its speech from paying the congratulations to the persons, honoured with the state distinctions because they are a signal that the mission of engineer and the persons dealing with the "hard matter" serves the best to the state. – The significantly increased presence of the world of science shows that the challenge for the engineers is going up. They stand at the first line of transfer of knowledge and technology to a



The Laureates of the 29th edition of the Plebiscite for the title of Golden Engineer

real world what is referred to all of us. As the difficult things are going on, it should be precise and quick, adequate to the mentioned great challenges. The engineers can do it and they do it really. The international societies want Polish engineers. We will be needed by our neighbours in the gigantic process of reconstruction of Ukraine in which we will utilize the newest engineering knowledge and the solutions in order to help them. We have to develop more dynamically our scientific and engineering potential, improve the quality of life and functioning of our society, strengthen our international position and cause that the contribution to the economy could become the contribution of modernity to the future. Let's encourage to a hard work according to our dream, conquest of the Cosmos and entering the world of nanotechnology.

THE LECTURES

After a short coffee break, **Prof. Dr hab. Janusz Wojtkowiak, Eng**, the director of Institute of Civil and Environmental Engineering at the Faculty of Environmental Engineering and Energy of the Poznań University of Technology submitted the lecture: "The future of Polish power system: atom, renewable sources of energy (OZE) and hydrogen". His lecture was based on the annex to the publication "Energy Policy of Poland up to 2040" where there were mentioned three key pillars: fair transformation, zero-emission power system and good quality of air and 8 detailed tasks.

He reminded that in 2022 the power of all sources of electric energy (conventional and OZE), being installed in Poland, exceeded, for the first time, 60 GW, from which 22GW (ca 36%) could be generated by OZE but due to atmospheric conditions, they delivered only ca. 17%. In respect of the power installed in 2022, the solar energy with 52%-participation in OZE exceeded, for the first time, the wind energy (34%) after which water power (9%) is unchangeably found. The sources, utilizing biogas and biomass

account somewhat for 5%. It is planned that in 2040, OZE will produce 28.5% energy in Poland. The lecturer presented also some greatest (in 2022) photovoltaic and wind farms, including the plans concerning the sea wind farms and hydro power plants and mentioned also biogas producing plants. He discussed also "Polish hydrogen strategy up to 2030 with the perspective up to 2040" and the perspectives for development of nuclear energy system in Poland.

Engineer Wiesław Paluszyński, MSc, as the President of Polish Information Processing Society, commenced his short lecture: "Artificial Intelligence (AI) – threat or development?" with the statement that he had already prepared experts – specialists for us. We may read in the newspapers that it enters e-learning and ChatGPT is tried in business and in the USA it gained medical competences. In the opinion of Wiesław Paluszyński, however, *ChatGPT has not caused any revolution. All techniques employed by Open AI are nothing new. It is not a technological breakdown comparable to conquest of atom. It appeared as a service being accessible to mass user but in comparison with Google browser, ChatGPT has one advantage: it gives one answer which we trust in; it makes it immediately more trustworthy – "human". It is not a technological revolution because the technologies, which created it, have been developed for dozens of years; it is not super-intelligent computer, as well.*

The official part of the ceremony was ended by the presentation of the students from the Scientific Circles under the title: "The sustainable development and transformation, as perceived by the young engineers". After the presentation, the Laureates and the guests spent time at the social meeting.

Jerzy Bojanowicz

Photos: Janusz M. Kowalski

PIOTR S. DRZEWIECKI – THE MEMORY OF THE OUTSTANDING CREATOR OF ENGINEERING CELEBRATED WITH THE APPROPRIATE RESPECT

PIOTR S. DRZEWIECKI – PAMIĘĆ WYBITNEGO TWÓRCY TECHNIKI GODNIE UCZCZONA

The list of the achievements of the prominent creator of technique, engineer Piotr Drzewiecki, the first President of Warsaw in the independent Poland, is impressive. He left a rich legacy in almost all domains which he had to deal with. The unveiling of his monument at the Piotr Drzewiecki Square in Mirowski Park in Warsaw on 2 March, 2023, was the occasion to recollect his numerous merits.

The initiative of honouring engineer Piotr Drzewiecki came from the Federation of Engineering Associations of the Chief Technical Organization (NOT) which nominated the Social Committee for Commemoration of the President of Warsaw, Piotr Drzewiecki and organized – among its members – the fundraising for the mentioned purpose. The capital city of Warsaw helped to implement this aim.

– We have waited for a long time for this happy moment, never losing the hope that it will happen one day – Ewa Mańkiewicz-Cudny, the President of the Federation of the Engineering Associations NOT and the Chairwoman of the Social Committee for Commemoration of the President said during this exceptional ceremony. – We have tried for many years that the progenitor of the association movement and patron of our organization could have his monument in the capital city which he managed in a very modern way in the years 1918–1921. He was earlier the major of Warsaw and the member of the City Council. It is impossible, in a short speech, to list all his merits. Prof. Marian Marek Drozdowski



The Chairwoman of the Social Committee for the commemoration of the President, Ewa Mańkiewicz-Cudny, the President of the Federation of Engineering Associations of Polish Chief Technical Organization (NOT)

and Prof. Lech Królikowski dedicated many biographic publications to His person. I thank our, Gentlemen, that you are with us today and will be able to share with the details from the life of Piotr Drzewiecki who was a man of many talents and achievements and played many social and professional functions with the success – The President Ewa Mankiewicz-Cudny reminded.

The comprehensively educated graduate of Mechanical Faculty of the Imperial Petersburg University of Technology and Institute of Civil Engineers (1886) was initially associated with the industry. He conducted successfully the companies, having the international range. As being the appreciated engineer and



Tomasz Bratek, Vice-President of the capital city of Warsaw read out the congratulation letter of the President, Rafał Trzaskowski, directed to the participants of the ceremony

industrial activist, he was the co-founder of the Association of Technicians in Warsaw and since 1899 – its long-time president.

After the outbreak of the World War I, he became the member of the Central Civil Committee and participated actively in organization of economic and social institutions. He was, *inter alia*, the president of Polish Electrical Engineering Society, Polish Union of Metal Industry, activist of the Central Union of Polish Industry, Mining, Commerce and Finances. During the years 1906 – 1918, he was the head of Society of Scientific Courses which contributed to reactivation of Warsaw University, Warsaw University of Technology and University of Life Sciences (SGGW).

His great merits for the capital city were recollected in the speech of Tomasz Bratek, Vice-president of Warsaw who read out the congratulation letter of the President Rafał Trzaskowski, as being directed to the participants of the mentioned ceremony. – *For us, Warsawians, the first president of the capital city in the independent Poland is the unrivalled symbol of the host of the city; moreover, he performed his function in the moment, being extremely difficult for our country. We must remember that it was also the time of Polish-Bolshevik war, when the Soviet hordes*

reached as far as near Warsaw. It gives a special rise of reflections today when the Russian army attacks Ukrainian cities – Tomasz Bratek summed up.

The enormous role played by Engineer Piotr Drzewiecki in respect of work in favour of Polish standardization was mentioned by **Teresa Sosnowska** – the deputy president of Polish Committee for Standardization. She reminded that in 1923, Technical Committee for standardization of industrial products and their delivery was set up with the initiative of Piotr Drzewiecki. In 1924, there was established Polish Committee for Standardization and Piotr Drzewiecki was just its first president. He created the mentioned institution from the very beginning and managed it effectively. He developed the strategy of its functioning and took care of the state of finances of this institution.

– *It is not difficult to imagine how the standardization (normalization) was important in the country which for more than 120 years was divided between three foreign powers. During the mentioned period of time, different measure, different currencies, different technical ideas and technological solutions*



were employed. At such historical moment, the unification and normalization played a very important role in the economic and technical development of Poland. We owe it all to the president Piotr Drzewiecki – Teresa Sosnowska added.

Unveiling of the monument was a very moving moment for the Piotr Drzewiecki descendants, who participated in the ceremony. In behalf of the nearest family, the great-granddaughter **Elżbieta Wodzyńska** expressed her thanks to the members of the Social Committee for the Commemoration of the President of Warsaw, Piotr S. Drzewiecki for the undertaken initiative. – *We are extremely grateful to all persons who have contributed to creation of this monument, being excellently performed by artist **Andrzej Franaszek**. This work will bring closer the silhouette of my great-grandfather to the inhabitants of Warsaw; the man with enormous merits for Warsaw and Poland, and very sensitive and family-oriented man for the family. It is sad that he passed away in such a tragic way. Being arrested by Germans in 1942, he was imprisoned in Pawiak prison, died from pneumonia in 1943 in Moabit prison*

in Berlin. Owing to the monument in Warsaw, he will live in our grateful memory forever.

Janusz M. Kowalski, as representing FSNT-NOT and presiding to the ceremony, read out the congratulation letter from Adam Struzik, the Marshall of the Mazovian voivodeship who stressed the great meaning of the professional and social activity of the first president of Warsaw for Mazovian region and for Poland.

This outstanding creator of engineering sector left – for the descendants – not only many significant achievements as the engineer, president and economic activist but also Decalogue of extremely valuable guidelines with the aim, *inter alia*, to proceed ethically, behave with dignity, loyally and protect justness and assess phenomena and people without prejudice, with friendly attitude and be always ready to act and cooperate”.

Jolanta Czudak-Tomaka

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