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Biogas Production Plants as a Method of Utilisation of Sewage Sludge in Relation to the Polish Legislation

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1. Introduction

Since October 1st 2001 the rules of waste management are regulated by the Act on Waste from April 27th 2001. Hierarchy of individual steps of waste management was determined there. The Act also introduced, among others, that only waste, of which disposal in another way is impossible for technological reasons or unreasonable for environmental or economic reasons, may be landfilled. Nevertheless, for the first time in Polish legislation a prohibition of landfilling of waste containing water (excluding sludge) in the amount exceeding 95% of the total weight, was introduced. In March 2001, the Ministry of Environment has developed a Plan of Implementation of Council Directive 99/31/EC from April 26th 1999 on landfilling of waste, where there were presented, among other, assumptions concerning the reduction of biodegradable components of the waste to be landfilled. This also applied to municipal sewage sludge. It was assumed then, that within two years after entering into force of the Act on Waste, a national program concerning reduction of the amount of biodegradable constituents in municipal waste will be developed [21]. Deadlines and required levels of reduction were also presented. It should be noted that only stabilized and dewatered municipal sewage sludge may be landfilled [12]. The Act on Waste from October 1st 2001 created, among other things, the legal and administrative provisions for the use of municipal sewage sludge in various alternative ways.

Sewage sludge for agricultural use directly from sewage treatment plants requires dewatering and stabilization. Such prepared sludge must be subjected to the process of composting or hygienization for sanitary and epidemiological reasons [12]. Very often sewage sludge are composted with vegetable matter or straw. This is the easiest, cheapest and most widely used method of composting that causes biological sanitation of sludge and conversion to a solid consistency (pasty). Sewage sludge deprived of microbial contamination is suitable for agricultural use [15].

Legal aspects of sewage sludge thermal processing are specified in section 6 of the Act on Waste.

Basing on the mandate included in Article 44, Paragraph 5 of the Act, Regulation of the Minister of Economy from January 29th 2002 on waste types other than hazardous and on types of installations and equipment, in which they may be thermally processed was issued (Journal of Laws No. 18 item. 176). In the Annex to Regulation, among waste other than hazardous that can be thermally processed in installations and equipment, there was also stabilized municipal sewage sludge (code 19 08 05). In Poland, plan to build several waste incineration plants was developed, but only half of those will be built. At the moment, in Poland there is only one such installation in Warsaw that during thermal treatment of waste produces heat and electricity [10, 21].

Sewage sludge may also be directed to the utilization in biogas production plants. It is certainly an interesting alternative for disposal of sewage sludge, both economically and technologically, due to the large potential of biogas yield. Annual amount of sewage sludge produced is so large that it should be rationally used, for example in incineration plant, in composting plants or in anaerobic digestion process. The remaining mass after digestion can be used in agriculture and forestry as a supplement enriching quality of soil.

2. Prospects for the development of biogas plants in Poland

In Poland, the increasing importance begins to play the recovery and use of biogas from anaerobic digestion process, in terms of renewable energy sources aiming to reduce emissions of greenhouse gases. Therefore, the planning, construction and operation of biogas recovery systems form nutrients rich media, is becoming more and more reasonable and cost effective. Increase of production of energy from biogas,

observed for many years, is mainly caused by administrative regulations being amended. This includes state aid in the form of certificates for electricity derived from renewable energy sources and investment subsidies on the level of national administration. After all, post digestion settlements are fertilizer of constantly increasing value [2, 17].

Renewable energy sources are becoming increasingly important element in the energy balance of the country, being characteristic value of innovative and forward-looking economy. In western Europe biogas plants on an industrial scale are being built since the eighties, but the rapid increase in the number of installations took place only in the last decade. This was the result of commitments of the EU countries on reduction of greenhouse gas emissions and promotion of renewable energy sources [2]. In Poland at the moment (June 2012) there are 23 biogas plants used, the first was built in 2005. Ministry of Economy in cooperation with the Ministry of Agriculture and Rural Development worked out a program called "Guidelines for the development of agricultural biogas plants in Poland," which was approved by the Council of Ministers in July 13th 2010. The implementation of the document is essential to the process of creation of one agricultural biogas plant using biomass from agricultural sources in each municipality, on an average, up to 2020, provided that a municipality has suitable conditions to launch such a project [2]. Because of limited amount of substrates from agricultural sources in the community, most of biogas plant will use feedstock from the food and agriculture industry, sewage sludge or municipal organic waste. The potential for obtaining biogas is estimated at around 1.7 billion m^3 per year. For comparison, about 14 billion m^3 of natural gas is consumed in Poland [2, 3].

3. Formation of biogas

Biogas is produced in a biological process from organic matter without presence of oxygen. Such process is widespread in nature and takes place in moors, at the bottom of the sea, in the manure and in rumen of ruminants. Organic matter is almost completely transferred into biogas. In addition, a small amount of heat or new biomass is produced [1, 19]. Biogas consists of methane (approximately two thirds) and carbon dioxide (about one-third). In addition, there are small amounts of hydrogen, hydrogen sulphide, ammonia and other trace gases found in biogas [3, 20].

The process of anaerobic digestion, in which biogas is produced, consists of four stages. In the first one, so-called hydrolysis, degradation of complex compounds (eg. carbohydrates, proteins, fats) to simple organic compounds (such as amino acids, sugar, fatty acids) takes place. Bacteria involved in this process release enzymes which degrade the matter in biochemical reactions. Then intermediate products are degraded in the next stage, so-called acidogenesis, into fatty acids (acetic, propionic and butyric acids), carbon dioxide and hydrogen by acidifying bacteria. In addition, small amounts of lactic acid and alcohol are formed [3, 20]. These products are in the next phase, so-called acetogenesis, are transformed with bacteria involved, into substances being precursors of biogas (acetic acid, hydrogen and carbon dioxide). Too high hydrogen content is harmful to acetogenic bacteria, so they must co-operate with the methanogenic bacteria, which during production of methane, consume hydrogen and provide the right conditions for acetogenic bacteria existence. In the next phase, methanogenesis, the last step of production of biogas, methane is produced from products of acetogenesis [3, 20].

4. Characteristics of sewage sludge directed to biogass production plants

The base of assessment of the correctness of procedure with given type of waste is its classification as required by art. 4 of the Act on Waste, in particular, to give a generic six-digit code, established basing on Regulation of the Minister of Environment from September 27th 2001 n Waste Catalog. Municipal sewage sludge belong to the group 19 Waste from installations and equipment for waste management, wastewater, drinking water and water for industrial purposes treatment plants, a subgroup 1908. Waste from wastewater treatment plants not otherwise specified, generic code 190805. Municipal sewage sludge, if they have been subjected to the processes of stabilization, are classified as non-hazardous waste [10, 21].

The biggest potential of biogas yield and methane content has a activated sludge, which is not stabilized. Unfortunately, obtaining a permit for the use not stabilized sludge in a biogas plant is virtually impossible. It is defined in the rules of Act on Waste from April 27th 2001, which include such sludge as hazardous waste. In article 3, paragraph 2 it is written that "hazardous waste is a waste: from categories or types of waste specified on

list B of Annex 2 to Act and containing any of the ingredients listed in Annex 3 to the Act, and having at least one of the properties listed in Annex 4 to the Act". Annex 3 at position 33 there is a record: "of sewage sludge, undisposable or not suitable for agricultural use" and in Annex 4 it is written: "infectious substances containing viable micro-organisms or their toxins of which it is known or for which there are reasonable grounds to believe that they cause human or other living organisms diseases" [10].

Stabilized sewage sludge has a much smaller potential of biogas yield and methane content than not stabilized. In some cases, in this regard, it is practically useless, as a result of technological methods of dewatering and stabilization of sludge after biological treatment. For example, if in the system there is a separated fermentation chamber, the sludge which is subjected to fermentation is devoid of significant amounts of carbon, which would be the main component of methane. In regard to the biogas production plant such sludge is a ballast in digesters tanks.

Type and dose of flocculant or coagulant supporting the process of dewatering are important in the context of the economic usefulness of sewage sludge used in the biogas plant. Flocculation process consists in formation of aggregates of smaller particles into form of so-called floccules as a result of addition of flocculation reagent to the sludge. Flocculant with its active part sets on the surface of grain, and the hydrocarbon chain is on the outside, forming a bundle of threads which are interwoven with one another and form an agglomerate. However, the process of coagulation consists in destroying hydration layer, centered around the grain, just by adding the electrolyte, so that grain can come closer to each other, on such a small distance, that the forces of mutual attraction may work [4]. Calcium hydroxide in the coagulation process causes pH value increase, which adversely affects the number of methane bacteria, and thus reduces the yield of biogas and methane.

Not stabilized sewage sludge has the potential of biogas yield of 350 to 500 m^3/t of dry mass. However, stabilized municipal sewage sludge after dewatering process with flocculant, without digestion chamber, have a potential of biogas yield of 140–220 m^3/t of dry mass. The potential of biogas yield can be increased by applying sludge homogenization process before digester (e.g. in a buffer tank). The homogenization process consists in destroying of floc structure of thickened sludge, releasing of water from the micro-pores and destruction of zoogleal aggre-

gates of micro-organisms. The homogenization process takes place during the high shear mechanical mixing of liquid in a tank with using special agitators, which create high shear forces, abrupt changes of pressure, and formation of local cavitation phenomena. Damage of zoogleal aggregates causes destruction of the protective layer, resulting in death of microorganisms. The resulting dead organic matter becomes substrate subjected to anaerobic digestion process [18]. Thanks to small investments to build a homogenizer increase of the potential of biogas yield can be achieved. In such case the economic balance looks much more advantageous, because the income of biogas plant will be a fee paid by municipal wastewater treatment plants for the disposal of municipal sewage sludge and fees gained from generated electricity and heat.

Inhibitors may cause delays in the process of anaerobic digestion. Significant amounts inhibitors may be present in municipal sewage sludge. These are substances that already in low concentrations are toxic to bacteria and disrupt the process of decomposition. This applies particularly to such substances as: antibiotics, disinfectants or solvents, herbicides, heavy metals or salts. But even essential trace elements in high concentrations may be toxic to bacteria. Bacteria can, in some extent, adapt to such substances. Concentration from which the substance becomes harmful is difficult to determine. In case of some inhibitors interaction with other substances may take place. Heavy metals are harmful to fermentation process only if they are present in free form. Hydrogen sulfide which is formed in the fermentation process combines with heavy metals, neutralize those [1, 17]. During the fermentation other substances that inhibit the process may develop. Ammonia at low concentrations is harmful to bacteria. Moreover, high combined concentration of NH_3 and NH_4 from 3 g/dm^3 can lead to inhibition of the production of biogas. Another product of the fermentation process and wastewater decay is hydrogen sulphide which in the free form at a concentration of 50 mg/dm^3 can inhibit the decomposition process [1, 17].

5. Legal regulations on biogas production plants

Agricultural biogas production plants are used to target production of biogas, in which products directly from the farm, among other products or agricultural residues, residues from food processing, livestock manure and slurry are substrates [6]. However, in utilisation biogas plants other

waste which may undergo fermentation process and not regarded as hazardous in accordance with the Act on Waste from April 27th 2001 may be substrates [10]. Such wastes include, among others: stabilized sewage sludge, catering waste, organic municipal waste. Therefore, obtaining the necessary permits for construction and operation of agricultural biogas plants, is different than in the case of utilisation biogas plants.

Agricultural and utilization biogas plants above 0.5 MW are qualified as projects that may potentially impact on the environment, which means need to go through the full procedure of environmental impact assessment for the investor. In order to obtain a decision on environmental conditions allowing to implement the project, a complete report on the environmental impact assessment (EIA) must be conducted. Procedures for the preparation of such report are determined in the Act on Waste from April 27th 2001 [9]. Documentation that is required to obtain environmental decision includes a number of attachments (copies of maps of land, excerpts and sketches from the local spatial development plan). However the most important is the description of the installation parameters, technology used, amount and composition of the feed and the ways of dealing with waste, which is mainly post-fermentation mass [2]. In the case of utilization biogas plants, it is important to determine the type of sewage sludge that will be used in the installation. Equally important is to determine the method of disposal of post-fermentation mass.

After obtaining all required documents mayor of the municipality issues a decision on the environmental conditions of the consent for the project realization. Presented documentation and prepared reports are subjected to public consultation. In practice, public opposition is inevitable, and its effects can extend the time of the investment realization, and even in extreme cases, to prevent its implementation [2].

According to the Act from April 10th 1997 (Act on Energy), the investor submits a request for issuing a decision on conditions of connection to the medium (or low) voltage of regional distribution system operator. Terms of connecting are stated in regulation of Minister of Economy from May 4th 2007 on the detailed conditions of operation of the electroenergetic system [2, 6]. Given conditions of connection include: the scope of work necessary to implement the connection and requirements for the equipment necessary for co-operation with the network. It is necessary to build a overhead or cable line to projected transforming

station in order to make a connection of the plant [2]. Conditions determine the connection power of the installation. In practice, co-operation with the regional distribution system operator takes a long time, for administrative reasons, so it should be included in the schedule of the conducted works.

In the next step, a necessary condition is obtaining a promise of concession for electricity generation in renewable source [13]. The application must be submitted to the Energy Regulatory Office, which makes decisions in this matter. The final stage is issuing by ERO licence for the production of electricity from renewable energy sources [6, 16].

Economic activity in the production of agricultural biogas or electricity, heating and cooling generation from agricultural biogas is an activity, as described by the Act on Freedom of Economic Activity, and requires to obtain an entry into the register of companies dealing with the production of agricultural biogas or electricity, heating and cooling generation from agricultural biogas – which is called "a register". Authority which manages the record is the President of the Agricultural Market Agency [14, 22]. However, the authority managing the register of utilization biogas plants, that is those in which one of the substrates is the sewage sludge is the President of Energy Regulatory Office [6]. In the near future Act from April 10th 1997 (Act on Energy) will be changed and additionally rates of charges for additional income from certificates of origin of green certificates will be changed. Probably agricultural biogas plants will be much more subsidized than utilization biogas plants.

According to Act on Spatial Planning and Development from July 27th 2003, documentation related with acquisition of decision on conditions of development depends on whether in the area of the planned investment there is a Local Spatial Development Plan (LSDP). Local Spatial Development Plan determines area appropriation and defines ways of development and conditions of development [11]. LSDP is a direct basis for applying for a building permit, without the need of acquiring a decision. In case when LSDP is realized, and it does not allow for the construction of the biogas plant, then it is necessary to first change the plan [2]. In case of lack of LSDP determination of ways of development and conditions of development is conducted by a decision on conditions of development (DCD). DCD is a decision which sets conditions of change of land use by building of an object or performing other works. This de-

cision was implemented in 2004 and replaced the decision on conditions of building and land development.. The decision in such form is issued only for the areas where LSDP is not implemented. The decision itself does not create a right to the land, or violates the rights of property. In practice, anyone can apply for a determination of conditions of development for any area. Municipal authority, which is responsible for issuing the decision is the mayor of municipality or mayor of town or city. Obtainment of development conditions decision is much simpler in areas where there is no LSDP [2, 3]. In practice, these are the areas away from the major population centres, where issuing such decision will not be associated with potential strikes of the local population. Unfortunately, all the protests result from belief that biogas plant contributes to odours emission, and is associated with delivery and storage of substrates such as: sewage sludge, fish waste, and slaughter waste.

Obtainment of a water permit according to the Act on Water from July 18th 2001 (Journal of Laws No. 115, item. 1229, as amended), is mandatory if: water consumption is bigger than 5 m^3 per day, industrial wastewater is discharged, agricultural wastewater is used in the extent not covered by normal use of water, wastewater is accumulated, recovery or disposal of waste is conducted [8]. In the case of agricultural and utilization biogas plants obtainment of a water permit is necessary, due to the above mentioned items. For example, the transport of digested mass with pumping system requires from the biogas plant large amounts of water for diluting substrates to about 8 to 12% of dry matter Also tank leakage tests require substantial amounts of water, for example, the fermentation tank volume in biogas plant of 1 MW of power capacity is about 3000 m^3. Moreover, post-fermentation mass for agricultural use, requires storage due to specific dates of fields fertilization [8]. Water permit is issued by decision for limited period. Application from water permit should be accompanied by The request for his release accompanied by a water operat, geodetic base with plotted equipment, copies of contracts with buyers of wastewater. It is important to obtain a water permit before starting the procedure of applying for a building permit [2].

In Poland, the rules for obtaining an integrated permit are regulated by the Act on Environment Protection from April 27th 2001 and the Regulation of the Minister of Environment on types of installations that can cause significant contamination of individual natural components or

the environment as a whole from July 26th 2002 [10]. Integrated permit replaces the following permits: for release of gases or particulates into the air, water permit for wastewater discharge into waters or soil, together with the conditions of water consumption; for waste generation along with permits for recovery, treatment, transport, and storage of waste, emission of noise and electromagnetic fields [2].

In order to obtain an integrated permit, considered installation running, due to the nature and scale of its activities, may cause significant pollution of individual natural components or the environment as a whole, and it is not required for each biogas plant. This includes the biogas plants at large breeding farms and meat processing plants. First of all, the obligation to obtain an integrated permit includes poultry farms with more than 40,000 stations, pig farms with more than 2,000 stations for pigs over 30 kg, 750 stations for sows. Such obligation also applies to installations for the recovery and disposal of dead or slaughtered animals or waste animal tissue processing of capacity of 10 tonnes per day [2]. If planned plant will be obliged to obtain an integrated permit, then report on the environmental impact of the project should include a comparison of the proposed technologies with the best available technologies (so-called principle of BAT – Best Available Technology) [2, 9].

According to building law, construction works may start only after the final decision on the construction permit is issued by the local governor. The application for a decision on a construction permit should characterize planned investment. Four copies of the construction project, including the opinions, agreements, licenses should be included. The obligation of obtainment of such arrangements results from the Act on Environment Protection, the Act on Water and the Act on Public Roads. Statements from relevant departments on ensuring provision of energy, water, heat, gas, wastewater collection and conditions of a plant connection to water supply, sewage, heating, gas, electricity, telecommunication and roads systems are also required. Geological investigations of ground on which plant is situated are also mandatory [2]. The procedure aiming to obtain a building permit for both agricultural and utilization biogas plants is the same.

Biogas plants which nominal heat output does not exceed 15 MW are currently exempt from obtaining of permission for emission of gases and dust into the air [24]. According to Article 152 of Act on Environ-

ment Protection (Journal of Laws of 2008 No 25, item 150, as amended) installation, from which emission does not require issuance of permit, which may have a negative impact on the environment should be reported to the environmental protection authority, whereas the principles of reporting of installation that may negatively impact on the environment due to generation of waste is governed by the Act on Waste [2, 9]. From January 1st 2011, new rules of reporting of operated installation to environmental protection authority are in force. Operator of installation is required to make a declaration before the start of its operation.

According to current regulations, operator does not have to apply for a decision on the emission of noise. It is issued ex officio, if it is established by the appropriate authority for issuing permits for emitting noise to the environment, that outside of the plant plot permissible noise levels are exceeded [2].

Under the Act on Technical Inspection from December 21st 2000 and Regulation of Council of Ministers on types of technical equipment under the technical supervision from July 16th 2002, it is necessary to obtain a decision authorizing the operation of technical equipment, which is issued by Technical Inspection Office. In biogas plants fermentation tanks, secondary fermentation tanks, pressure technological pipelines and, if present, biogas tanks are subject to technical inspection.

According to the Act on Waste from April 27th 2001, recovery is understood as any action posing no threat to human life, health or to the environment which involves the use of waste in whole or in part, or leading to the recovery of substances, materials or energy and their utilization. The Act sets out several variants of recovery, which are labeled R1 to R14. In the case of biogas plants following variants may be used: recycling or reclamation of organic substances, e.g. methods of fermentation during which biogas for energy production is generated (R3); distribution on the surface of ground in order to fertilize or improve soil (R10); use of waste vegetable matter or animal tissue (R14) [2, 10]. Issued permit determines type and amount of waste to be recovered or disposed per year. It also defines the place and approved methods for recovery or disposal of waste and additional terms and conditions of conducting activities on recovery or disposal of waste, if it is required by the specific of waste. The permit also specifies the place and method of storage of waste, and the duration of the permit [2, 10].

Regulation of the European Parliament and Council No 1774/2002 specifies limits regarding the use of chemical fertilizers and soil improvers. The regulation does not specify method of dosage of fertilizers, principles of supervision, and possible penalties for exceeding [5]. EU parliamentarians have left this issue to be settled by national law. In Poland, after consultation with the Institute of Soil Science and Plant Cultivation and the Chief Inspector of Veterinary Medicine the Regulation of Minister of Agriculture and Rural Development from December 7th 2004 on veterinary requirements for soil improvers was issued. In the Act from July 10th 2007 on fertilizers and fertilizing natural fertilizers are: manure, slurry or liquid manure intended for agricultural use [7]. Post-fermentation mass is not within a definition of natural or organic fertilizer, but it is within the definition of soil conditioner. Soil conditioners are substances added to the soil to improve its properties or its biological, chemical, physical or physico-chemical parameters, that can be used on own fields without permission. However, according to the Act on fertilizers and fertilization organic fertilizers trade requires a permit, which is issued by the Minister responsible for agriculture. For post-fermentation mass from utilization biogas plants, the same rules are applied as for post-fermentation mass from agricultural biogas plants. However, in this case, more controls should be expected, due to the significantly bigger probability of the exceedings of the permissible values, in particular microbiological or heavy metals content [7, 23]. New legal provisions in the draft law on fertilizers and fertilization define the post-fermentation products as a liquid or solid organic substances coming from production of agricultural biogas using natural fertilizers, plant biomass from agriculture or forest biomass, intended for agricultural use [7, 23]. Draft law also states that post-fermentation product may be intended for direct agricultural use under the same conditions as as natural fertilizers, without acquiring any formalities (tests, evaluations, permits for trading). It also may be sold for direct agricultural use basing on an written agreement.

Post-fermentation mass, depending on the substrates, is characterized by a high water content. In practice, post-fermentation mass thickening in separators is applied, which results in obtaining a solid and liquid phases. Both phases can be used as a soil improvers. There are also alternative solutions. Post-fermentation solid mass may be dried and then it

may be used for production of pellets or briquette. Unfortunately, in biogas plants, where one of the substrates is sewage sludge post-fermentation mass may contain chlorine. Pellets or briquettes containing chlorine, when combusted may cause excessive emission of polychlorinated dibenzodioxins and polychlorinated dibenzofurans. Post-fermentation liquid phase, when no rational solution is found for it, may be treated, for example by UV radiation or in the SBR reactor, and then directed to the sewage system.

6. Conclusions

Presented study analysis allows to state the following conclusions:

1. Undoubtedly in the next few years there will be a significant development of biogas plants in Poland, which will result in increasing share of energy produced from renewable sources.
2. During planning if investments regarding to the construction of biogas obtaining the necessary permits and decisions is time-consuming and it should be considered.
3. Utilization of sewage sludge in biogas plants, as well as the use of post-fermentation mass for agriculture generates additional income for the utilization biogas plant.
4. Controlled methane fermentation process taking place in biogas plants reduces carbon dioxide emission into the atmosphere.
5. In the process of methane fermentation sewage sludge microbiologically contaminated and containing heavy metals should be avoided.
6. The increase in the intensity of biogas release from the fermentation of disintegrated (homogenized) sludge allows for additional energy recovery.

References

1. **Niebaum A., Schattauer A., Scholwin F., Weiland P., Gattermann H., Kaltschmitt M.:** *Biogasgewinnung und -nutzung*. Institut für Energetik und Umwelt gGmbH, Gülzow. 2006.
2. Przewodnik dla Inwestorów zainteresowanych budową biogazowni rolniczych. Instytut Energetyki Odnawialnej, Warszawa. 2011. http://www.mg.gov.pl/files/upload/13229/poranik%20biogazowy.pdf

3. **Jin Y., Wen J., Nie Y., Chen H., Wang G.:** *Biomass-biogas Recycling Technique Studies of Municipal Food Waste Disposal: A Review*. Rocznik Ochrona Srodowiska, Vol. 14, 21–56 (2012).
4. **Piecuch T.:** *Technika wodno-mułowa – urządzenia i procesy*. WNT, Warszawa. 2011.
5. *Rozporządzenie Parlamentu Europejskiego i Rady nr 1774/2002.*
6. *Ustawa z dnia 10 kwietnia 1997 r. Prawo energetyczne.*
7. *Ustawa z dnia 10 lipca 2007 r. O nawozach i nawożeniu.*
8. *Ustawa z dnia 18 lipca 2001 r. Prawo Wodne.*
9. *Ustawa z dnia 27 kwietnia 2001 r. Prawo ochrony środowiska.*
10. *Ustawa z dnia 27 kwietnia 2001 r. O odpadach.*
11. *Ustawa z dnia 27 lipca 2003 r. O planowaniu i zagospodarowaniu przestrzennym.*
12. *Krajowe regulacje prawne w zakresie stosowania osadów ściekowych*. Wojewódzki Inspektorat Ochrony Środowiska w Rzeszowie, Rzeszów. 2007.
13. *Pakiet informacyjny (OZE) dla przedsiębiorstw zamierzających prowadzić działalność gospodarczą polegającą na wytwarzaniu energii elektrycznej w odnawialnych źródłach energii (OZE)*. Urząd Regulacji Energetyki, Departament Przedsiębiorstw Energetycznych. Warszawa. 2011.
14. Projekt Ustawy o odnawialnych źródłach energii. Ministerstwo Gospodarki, Warszawa. 2012.
15. **Wołoszczuk Cz., Krzywy E., Iżewska A.:** *Wartość nawozowa komunalnych osadów ściekowych*. PTIE oddział w Szczecinie. Szczecin. 2000.
16. **Myczko A., Myczko R., Kołodziejczyk T., Golimowska R., Lenarczyk J., Janas Z., Kliber A., Karłowski J., Dolska M.:** Budowa i eksploatacja biogazowni rolniczych. Poradnik dla inwestorów zainteresowanych budową biogazowni rolniczych. Wydawnictwo ITP, Warszawa – Poznań. 2011.
17. **Szczypko A.:** *Tendencje oraz perspektywy rozwoju technologii biogazowych w Polsce*. Praca Magisterska, Politechnika Wrocławska, Wydział Elektryczny, Instytut Energoelektryki, promotor: dr inż. Zbigniew Leonowicz, Wrocław. 2008.
18. **Fukas-Płonka Ł.:** *Wpływ homogenizacji osadu na produkcję biogazu*. http://osady.pl/artykuly/wplyw_homogenizacji_osadu_na_produkcje_biogazu.pdf
19. **Barzyk G.:** *Energetyka biomasowa*. Opracowanie. http://www.barzyk.pl/teksty/energetyka%20biomasowa.pdf
20. *Plan działań na rzecz zrównoważonej energii Gminy Łubianka*. Opracowanie: dr inż. Zbigniew Wyszogrodzki, 2010. http://www.pnec.org.pl/apetyt/docs/seap/SEAP_Lubianka.pdf
21. http://www.wios.rzeszow.pl/stara/monitoring_pliki/opracowania/odp_sciek/r2.html

22. http://www.eu-go.gov.pl/pl/dla-konsumenta/kreator-procedur/procedura/1077/
23. http://prawo.legeo.pl/prawo/obwieszczenie-ministra-gospodarki-z-dnia-15-listopada-2011-r-w-sprawie-raportu-zawierajacego-analize-realizacji-celow-ilosciowych-i-osiagnietych-wynikow-w-zakresie-wytwarzania-energii-elektrycznej-w/zal1/
24. http://www.mikolowski.pl/wprowadzanie-gazow-i-pylow-do-powietrza/uzyskanie-pozwolenia-na-wprowadzanie-gazow-lub-pylow-do-powietrza

Biogazownie utylizacyjne jako propozycja utylizacji osadów ściekowych w odniesieniu do ustawodawstwa polskiego

Streszczenie

W artykule przedstawiono analizę studialną uwarunkowań prawnych dotyczących budowy i eksploatacji biogazowi utylizujących osady ściekowe w porównaniu do biogazowi rolniczych.

Osady ściekowe mogą być kierowane do utylizacji w biogazowniach utylizacyjnych. Jest to niewątpliwie interesująca alternatywa utylizacji osadów ściekowych, zarówno pod względem ekonomicznym jak i technologicznym, ze względu na duży potencjał uzysku biogazu. Należy nadmienić, że roczna ilość powstających osadów ściekowych jest tak duża, że należy je racjonalnie wykorzystać, np. w spalarni, w kompostowniach, czy w procesie fermentacji metanowej. Natomiast pozostała masa pofermentacyjna może znaleźć zastosowanie w rolnictwie i leśnictwie jako dodatek wzbogacający jakość gleby.

Niewątpliwie w najbliższych latach nastąpi znaczny rozwój biogazowni w Polsce, czego skutkiem będzie zwiększenie udziału energii wytworzonej z Odnawialnych Źródeł Energii. Przy planowaniu inwestycji budowy biogazowni należy uwzględnić czasochłonność w pozyskaniu niezbędnych pozwoleń i decyzji. Utylizacja osadów ściekowych w biogazowniach jak również wykorzystanie masy pofermentacyjnej na cele rolnicze generuje dodatkowe przychody dla biogazowni utylizacyjnych. Kontrolowany proces fermentacji metanowej zachodzący w biogazowniach powoduje ograniczenie emisji ditlenku węgla do atmosfery. W procesie fermentacji metanowej należy unikać osadów ściekowych skażonych mikrobiologicznie oraz zawierających metale ciężkie. Wzrost intensywności wydzielania biogazu w wyniku fermentacji zdezintegrowanego (homogenizowanego) osadu ściekowego pozwala na dodatkowy odzysk energii.