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EFFECT OF "HAJDOW" WASTEWATER TREATMENT PLANT MODERNIZATION ON WASTEWATER PURIFICATION PROCESS

WPŁYW MODERNIZACJI URZĄDZEŃ MIEJSKIEJ OCZYSZCZALNI ŚCIEKÓW „HAJDÓW" NA PRZEBIEG PROCESU OCZYSZCZANIA

Abstract: The study presents the effect of modernization of selected elements of the technological line in the 'Hajdów' municipal wastewater treatment plant (WWTP) on the course of the process of wastewater treatment. The researchers paid special attention to the changes in the amount of emerging waste (rake bar screens, sand, excess sludge) due to modernization, and the elimination of odour nuisance from the plant. Technological changes in the system of activated sludge bioreactor contributed to a considerable increase in the amount of excess sludge. This caused problems with its effective management with the use of previously applied methods and devices; therefore, facilities were introduced supporting the dehydration of excess sludge. Therefore, the article also presents the description of solutions concerning the processing of sludge introduced to-date in the 'Hajdów' WWTP and further modernizations implemented.

Keywords: activated sludge, sludge management, odour nuisance, biofilters, WWTP modernization

Introduction

Research Poland's accession to the European Union resulted in the necessity for adjustment of Polish law to the Community law. The Accession Treaty assumes the full implementation of the Directive 91/271/EEC of 21 May 1991 (with later amendments)

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by 31 December 2015, with transitional periods during 2005, 2010, 2013 (reporting to the European Commission) [1]. If the obligations arising from the Directive are not fulfilled within the specified terms, the European Commission (EC) may issue a complaint to the European Court of Justice, and then impose financial penalties on the member states. The basic instrument for the implementation of the provisions of the Directive 91/271/EEC is the National Programme for Municipal WWTP [2]. The Directive regulations were transposed into Polish law, among others, in: the Act in the matter of collective water supply and collective wastewater discharge, the Water Act, or the Regulation by the Minister of Environment of 24 July 2006 in the matter of conditions to be fulfilled while discharging wastewater into waters or soil, and in the matter of substances especially hazardous for the water environment [3–10].

Therefore, the modernization of the wastewater treatment plant all over the world has become necessary in order for it to function in accordance with the provisions of the law, and that transgressions of the law do not result in financial penalties [11]. In addition, ways to improve the performance of wastewater treatment is very much and they are not just reconstruction or expansion of existing facilities as well as the introduction of new or alternative technologies [12–15].

The modernization of the plant results also from the fact that the unit's function in constant contact with wastewater exerting an aggressive effect, and relatively quickly become used. As a result of modernization, the treatment plant is becoming increasingly more environmentally friendly, its odour nuisance decreases, and the effectiveness of wastewater treatment increases. Thus, for more than a dozen years the 'Hajdów' wastewater treatment plant has been undergoing subsequent modernizations in order not to deviate from the European standards of wastewater treatment.

The 'Hajdów' wastewater treatment plant is a mechanical-biological facility using activated sludge technology, to which enter sanitary and industrial wastewater from the Lublin agglomeration (Lublin, Świdnik, Wólka, Konopnica). In the first half of the 2014, the amount of the influent was approximately 60 174 m^3/daily on average [17,18]. The effluent is discharged into the Bystrzyca River. The treatment plant was designed in the 1970s, and its construction lasted until 1992.

The process of wastewater treatment consists of mechanical and biological parts. In the mechanical part, wastewater flows subsequently through the screens, grip chamber and preliminary settling tanks. At this stage, rakings, sand and raw sludge are trapped. Suspensions which are difficult to settle and dissolved substances are removed in the biological part of the treatment plant. Purification is performed in bioreactors with activated sludge, which function in a modified Bardenpho system for the removal of carbon, nitrogen and phosphorus compounds. After the process of treatment in bioreactors, wastewater is separated from secondary sludge in secondary settling tanks [17–20]. Sludge emerging in the processes of wastewater treatment is subjected to fermentation in selected fermentation chambers (SFCs), and subsequently mechanically dehydrated on belt-filter presses. Dehydrated sludge is subjected to the process of thermal drying. In the WWTP, three lines of fluidized bed pneumatic dryers are installed. The use of this technology allows the hygienization of sludge, reduction of the mass and volume of sludge by several times and, in consequence, a reduction in the

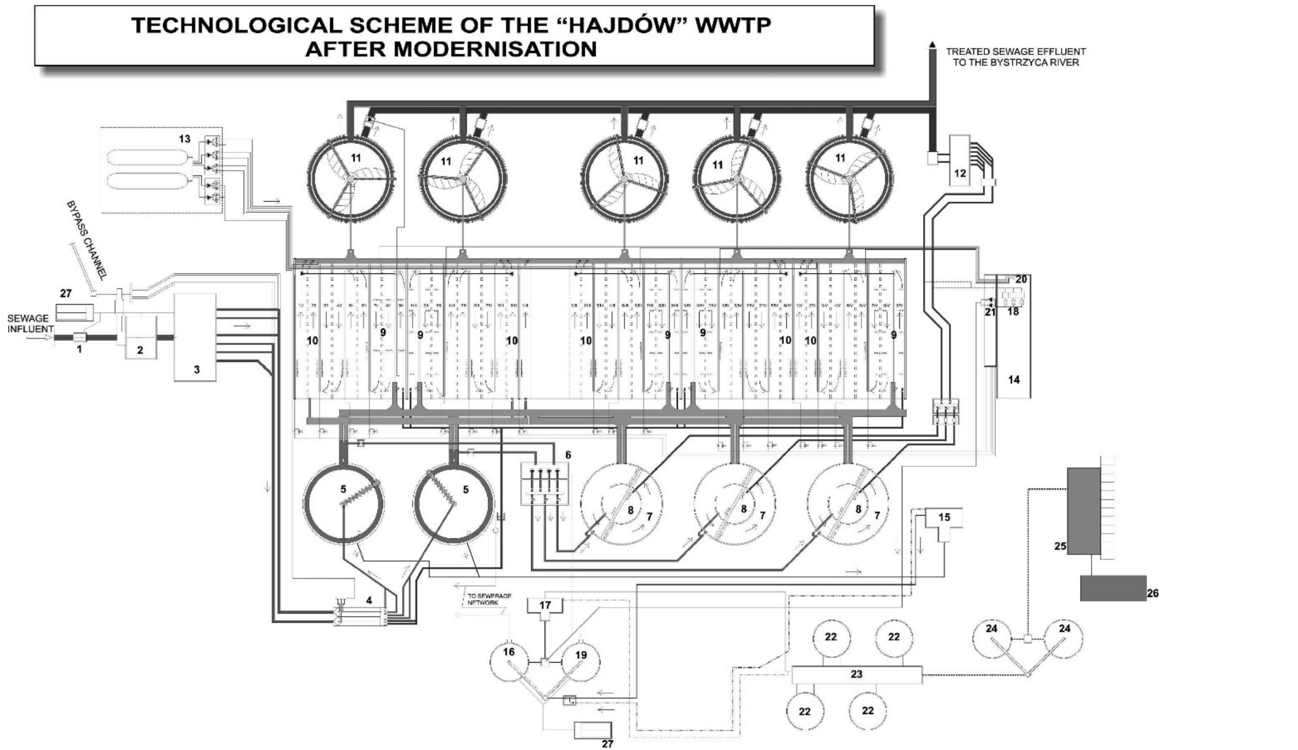

Fig. 1. Technological scheme of 'Hajdow' wastewater treatment plant in Lublin
Legend: 1. Venturi tube in open channel, 2. Screens 3. Main pumping station 4. Aerated sand trap 5. Primary settling tanks 6. Intermediary pumping station 7. Anaerobic chambers 8. Return sludge pre-denitrification chambers 9. Denitrification chambers 10. Nitrification chambers 11. Secondary setting tanks 12. Return sludge pumping station 13. PIX preparation and dosing station 14. Blowers station 15. Primary raw sludge pumping station 16. Primary sludge thickener 17. Thickened sludge pumping station 18. Sludge mechanical thickening station 19. Sludge digester 20. Flocculent preparation and dosing station 21. Thickened surplus sludge pumping station 22. Closed digestion chambers 23. Operational building 24. Digested sludge thickeners 25. Mechanical dewatering sludge station 26. Thermal drying station for the dewatered sludge 27. Biofilter [3]

costs of transport and potential storage of waste. After drying, the sludge is destined for economic use – as an alternative fuel or component of mineral-organic fertilizer.

As a result of the methane fermentation process, biogas is produced which, in a modernized heat and power station, is used for the production of thermal and electric energy. The thermal energy produced fully covers the demand of the treatment plant, while electric energy covers approximately 14 % of the plant's demand. Biogas is also used as fuel in the process of drying of sludge in fluidized bed dryers. Figure 1 presents the scheme of the mechanical-biological 'Hajdow' wastewater treatment plant in Lublin.

Considering the progress in the technology of wastewater treatment, changes of legal regulations, and changes in the amount and composition of influent wastewater the modernization has become necessary of both the devices and technologies used in the treatment plant. The first modernization undertakings began soon after its start-up. It should be noted that the latest modernization was co-financed from the European Union resources.

Modernization of rake bar screen

The first unit in the technological line of wastewater treatment is the rake bar screen. Initially, a bar screen was installed made of ordinary steel, with spacing of 20 mm. The system of transport of disposed contaminants consists of an unshielded conveyor and trolley, which conveys wet screenings to the height of 8 m into an open container. The modernization of the bar screen is accompanied by a change in the technology of dehydrating and transporting of screenings within the unit.

In 1996, old bar screens were removed, and replaced by step bar screens with bar spacing of 5 mm, produced of stainless steel. For the transport of screenings, four band conveyors were used which by means of rotating spirals enabled the transport of wet materials (hygienically dangerous) at various angles and at considerable heights, simultaneously providing total hermetic sealing of the system. A press was also installed allowing a decrease in the hydration of screenings, equipped with a hermetic shield. Dehydrated screenings from the conveyor are transported into a closed container via two plastic sleeves. In order to suppress emission of odour nuisance from the container, a ventilation duct was additionally installed, attached to negative pressure ventilation. This system also collects contaminated air from the shielded screens and carries it away to the biofilter, where purification takes place [18].

In 2012, the bar screens and the system of transport of screenings were modernized once again. In the screen bar unit, four conveyor rake sieves with hook-like plates were installed with spacing of 6 mm. These sieves provide a greater separation of screenings (especially fibrous contaminants), and the screenings washing presses guarantee a high degree of washing away of dissolved organic substance and the reduction in the amount of screenings. These presses function automatically according to the level of wastewater in front of the screen. Screenings captured on the bar screens are transported by a system of horizontal and vertical screw conveyors through two washing presses into the container. Similar to the last modernization, the air from all nuisance odour units is carried away to the biofilter. The biofilters were started up in 2002 and function to-date.

Figure 2 presents changes in the amounts of screenings retained in the subsequent years. Directly prior to modernization the amount of contaminants retained on screens was 336 Mg annually, while a year later this was as much as over 1100 Mg annually. In 2013, the amount of retained screenings was 577.74 Mg annually.

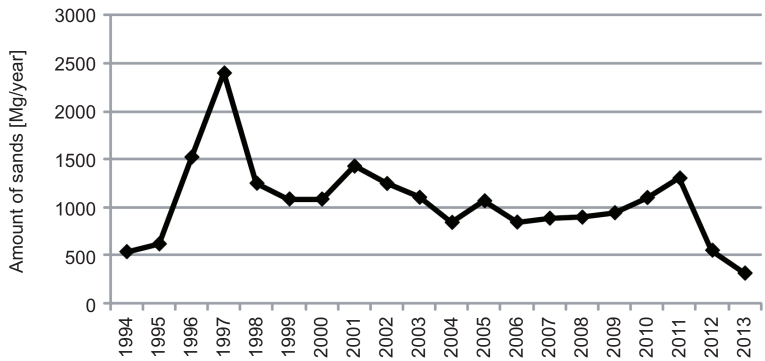

Fig. 2. Amount of screenings retained prior to and after modernization in 1996 and 2012 [3, 6]

Modernization of sand washer

Wastewater pumped from the grates by means of an intermediate pumping station are transported into two distribution chambers, from which through a system of valves may be directed to each of the four funnels of the sand washer. In order to improve the effect of sand removal, the funnels are aerated with compressed air from the blower station.

Modernization of the sand washer consisted in replacing the former pump--hydrocyclon system by light bridges with suspended floodable pumps [19]. Sand hydrated by the pumps is transported into a gutter and stationary separator; therefore, it was possible to cover the sand washer with polyester-glass laminate plates over the wastewater mirror. All construction elements in contact with wastewater were made of stainless steel.

In 2012, during the modernization of the sand washer, Zickert scrapers and sand separator were installed. Sand retained at the bottom is removed to the sand hopper by four bottom scrapers placed in each chamber of the sand washer. From each hopper, sand is removed by means of a pump, then directed to the separator, from where it is transported to the container. The use of the separator with a grit washer allowed for the separation of organic matter from the sand (organic substance returns to the process of purification), which significantly reduced the amount of the removed sand.

Figure 3 presents changes in the amount of sand removed in the subsequent years. Before modernization, the amount of the sand removed was 616.40 Mg annually, whereas after modernization – approximately 2400 Mg annually. In 2012, after

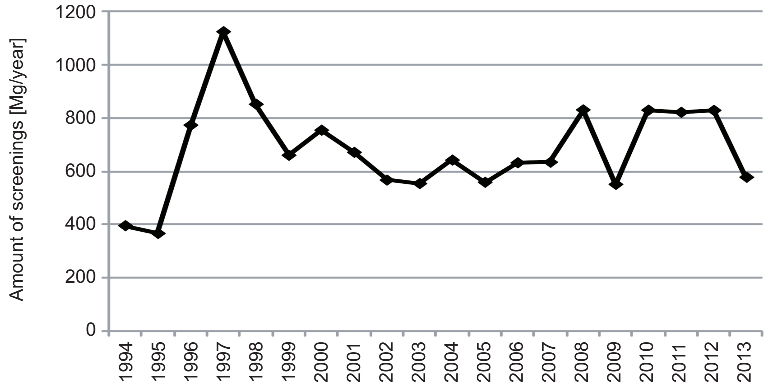

Fig. 3. Amounts of sand removed prior to and after modernization in 1996 and 2012 [3, 6]

installation of the sand separator, the amount of sand removed was 550 Mg annually, while a year later, in 2013 – 311.28 Mg annually.

Sealing of wastewater treatment plant units

For a long time, problems related with suppression of odour nuisance in the units of wastewater treatment plants had been noticed by the authorities in West European countries. In these countries, the regulations univocally indicate that the odour quality of the air is an important element of the environment [21–31]. The Municipal Enterprise for Water Supply and Sewage Systems in Lublin has undertaken a number of investments and organizational undertakings in order to solve this problem.

Firstly, the units within the wastewater treatment plant which were most noxious with respect to odour were sealed: measurement reducers chamber, emergency outflow chamber, rake bar screen, wastewater pump chamber, sand washer, and raw sludge densifier.

Measurement reducers were hermetically sealed in 1995, and modernized in 2009. The modernization consisted in reconstruction of the Venturi KPV-XI reducer for the KPV-IX reducer, and reconstruction of sewage collectors at the rake bar screen and emergency outflow chamber.

The measurement reducers chamber was covered by three domes made of polyester-glass laminate (with inlet and revision slots), based on a reinforced concrete construction of the chamber. The emergency outflow chamber was covered with two domes supported on a reinforced concrete foundation [18]. Hermetic sealing of the densifiers of raw sludge was performed by covering them with laminate elements, supported on separate foundations and suspended on a steel construction.

The glass laminate applied is resistant to atmospheric conditions and the effect of chemical agents produced during the processes of water treatment; simultaneously, this material is light and easy to form. The rake bar screen building was subjected to the previously described modernization and hermetic sealing. The construction of new rakes limits the emission of odours into the atmosphere. Also, the hermetic sealing of the transport of screenings into a closed container was applied.

The sealing also covered the densifiers of raw sludge and a fermenter, as well as densifiers of fermented sludge, buffer tanks, press station, and preliminary settling tanks, from which the odour nuisance is directed into a biofilter.

Sealing of the grit chamber was performed using panels made of synthetic materials. However, considering the small volumes of the hermetically sealed elements, only the sealing of the grit chamber was performed, without carrying away the air to the biofilter.

The last sealed unit in the mechanical part of the wastewater treatment plant are sawtooth weirs of preliminary radial settling tanks. It was decided to make covers of glass laminate for these elements, considering both the odour nuisance of mediocre intensity occurring at this place, and considerable amounts of aerosols produced.

Odour nuisance from the sealed units is directed via a special ventilation system into the biofilter. Microorganisms settling in the biofilter decompose the odour nuisance gas substances, while the purified air is released into the atmosphere through the uncovered upper surface of biofilter filling [18].

The following biofilters are used in the wastewater treatment plant:

– Biofilter I – neutralizing odour nuisance from the following units: measurement reducers chamber, emergency outflow chamber, emergency hatch chambers, rake bar screen, and wet well in raw wastewater pump-room.

– Biofilter II – neutralizing odour nuisance of the air from preliminary sludge densifiers covered by a conical laminate cover.

– Biofilter III – for the removal of odour nuisance gas at buffer tanks.

– Biofilter IV – at preliminary settling tanks which purifies the air carried away from the roofed volumes over the sawtooth outflows.

– Biofilter V – at the sludge dehydration station, purifying the air from the following units of the thermal dehydrated sludge drying station, purifying the air from the following units: dehydrated sludge buffer tank, system of dehydrated sludge conveyers, hermetically sealed presses at the sludge dehydration station, and three lines for sludge drying, three silos of dried sludge granulate.

– Biofilter VI – installed at fermented sludge densifiers.

According to the design assumptions, which have been confirmed by preliminary studies, the reduction of odour nuisance was obtained in 90 %. As a result of these investments, the state of occupational safety and work hygiene in the wastewater treatment plant has improved. Modernization contributed to both an improvement in the work conditions of employees operating and maintaining the units of the plant, as well as the reduction in complaints of the inhabitants from the nearest surroundings of the plant, which allowed avoidance of the creation of a protective zone around the WWTP.

Modernization of biological part

Bioreactors have been modernized within the investment co-financed from the resources of the Instrument for Structural Policies for Pre-Accession (ISPA).

The process of biological treatment of wastewater in the treatment plant described is based on the modified Bardenpho system (system of integrated disposal of carbon, nitrogen and phosphorus compounds). The system consists of a chamber of anaerobic activated sludge (created after the reconstruction of the preliminary settling tank, which performs the function of mixing wastewater after mechanical treatment with activated sludge, as well as the function of a prenitrification chamber and a block with distinguished zones: anaerobic, anoxic-aerobic, and secondary settling tank. Figure 4 presents the scheme of the division of a single reactor into blocks.

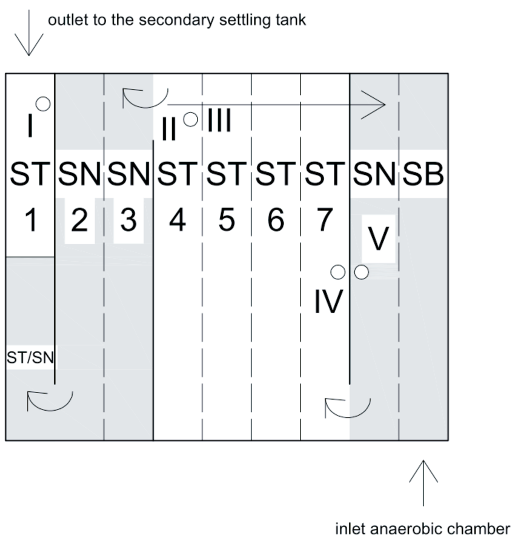

Fig. 4. Scheme of division of a single bioreactor into zones [3] ST – aerobic zone, SN – anoxic zone, SB – anaerobic zone, I – online measurement of $N-NH_4$, $N-NO_3$, sludge concentration, pH, II – alternative measuring location, III – internal recirculation, IV – online measurement of O_2, V – measurement of redox and O_2

The detailed division of the biological reactor block depends on transformations and the existing conditions, and covers several zones: the first zone (chamber) with anaerobic conditions, the second zone for preliminary nitrification, followed by four nitrification zones, the subsequent two zones, where the second-step of the nitrification process takes place, and the last chamber, which is divided into two parts: the first part serves a dual purpose – nitrification or denitrification, while in the second part, the ultimate nitrification process takes place. Thus, summing up, it may be considered that the biological part of the treatment plant, which functions as a five-step modified Bardenpho system, consists jointly of seven zones operating in series, with two of them placed in the spaces created after the reconstruction of the settling tanks, while the subsequent five zones – in modified chambers of the blocks in the aeration chambers. The internal recirculation required in the system takes place from the end of the first stage of nitrification (ST 4) until the initial area of preliminary (SN 8), the nitrification stream usually oscillates within 250 % of the amount of inflowing raw wastewater.

Modernization of the biological part of the WWTP consisted in up-dating the technologies used, which allowed the obtaining of the quality of wastewater treatment adjusted to the EU requirements. The reduction of the level of biogenic compounds has been achieved by construction of new pipelines transporting wastewater to the preliminary settling tanks, modernization of primary settling tanks, adaptation of three settling tanks to the function of an anaerobic chamber, modernization and re-construction of aeration chambers in order to adjust them for carrying out the processes of nitrification and denitrification, and biological dephosphatation. All units have been equipped with adequate sensors for on-line measurements of the key parameters, which provide information concerning the course of treatment processes: dissolved oxygen, redox, $N\text{-}NH_4$, $N\text{-}NO_3$, pH, and concentration of activated sludge. The above-mentioned measurement sensors are connected with the Supervisory Control And Data Acquisition (SCADA) system functioning in the WWTP. Also, an installation for chemical removal of phosphorus has been installed. The completion of the above-mentioned tasks enabled an improvement in the efficacy of disposal of carbon, nitrogen, and phosphorus compounds.

The process of phosphorus removal by the chemical method based on coagulating reagent dosing is providing as additional, applied exceptionally only in emergency situations. Coagulant is added to sewage leaving the nitrification and denitrification chambers. In order to cause primary sedimentation in preliminated settling tank, coagulant is dosed to the grit chamber.

The main elements of the dosing station are: storage tank, tank tray and dosing system. PIX-113 is a coagulant used in this station. PIX is a non-organic coagulant based on Fe^{3+}, in the form of a water solution of iron (III) sulfate.

Modernization of sewage sludge processing units

The first investment within the units for sewage sludge processing was the construction of the station for mechanical dehydration of fermented sludge in 1993. At this station, four belt-filtration presses were installed with a total efficacy of approximately 42.5 m^3/h. Sludge is directed to the presses from fermented sludge densifiers via screw pumps. Parallely, an organic flocculant is added in order to support dehydration. Dehydrated sludge is transported by conveyers to the drying station, or to containers placed below the last conveyer. After installation of the presses, the volume of sludge decreased from 600 m^3 daily down to approximately 80 m^3 daily, and its hydration was reduced from approximately 95–97 % down to about 80 %.

In 2003, an excess sludge densification station and a fermenter were started-up. It was decided to choose such a solution because as a result of changes in the technology of biological treatment, the amount of excess sludge produced considerably increased. Therefore, it became necessary to construct a station for the mechanical densification of sludge [5]. The station consists of two conveyor densifiers with an installation for digestion and dosing of flocculant. The use of this solution allowed the reduction in the content of water in sludge from 99.5 % down to 95 %, which means a considerable decrease in its volume by approx. 8–10 times. The mean daily amount of excess sludge currently conveyed to the densification station is approx. 3000 m^3 daily, while the average amount of sludge outgoing for further processing is approx. 370 m^3 daily (mean values acc. to data of 2005). According to the data of 2013, the mean daily amount of excess sludge was approximately 2400 m^3/daily, whereas the amount of sludge outgoing for further processing – approximately 340 m^3/daily. According to the data of the first half of 2014, the mean amount of excess sludge was 2000 m^3 daily, while the amount of sludge outgoing for further processing – 280 m^3/daily.

During modernization, one of the densifiers of raw sludge was converted into a sludge fermenter for the production of volatile fatty acids necessary for the intensification of the processes of phosphorus and nitrogen removal in the biological part of the plant. The designed fermentation time is four days for 170 m^3/daily of raw sludge. Sludge supernatant from the fermenter is carried to the wastewater wet well in the intermediate pumping station.

In 2008, a station for the thermal drying of sludge was started up, which was attached to the existing sludge dehydration station. In the thermal drying station, three lines of pneumatic dryers were installed with the fluidized bed and sludge feeding substation and silos for granulate (dried sludge).

Sediment in presses in the amount of approximately 96.27 tons daily is hydrated in about 79.7 %, and contains in the dry mass approximately 59.4 % of organic substances. The dryers allow the drying of sludge to the level of over 95.3 % dry mass.

A fluidized bed dryer is divided with a fluidized mesh into: blowing chamber, drying chamber, and air chamber placed above the drying chamber.

Each technological line for drying is composed of the following units:

– Pump supplying feed from the buffer tank to the dosing devices of the drying line (fixed at the bottom of buffer tank);

– Technological dehydrated sludge pipelines with fittings and measurement equipment;

– Fluidized dryer;

– Two air heaters of power 800 kW each, with modulating burners for the combustion of GZ50 and biogas;

– Blowing ventilator with stepless blow control.

The capacity of each line is 1.5 Mg/h of evaporated water.

The drying agent is air at a temperature of approximately 130 ^oC, heated in the thermal centre using a gas burner. The fuel is petroleum gas or biogas. The result of drying is a granulate with a grain size of several millimeters. The constructed installation enables the drying of about 4 Mg/h of sludge with dry mass up to 25 %. As a result of this process, approximately 92 % of dry mass is obtained, and the expected operation time of the installation is about 8000 hours annually.

Modernization of separated fermentation chambers (SFCs) with the operations building and biogas tanks

The SFCs functioning in the 'Hajdow' WWTP are closed tanks made of reinforced concrete for the single-stage mesophilic fermentation of sludge. They are made of reinforced concrete. The middle part has a cylindrical shape, while the upper and bottom parts – the shape of a cone. Densified sludge inflows subsequently into each of four tanks. Prior to modernization, the mixing of the content of the chambers, together with preheating of sludge in heat exchangers, took place by means of circulation pumps and heat exchanges located in the operation building. The heating agent was water at the temperature of 76 ^{o}C, supplied from the gas boiler. A separate pump was used for breaking the scum forming in the SFC, which pumped sludge over the upper level of sludge in the SFC, and as a result of outflow through four nozzles flooded the forming scum.

The drainage of fermented sludge took place by means of a telescopic spillway or by opening the valve on the drain pipeline. An emergency spillway secures against exceeding the upper maximum level of sludge in the chamber. The level of sludge in SFC was measured using isotopic level indicators.

Biogas produced during fermentation was handled using a gas catcher with water lock, and discharged to the sulphur recovery system and gas tank.

At present, modernization is ongoing of selected fermentation chambers, which covers the change of the method of mixing sludge (from that previously used by means of pumps, to mixing with a mixer with a central pipe forcing sludge flow), heating, breaking scum and slaking foam. New pumps, fittings, and gas uptake will be installed. Also, new homogenization and excess sludge disintegration units will be installed, which will increase the susceptibility of sludge to fermentation. Disruption of fluff and microorganisms present in sludge will increase the availability of the organic substance during the fermentation process. It is expected that modernization will result in an increase in biogas production, increase in the degree of sludge mineralization, reduction of fermentation time, and increase in the degree of dehydration of sludge, which in consequence, may decrease the amount of sludge for management and contribute to the minimization of the costs of its processing and utilization.

Before modernization, steel tanks for biogas were installed in the treatment plant, which served for the storage of biogas produced in SFC, and to equalize the pressure of gas during the drainage of sludge from SFC. The pant possessed two steel tanks of the volume of 2000 m^3 each. Each tank consisted of a water pond and a mobile segment filled with gas (bell).

At present, tanks made of plastic are installed in the treatment plant. The biogas tank consists of two membranes: external (protective) and internal (storage). The bottom part of the storage membrane also seals the biogas tank on the part of the baseplate. The pressure in the tank and the state of constant tension of the external membrane is obtained by the functioning of an air ventilator placed on a baseline directly at the biogas tank.

Production of biogas

The possibilities of using biogas are limited by the high concentration of hydrogen sulphide (3.89 g H_2S/m^3 biogas) (exceeding allowable values for heating equipment and generators). Table 1 presents the composition of biogas produced in the wastewater treatment plant. Until 2008, the removal of sulphur from biogas was conducted by the 'dry method' using bog iron ore. Biogas flowed through adsorbers filled with bog ore, where sulphur compounds were retained. At the same time, compressed air was supplied for the regeneration. The efficacy of the process depended on the capacity of ore, and clearly decreased when the amount of settled sulphur reached 25 % of the initial ore mass.

Table 1

'Hajdow' biogas composition [3]

Gas type	Percent volume [% vol.]
CH_4	65.0
CO_2	33.7
N_2	0.2
H_2S	1.1

During the last modernization, there was a change in the technology for the removal of hydrogen sulphide. The method of hydrogen sulphide removal in via a cylindrical bed. This is an economic and highly effective method of hydrogen sulphide removal from biogas currently used in WWTP. The process of biological removal of H_2S from biogas consists in its aeration to the form of simple sulphur or sulphate by bacteria. Sulphur bacteria engaged in this process develop inside the upper part of the reactor which is filled with polymer elements with an appropriately shaped surface, enabling the settling and development of bacteria. The layer consisting of special forms of Tiobacteria is located on the external surface of the carrier material. These bacteria use the process of H_2S aeration as a source of energy for development and prolification. Microbiological aeration results in the conversion of approximately 75 % of H_2S to simple sulfur, and to approximately 25 % of sulfates. Purified gas is transported to the tank.

Figure 5 presents the amount of production of biogas and the way of its management in 2013.

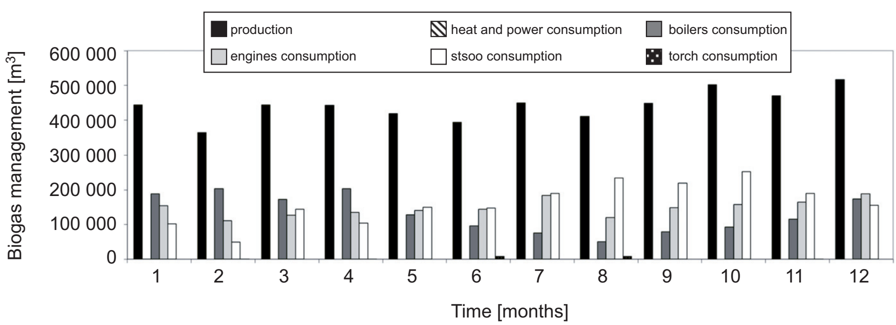

Fig. 5. Biogas management in 2013 [3]

Conclusions

The first modernization undertakings in the 'Hajdow' WWTP began soon after its construction, and have been constantly carried out until today, while further undertakings are planned. The need for modernization was caused by adjustment of Polish law to the EU Council Directive in the matter of urban waste and European standards specified in EEC/91/271. These requirements concern a decrease in the amount of contaminants – mainly biogenic compounds in purified sewage disposed to the receiver. Practically, from that time, modernization activities have been carried out in each part of the WWTP, mechanical, biological, and sludge processing. From the beginning of the functioning of the plant, many pieces of equipment and units have been modernized several times, eg rake bar screens, sand washers, and bioreactor chambers.

New investments covered the majority of units in the WWTP, which contributed to the decrease in the concentration of contaminants in the effluent from the plant, and improvement of the quality of water in the receiver – the Bystrzyca River.

The use of new solutions allowed an improvement in the effectiveness of the technological line in the plant.

As a result of the hermetic sealing of the elements with the greatest odour nuisance and application of biofilters, the noxiousness of the plant for both the local inhabitants and workers supervising the operation of the equipment, was reduced. This solution allowed avoidance of the creation of a costly protective zone around the plant.

After the completion of investments, the ‘Hajdow’ WWTP will belong to the group of the most modern and technologically advanced facilities of this type in Poland.

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WPŁYW MODERNIZACJI URZĄDZEŃ MIEJSKIEJ OCZYSZCZALNI ŚCIEKÓW „HAJDÓW” NA PRZEBIEG PROCESU OCZYSZCZANIA

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Abstrakt: W pracy przedstawiono wpływ modernizacji wybranych elementów ciągu technologicznego miejskiej oczyszczalni ścieków „Hajdów” na przebieg procesu oczyszczania ścieków. Autorzy zwrócili szczególną uwagę na zmiany w ilości powstających odpadów (skratki, piasek, osad nadmierny), spowodowane modernizacją, oraz na likwidację uciążliwości zapachowych oczyszczalni. Zmiany technologiczne w systemie bioreaktorów osadu czynnego przyczyniły się do znacznego wzrostu ilości osadu nadmiernego. Spowodowało to problemy z jego skutecznym zagospodarowaniem z użyciem stosowanych uprzednio metod i urządzeń, stąd też wprowadzono urządzenia wspomagające odwadnianie osadu nadmiernego. W związku z tym praca przedstawia również charakterystykę rozwiązań w zakresie przeróbki osadów wdrożonych dotychczas w oczyszczalni „Hajdów” oraz wprowadzane dalsze modernizacje.

Słowa kluczowe: osad czynny, gospodarka osadowa, uciążliwości zapachowe, biofiltry