CIVIL AND ENVIRONMENTAL ENGINEERING REPORTS

No. 6 2011

THE POSSIBILITIES OF SLUDGE MANAGEMENT, GENERATED IN THE INDUSTRIAL – LAUNDRY WASTEWATER TREATMENT PROCESS IN THE FLIEGEL TEXTILSERVICE LAUNDRY IN NOWE CZARNOWO

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Sludge is generated in all methods of sewage treatment. Choosing a sewage treating technology is necessary to analyse simultaneously the possibilities of sludge management. The methods of sludge management, generated in the industrial sewage treatment processes, besides technological conditions, meet also law restrictions. In this paper, the possibilities of sludge management, generated in the industrial-laundry sewage treatment process in the Fliegel Textilservice laundry in Nowe Czarnowo are presented. Because of location factor (the closed vicinity of Dolna Odra Power Plant in Nowe Czarnowo), it seems that the best method of sludge disposal is the nature sludge utilisation.

Keywords: sludge management, industrial-laundry sewage

1. INTRODUCTION

Fliegel Textilservice laundry is located in Nowe Czarnowo near Gryfino. The plant operates on a service activity in the range of classical – wet laundering. Nowadays sewage, generated during washing, are transported to communal sewage system and then to sewage treatment plant in Gryfino.

In 2009 Fliegel Textilservice laundry acceded to the task realisation of building their own laundry sewage treatment plant. In the designing sewage treatment plant, some types of sewage will be decontaminated and then, by designed outfall, carried off to the receiver (Kanał Ciepły).

The following types of sewage are:

- sewage stemming from washing processes (industrial – laundry sewage)

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- sewage from regeneration of ion exchangers that are used for softening of technological water (mostly polluted by NaCl).

It is being planned that within the framework of enterprise the following objects will be erected:

1) biological – chemical industrial – laundry sewage treatment plant
2) pipeline of treated sewage ended by outfall to the receiver – Kanał Ciepły (this channel carries off cooling waters from the Dolna Odra Power Plant to the Odra River).

During treating processes in the designed sewage treatment plant, like in all methods of sewage treating, sludge will be generated. The main purpose of this paper is to present the possibilities of their disposal.

2. TESTING OF SEWAGE QUALITY – THE RESULTS OF PILOT SURVEY AND DESIGNED TECHNOLOGY OF WASTEWATER TREATMENT

In order to find the most optimal technology to purify laundry sewage, pilot surveys were carried out in the period 12.2009 – 07.2010. Within the framework of these surveys untreated sewage were tested twice a week. The results are presented in tab. 1 below.

Table 1. The quality of raw and treated wastewater

Indicator		Raw wastewater	Treated wastewater
pH	[-]	10 – 7.4	8.0 – 8.9
BOD_5	$[gO_2/m^3]$	122 - 386	11 - 18
COD	$[gO_2/m^3]$	814 - 1159	73.5 - 125
Total suspension	$[g/m^3]$	130 - 415	
Total phosphorus	$[g/m^3]$	2.69 – 12,7	3.0 – 2.4
Phosphates	$[g/m^3]$	7.92 – 33.8	
Total nitrogen	$[g/m^3]$	8.3 – 15.2	3.1 – 14.0
Ammonia nitrogen	$[g/m^3]$	0.29 – 1.63	0.2 – 9.04
Anion surface-active substances	$[g/m^3]$	13.2 – 32.9	0.9 – 2.1
Non-ionic surface-active substances	$[g/m^3]$	24.9 – 43.7	1.9 – 4.1
Chlorides	$[g/m^3]$	436 – 787	443 - 527
Sulfates	$[g/m^3]$	236 - 305	140 - 203
Total organic carbon	$[g/m^3]$		24.4 -35.1

Within the period of time from 04.2010 to 27.07.2010 pilot surveys of sewage treatment plant working in two-stage aerated biofilter technology were carried out. During the pilot tests raw sewage flowed in to two-stage biological sewage treatment installation. In this installation, micro-organisms taken part in purifying processes, were located on high-porous sponges. These sponges, being fluidal filling of aeration tank, were earlier vaccinated by appropriate bacterial cultures.

Pilot installation wasn't equipped with secondary settling tank, so tested treated sewage samples were analysed after sedimentation, and sewage samples were taken from the top cleared layer of sewage. The quality of cleared treated sewage according to the analyses of plant laboratory was characterised by the values also presented in table 1.

In the period 11.06 – 05.07.2010, the sedimentation of suspension in treated sewage was also examined, in order to determine the sludge susceptibility on densification processes. Sample of treated sewage, taken from the pilot installation, was being treated in two hours sedimentation in Imhoff funnel. Volume of sludge was registered after 30, 60, 90 and 120 minutes of sedimentation, and the obtained measurements are:

– after 30 minutes - 10-28 ml/dm^3
– after 60 minutes - 9-24 ml/dm^3
– after 90 minutes - 9-20 ml/dm^3
– after 120 minutes - 9-18 ml/dm^3

The obtained results of thickening indicates the possibility of applying gravitational sludge thickening process.

On the basis of the analysis of pilot installation work results, the expected quality of treated sewage, carried away from new projected sewage treatment plant, was estimated. However it is necessary to point out that estimation of true quality of treated sewage will be possible not before the complete start-up of sewage treatment plant. In the period of optimum work of pilot installation, all values required by *Decree of the Minister of Environment of 24 July 2006 on requirements set for waste water discharge to water bodies or to soil* were kept. Insignificant deviations will be eliminated during the complete work of sewage treatment plant.

According to the conducted tests, executed analysis and obtained results the following conclusions were reached:

– laundry sewage seems to be high biodegradable, it especially concerns non-ionic and anion surface-active substances;
– it can be accepted, that using an effective method of suspension separation, the quality of sewage after two-stage biological treating in aerated biofilter will satisfy all conditions allowing to discharge them to surface water.

3. THE CHARACTERISTIC OF SLUDGE GENERATED IN NEW PLANNED SEWAGE TREATMENT PLANT

At the stage of pilot experiments, detailed research of generated sludge wasn't carried out (mainly because of leading purpose of pilot experiments to determine the optimum technology of laundry sewage treatment and because of lack of secondary settling tank and thereby the impossibility of constant extraction of excessive sludge. Consequently, further calculations are estimated, but they are sufficient to preliminary selection of sludge treatment technology.

3.1. The amount of sludge

The total amount of excess sludge consists of:
- biological excess sludge;
- removed suspended solids;
- sludge from chemical phosphorus precipitation.

One can estimate that the indicator of biomass growth in moving bed film reactors is equal to 0.1-0.4 kg of sludge dry mass per one kg of removed COD [4]. The wastewater technology supplier declared that biomass growth indicator is equal to 0.3 kg of sludge dry mass per one kg of removed BOD_5. The ratio of COD/BOD_5 in raw wastewater under investigation is equal to 2.22 which lead to conclusion that expected biomass growth can be on the level of 0.135 kg of sludge dry mass per one kg of removed COD (0.15 has been used for sludge amount estimation).

The dose of iron salt required for simultaneous phosphorus precipitation is equal to 1.28-2.67 kg of Fe(III) per one kg of removed phosphorus [5].

Assuming that ca. 5 g P/m^3 should be removed by chemical precipitation, the dose of 13 g Fe(III) $/m^3$ has been used for sludge amount estimation. Dosing of 13 g Fe(III) $/m^3$ generated sludge in amount of 35 g of sludge dry mass per one cubic metre of wastewater (7.0 g of sludge dry mass per one g of removed phosphorus). The estimation of sludge amount is presented in table 2.

Table 2. Estimation of sludge amount

Indicator	Raw wastewater [mg/dm^3]	Treated wastewater [mg/dm^3]	Volume of wastewater [m^3/day]	Load removed [kg/day]	Amount of sludge dry mass [kg/day]
COD [gO_2/m^3]	900	125	540	418.5	62.8
Total suspension [g/m^3]	250	35	540	116.1	116.1
Total phosphorus [gP/m^3]	8	3	540	2,7	18.9
				Total	197.8

Making such assumption estimated amount of excessive sludge is up to 200 kg of sludge solids per day. With the range of hydration of mechanical dehydrated sludge 82-80% [2], it gives 1000-1110 kg of dehydrated sludge per day. Moreover according to the applied process, in case of lime stabilisation, the final amount of disposed sludge will also provide for the dose of lime used for disinfection and stabilisation of sludge. With established dose of 1 kg of lime per 1 kg of sludge solids (according to literature dates used dose of lime to sludge stabilisation is 0.5-1.2 kg of lime per 1 kg of sludge solids [3]) day output of sludge disposed from projected sewage treatment plant will be about 1.2-1.3 tons per day.

Yearly amount of disposed sludge will be about 440-475 tons per year.

3.2. The quality of sludge

Taking into account that the quality of raw sewage arises directly from pollutants removed in washing processes and from used detergents (majority of detergents are organic and biodegradable), an assumption was made that the quality of generated sludge will not significantly differ in properties from sludge generated in typical municipal sewage treatment plant.

To confirm this assumption it is necessary to generate more amount of sludge. Therefore, despite of the end of the investigation tending to determine the proper technology of sewage treatment, it was decided to continue the work of pilot installation, what will allow to optimize the treatment technology of generated sludge.

4. THE TECHNOLOGY OF SLUDGE TREATMENT AND THE ANALYSIS OF SLUDGE DISPOSAL POSSIBILITIES

From the law point of view the possibilities of using the given method of sludge management depends on qualification of arising sludge.

Besides the accepted method of sludge management determines the technology of sludge treatment and the selection of devices for sludge processing.

It was initially assumed that the sludge management in designed sewage treatment plant will contain gravitational and mechanical sludge dehydration and sludge stabilisation and disinfection by adding lime. Mechanical dehydration processes will be supported by the addition of polymeric flocculent. With such technology the way of sludge after building sewage treatment plant will be forming in the following:

- sludge from secondary settling tank with hydration circa 99.5 – 99.0 % will be guided to sludge consolidation tank, performing simultaneously the function of sludge reservoir;
- thickened sludge will be transported by sludge pump to installation of mechanical sludge dewatering – filter press; dewatering will be supported by addition of polymeric flocculent.
- mechanical dehydrated sludge will be mixed with burnt lime for stabilization or for possible disinfection.

The flow chart of sewage treatment plant was presented in fig. 1.

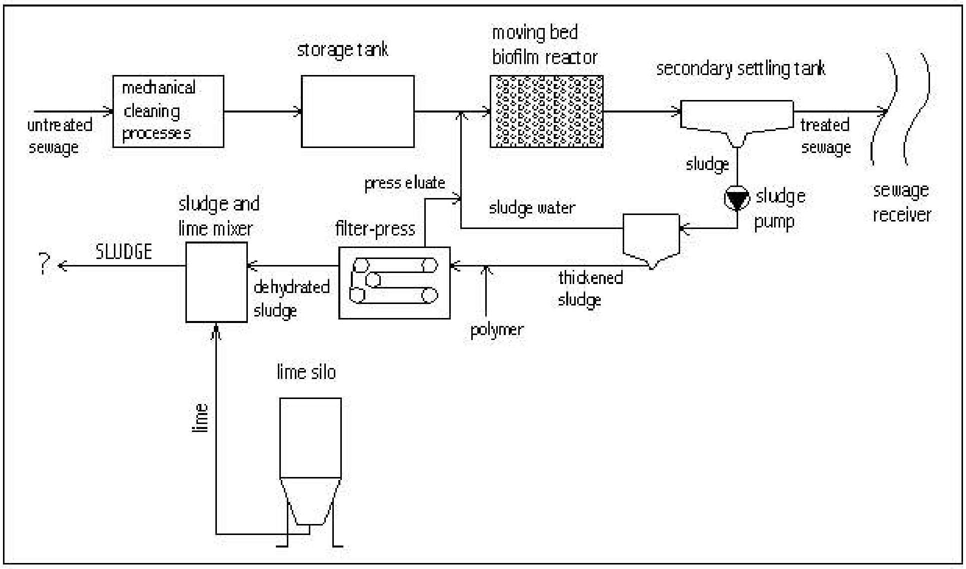

Figure 1. The flow chart of sewage treatment plant

It was assumed that after all processes of sludge conversion, we will get sludge dehydrated to the level in the range of 82-80%, disinfected and stabilised. Such converted sludge will be a waste with the code of 19 08 12 – it means mud from biological industrial sewage treating other than sewage mentioned in 19 08 11.

At the same time notation in the *waste act*: Article 3. paragraph 3. Whenever there is information about municipal sludge – we mean arising in sewage treatment plant sludge from sludge digesters or other installation for municipal sewage treating or other sewage with composition similar to municipal sewage.

- indicates the possibilities of treating obtained sludge like municipal sludge.

As real possibilities of sludge management, the following variants were analysed:

- burning or co-burning in the incinerating plant;
- storing at waste dump;
- nature sludge utilisation.

4.1. Sludge burning or co-burning in the incinerating plant

As a place of sludge burning, burning in own boiler house or burning outside the laundry were considered.

Sludge intended for burning should be adequately dehydrated and dried (it is possible to use the steam from neighbouring power plant as a heating medium), but stabilisation would not be necessary.

Burning in the place of arising sludge would be the best solution (it isn't necessary to transport them to the incinerating plant) in case of incinerating plant existing on the plant territory. Owing to the fact that Fliegel Textilservice laundry has no boiler house, the solution would require to build incinerating plant, which first costs would probably repeatedly exceed later savings. Burning of sludge in external incinerating plant will require road transport of dehydrated sludge to incinerating plant. A borne costs will mainly depend on the distance to a chosen incinerating plant. It could be the potential incinerating plant in the Pomorzany sewage treatment plant in Szczecin (the distance about 30 km).

It would be very advantageous (minimal transport costs) to burn sludge in neighbouring Dolna Odra power plant (the power plant burns considerable more "own" sludge generated in plant's sewage treatment plants). Such solution encounters on problems of law nature. The power plant, not having the status of incinerating plant, may not take to burn any sludge from outside.

4.2. Storing at waste dump

Storing at waste dump (considered as the most disadvantageous variant) – requires road transport of sludge to chosen waste dump. Like in case of the external incinerating plant, the costs of such solution will depend on the distance of sludge transport. This solution requires earlier sludge dehydration, and depending on waste dump (permission to storage given sort of waste) also their stabilisation. In this variant the transport of stabilised and dehydrated sludge, for example to Ekomyśl near Myślibórz (the distance about 40 km), was taken into consideration, after earlier stabilisation through adding lime.

4.3. Nature sludge utilisation

The conditions of sludge utilisation to waste dumps reclamation are defined by *Decree of the Minister of Environment of 21 March 2006 on recovery or rendering harmless of waste outside the installations or devices*.

In this decree, the types of waste and conditions of recovery them in recovery process R 14 (other action consisting in waste usage as a whole or as a parts) are defined.

In accordance with annex number 1 of this decree to biological recovery of closed waste dumps or its part (so called reclamation cover) waste may be used with the following codes:

10 01 01 slag, furnace ashes and flue dust
10 01 02 coal fly-ashes

10 01 15 furnace ashes, slag and flue dust from co-burning
10 01 80 ashes – slag mixture from wet draining of furnace waste.
Thickness of layer of used waste should depend on planned seeding or planting. Waste with mention above codes before usage should be mixed in proportion 1:1 with dehydrated sludge and applied as a layer with thickness maximally 1 meter in case of low planting or 2 meters in case of tree planting.

In case of such a method of sludge disposal it will be necessary to establish co-operation with plant, in which during manufacturing processes mention above furnace waste are generated (optimally, due to closed vicinity, with Dolna Odra Power Plant in Nowe Czarnowo).

5. CONCLUSIONS

At the time of starting of sewage treatment plant by Fliegel Textilservice laundry, practically immediately the problem of necessity sludge disposal will appear. Up to now, from considered possibilities, only burning in own incinerating plant, because of too big capital costs, was excluded. Burning of sludge in the Dolna Odra Power Plant would be very beneficial, but for the moment law nature limitation occur. It might be similar with nature sludge utilisation.

However, it is necessary to emphasise that the proposed method of sludge treatment (dehydration and stabilisation through adding lime) does not close any analysed method of sludge management, and the final selection will only depend on current economic calculation.

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MOŻLIWOŚCI ZAGOSPODAROWANIA OSADÓW ŚCIEKOWYCH POWSTAJĄCYCH W PROCESIE OCZYSZCZANIA ŚCIEKÓW PRZEMYSŁOWYCH POPRALNICZYCH NA PRZYKŁADZIE PRALNI FLIEGEL TEXTILSERVICE W NOWYM CZARNOWIE

S t r e s z c z e n i e

Osady ściekowe powstają w każdej metodzie oczyszczania ścieków. Dlatego przy doborze technologii oczyszczania ścieków, należy jednocześnie analizować możliwości zagospodarowania osadów ściekowych. Metody zagospodarowania osadów powstających w procesach oczyszczania ścieków przemysłowych uwarunkowane są przede wszystkim względami technologicznymi i możliwościami ich przeróbki. Jednakże mogą występować również ograniczenia natury prawnej, które nie występują w przypadku osadów powstałych podczas oczyszczania ścieków komunalnych. W referacie przedstawiono możliwości zagospodarowania osadów ściekowych powstających w procesie oczyszczania ścieków przemysłowych popralniczych na przykładzie pralni Fliegel Textilservice w Nowym Czarnowie, województwo zachodniopomorskie. Osady te pod względem składu nie różnią się znacznie od „klasycznych” osadów komunalnych. W związku z tym analizowane były trzy warianty: spalanie lub współspalanie osadów w spalarni, składowanie na składowisku odpadów oraz przyrodnicze wykorzystanie osadów. W ramach przeprowadzonej analizy uwzględniono również czynnik lokalizacyjny, tj. bezpośrednie sąsiedztwo elektrowni Dolna Odra w Nowym Czarnowie.