SMART SLUDGE MANAGEMENT AUDIT CONCEPT AND TOOL

Development and results from audited wastewater treatment plants in the project IWAMA – Interactive Water Management

IWAMA Interactive Water Management

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Smart Sludge Management Audit (SSMA) concept was developed within the INTERREG Baltic Sea Region (BSR) funded Interactive Water Management (IWAMA) project by the University of Tartu. The audit concept was developed and tested in cooperation with wastewater treatment plants (WWTP) in the BSR. A total of 9 WWTPs took part in the development process: Grevesmühlen WWTP from Germany, Pomorzany and Zdroje WWTPs from Szczecin, Poland, Kaunas WWTP from Lithuania, Daugavpils and Jurmala WWTPs from Latvia and Tartu and Türi WWTPs from Estonia. The aim of the SSMA was to evaluate the sludge treatment process from primary/secondary sludge generation until the final usage of the treated sludge. The evaluation included sludge generation in biological wastewater treatment process, thickening, anaerobic digestion, dewatering, biogas utilisation, further treatment processes, treated sludge quality and final use of the treated sludge. The SSMA concept was made into a MS Excel based tool, which interested WWTP operators and other parties could use to evaluate their WWTPs without external help needed (self-auditing process).

In order to share knowledge and experience and make sure the audit process is doable without very specific internal or scientific knowledge, the testing of the SSMA concept was done together with an international group of students. Students from Germany, Sweden, Finland and Estonia took part in all the audits carried out in partner WWTPs and under the leadership of specialists from the universities, local treatment plant operators and electricians gathered the necessary data, asked additional questions and compiled the overall database with results. During the development process the audit group consisting of students, representatives from WWTPs and IWAMA project steering group met a total of three times to share results, experiences and knowledge, all of which was used to develop the SSMA concept and self-audit tool.

Current report gives a short overview of different parameters evaluated in the SSMA concept with results from the IWAMA project partners, who participated in the audit development and testing process. In the first section, the more interesting parameters together with gathered results are presented one by one, while in the second section biggest findings from the audits are shown by participating WWTP. As the participating WWTPs varied greatly from both size (5000 PE – 740 000 PE) and used technologies (from no sludge treatment up to drying and incineration) not all data is available for every parameter, while the results for WWTPs with more complex sludge treatment processes are more comprehensive.

TABLE OF CONTENTS

1. SMART SLUDGE MANAGEMENT AUDIT CONCEPT OVERALL RESULTS

1.1 Sludge age and effect on secondary sludge production

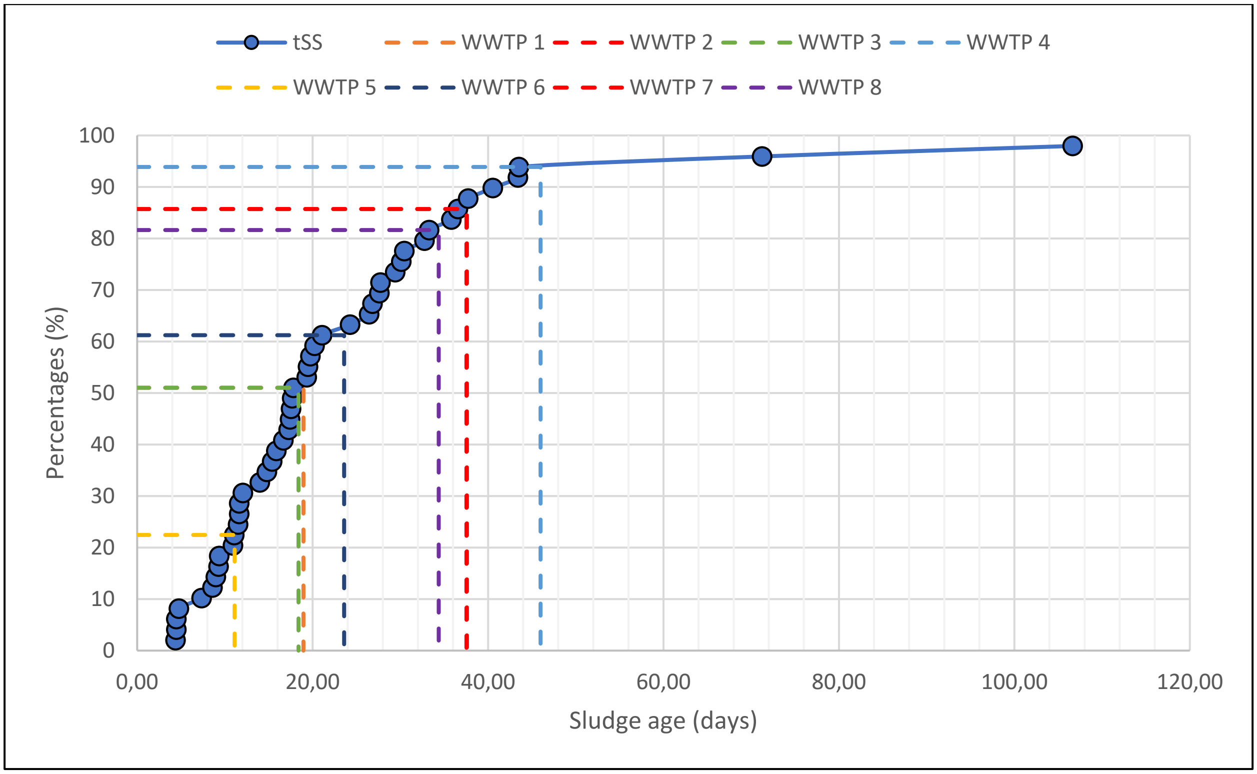

***Figure 1 - Calculated sludge age for audited plants** (8 WWTPs shown, 9th WWTP did not have the required data for calculation), background data from collected key figure data for sludge benchmark from the Baltic Sea Region.*

The sludge age in the Smart Sludge Management Audit concept, the simple sludge age was calculated based on ATV-DVWK-A 131E standard. The differences between WWTPs can be seen on Figure 1. While the lowest sludge age was 11.1 days, which is even lower the recommended 15 days, the highest calculated sludge age was 46 days. The sludge age is not very important for smaller WWTPs which do not use anaerobic digestion – longer sludge age might even be beneficial as the amount of secondary sludge produced is lower (up to 20% comparing sludge age of 15 and 45 days). The reduction of secondary sludge mass is due to the degradation of easily degradable organics in the biological treatment – while beneficial for smaller plants it also indicates lost biogas potential for anaerobic digestion. A total of 4 audited plants were near the recommended sludge age of 15 days, all of them also used anaerobic digestion, while the other 4 plants had sludge age much higher than recommended. As 2 of them also had digestion, recommendation to lower the sludge age if possible was given.

1.2 Thickening efficiency and used technologies

As water is the main component of the waste activated sludge (WAS), thickening and dewatering processes in the WWTPs are vital to decrease the volume that needs to go to sludge treatment. While the sludge coming from secondary clarification is usually around 0.7 – 1.5 % of total solids (7 – 15 g TS/L), anaerobic digestion and other sludge treatment processes need much higher solid content than that. The smaller plants often use gravitation thickening, which comes with lower costs, while medium and large sized WWTPs prefer mechanical thickening for the efficiency and speed. Also the maximal achievable TS content is usually considered lower with gravity thickening (around 2 – 4 % TS), while mechanical thickening usually reaches around 6 % TS (Figure 2). Only one audited WWTP used gravity thickening, reaching almost 4%, while one of the WWTPs with drum thickeners reached also 4%. Most of the audited plants reached a similar TS content – between 5.5 and 6.5 %, which can be considered a high efficiency.

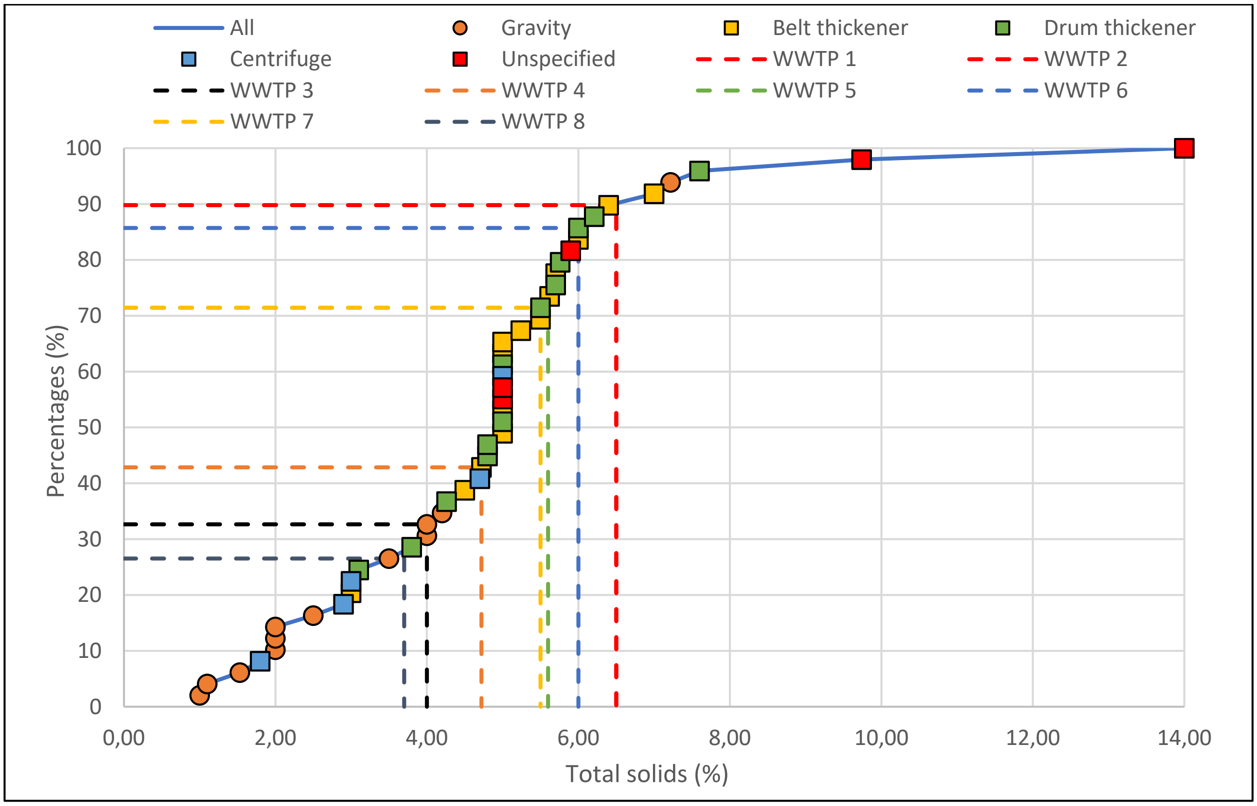

Figure 2 – Achieved total solids content with thickening *(8 WWTPs shown, 9th WWTP did not have separate thickening process), background data from collected key figure data for sludge benchmark from the Baltic Sea Region.*

1.3 Effect of digestion on dewatering efficiency

Dewatering is a process that usually follows digestion, while it can also be used after thickening to increase the total solids content of the sludge and again decrease greatly the volume of untreated sludge. Dewatering efficiency is dependent on the sludge characteristics – age, degree of degradation, size of particles, physio-chemical properties and many other parameters. Therefore, sludge maximal dewaterability is a complex and difficult to evaluate parameter and is not usually tested. General research has shown that digested sludge has higher dewaterability than undigested, which was also seen in the sludge benchmark collected during the project (Figure 3). Another big influence on TS achieved with dewatering is the amount of polymer added during the process as too high polymer concentrations cause a negative effect. The optimal polymer dosage and achievable TS is individual for each WWTP and changes in the course of time – therefore in-situ polymer dosage tests need to be done every few years.

From the audited WWTPs, all WWTPs used dewatering – 3 dewatered undigested sludge and 6 dewatered digested sludge. All the audited plants used decanting centrifuges. While all digested sludges achieved TS content of 20% or more, the undigested sludges were below that (16.5 – 19%). As many dewatered digested sludges went further or to drying, TS content higher than 22% was said to start causing problems for specific drying equipment, therefore 3 of the audited plants didn't strive to increase their dewatering efficiency. The highest TS achieved from the audited plants was 24%, while previous studies have shown that up to 30% could be achieved for digested sludge. As previously mentioned, the maximal dewaterability is very specific and tied to different parameters of the WWTP and sludge, therefore we recommended maximal dewaterability testing and polymer coagulation tests to 2 WWTPs.

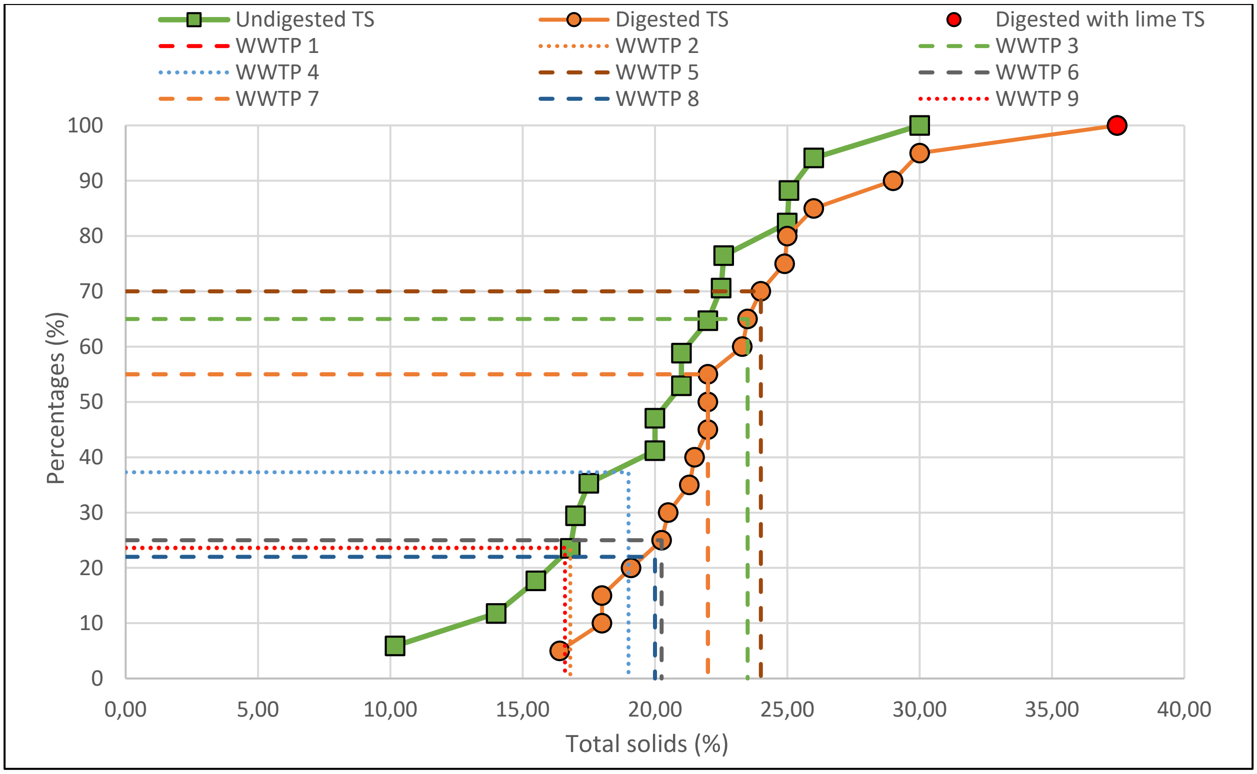

Figure 3 - Total solids achieved with dewatering for both undigested and digested sludge *(all 9 WWTPs shown, 3 marked with dotted line used undigested sludge, 6 marked with dashed line used digested sludge), background data from collected key figure data for sludge benchmark from the Baltic Sea Region.*

1.4 Biogas production per TS load to digester

As energy-neutral wastewater treatment has become a very popular topic for discussion, one of the main positive-energy processes in WWTPs is the anaerobic digestion. In anaerobic digestion, organics are degraded and biogas, consisting of 55-65% of methane is created. The amount of biogas produced is mostly dependent on the organic content loaded to the digester (OLR). When the organics part of the total solids in the sludge is low, efficiency can be increased by adding biodegradable waste to the digester.

On Figure 4, the biogas production per total solids loaded to the digester is shown. This does not take into account the biogas production per organic matter loaded, but the total biogas production per both organic and inorganic matter loaded into the digester. A total of 6 of the audited WWTPs used anaerobic digestion, all of them mesophilic, operating mostly in the range of 35-38 °C, apart from one of the WWTPs (around 47 °C). The highest results were achieved by a WWTP with a large industrial wastewater influent proportion (easily degradable organics), also accepting untreated sludge from smaller WWTPs in the region into their digestion. At the same time, the hydraulic retention time (HRT) in the digestion was only 11 days, much lower than for all the other audited WWTPs.

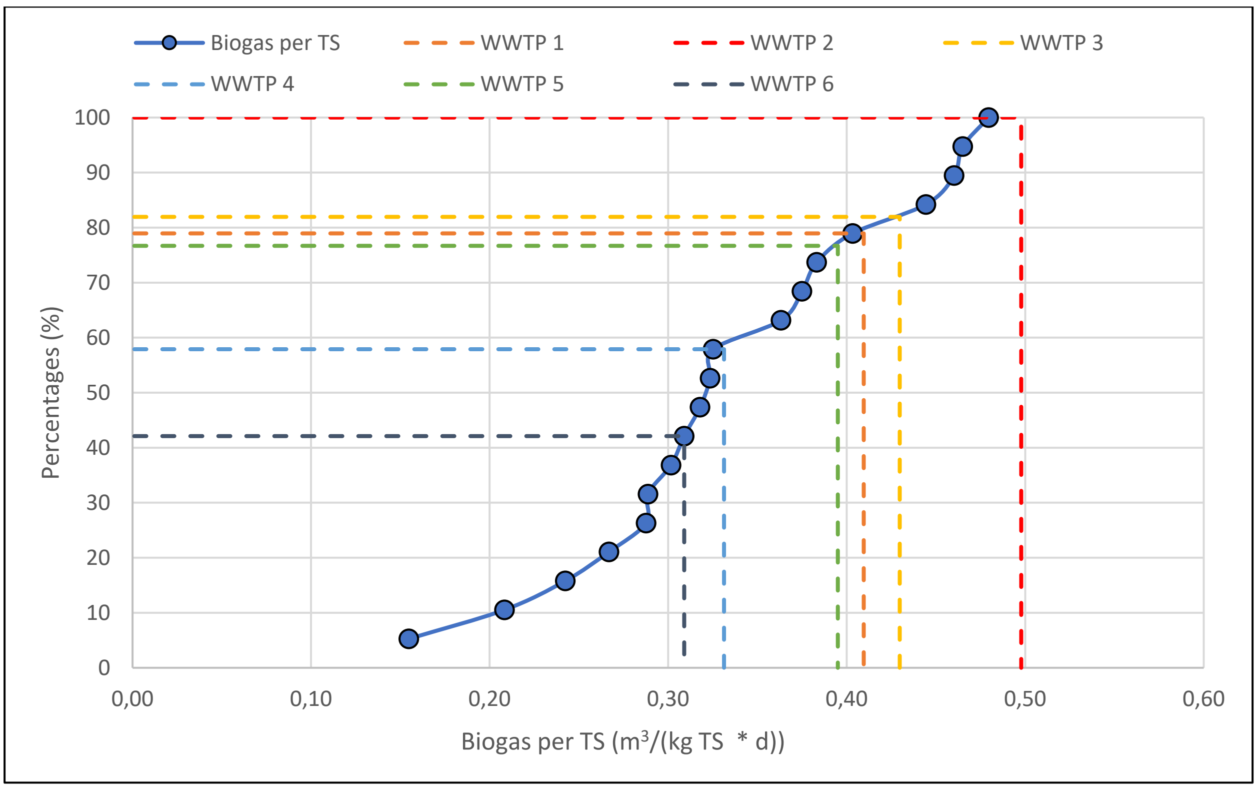

Figure 4 - Biogas production per total solids loaded to anaerobic digestion *(6 WWTPs with anaerobic digestion shown), background data from collected key figure data for sludge benchmark from the Baltic Sea Region.*

The two WWTPs with average results compared to the regional key figure data did not have any extra inflow of easily degradable organic material. The industrial wastewater proportion for both plants was low as well (around 10% of volume). Recommendations were given to both WWTPs to accept biodegradable waste, grease trap waste or other waste with very high organics content, in order to increase the total biogas production. As all these WWTPs already have pre-existing infrastructure for biogas production, cleaning and utilization, maximizing their possible potential for energy production is more feasible in the long term.

1.5 Biogas utilization and energy production

The biogas generated in anaerobic digestion is usually converted into energy in the WWTP, either used in a combined heat and power generator (CHP) or used directly as a fuel for heating. In theory a cubic meter of biogas with around 60% of methane has a total energy potential of 6 kWh, which is almost obtainable if only heat is generated from the biogas. With electricity generation the losses tied to energy conversion are bigger, so with a good CHP the estimated amount of 2 kWh of electricity and 2.5 kWh of heat (a total of 4.5 kWh) of total energy is considered obtainable.

On Figure 5 the results of total energy production from biogas for the audited plants is shown. This figure is the sum of both electricity and heat generation, although some audited WWTPs used biogas for various purposes (offices heating, directly as a fuel for dryers, CHPs). 4 of the audited plants are very near or even above the good combined energy value of 4.5 kWh, while the WWTP with the highest value (5.1 kWh) converts some of the biogas to heat directly for the dryers and uses only half of the produced biogas directly in CHP. The other two highest values around 4.8 kWh are both WWTPs with new and very efficient CHPs, which leads to high total energy production values using only cogeneration.

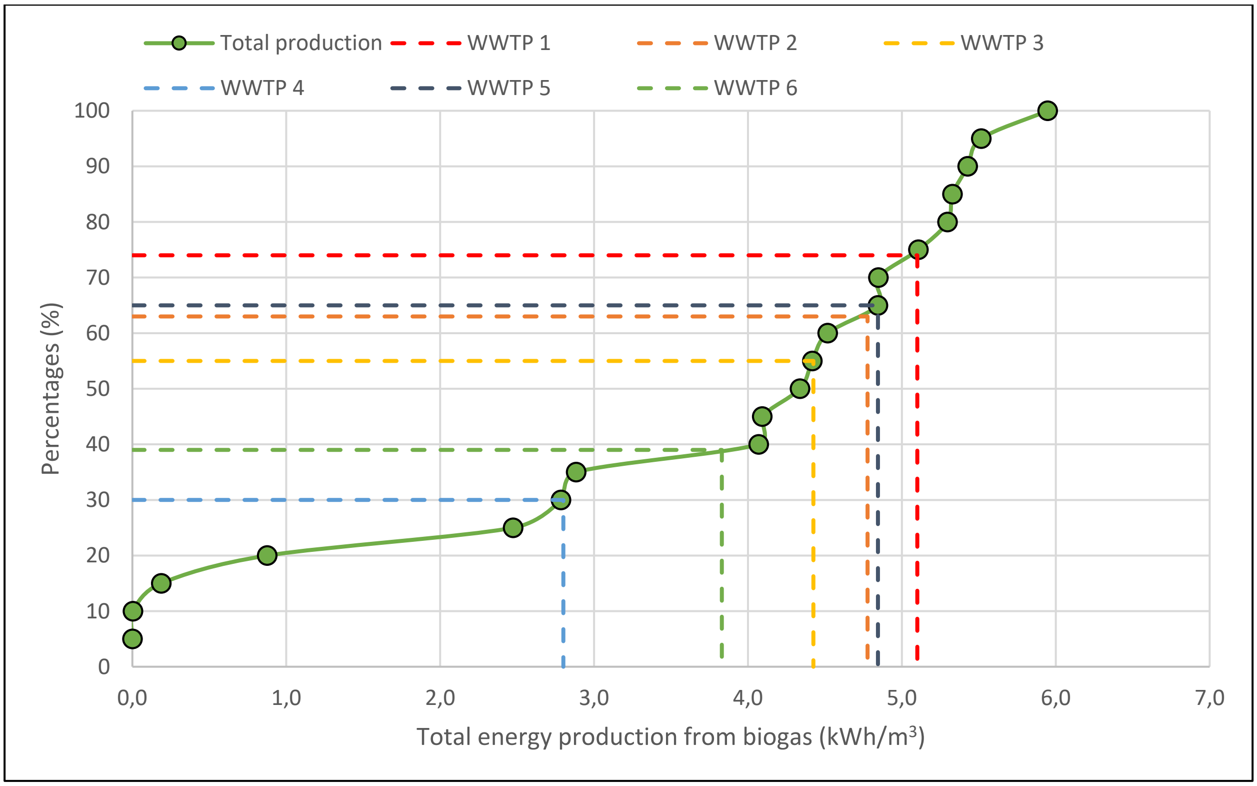

Figure 5 - Total energy production *(sum of heat and electricity production) per m^3 biogas produced with anaerobic digestion (6 WWTPs with anaerobic digestion shown), background data from collected key figure data for sludge benchmark from the Baltic Sea Region*

Two WWTPs with lower energy production values both had either a start-up of new technology during the audited year (use of biogas changed) or problems with the CHP. Therefore, their results might not completely represent the achievable energy production potential in the WWTP and are expected to be higher in the following years.

With high energy production values, the WWTPs could achieve energy neutrality with the inclusion of additional substrates to the anaerobic digestion, as the CHP capacity is not usually a limiting factor for the WWTPs. Higher biogas yield directly translates to more energy produced while the estimated cost of treatment/production per m3 of biogas produced should decrease for WWTPs with extra available treatment volume in digester.

2. SMART SLUDGE MANAGEMENT AUDIT SPECIFIC RESULTS AND HIGHLIGHTS

2.1 Pomorzany WWTP in Szczecin, Poland

Pomorzany WWTP in Szczecin is a large treatment plant with a population equivalent (PECOD,120; calculated based in inflow chemical oxygen demand (COD) load) of 428 000. Pomorzany was the first WWTP audited with the student group and as a new construction served as an excellent basis on understanding the energy and sludge treatment processes, main influencers and good operation in general.

The sludge treatment in Pomorzany WWTP was advanced, consisting of three main treatment steps – anaerobic digestion, drying and incineration. In the sludge audit, thickening, dewatering and biogas utilization were also looked at with mostly great results on all categories.

One of the main shortcomings identified was the biogas production by inflow PE value – comparing how much biogas the WWTP produces based on the amount of people it services. As the WWTP didn't receive any additional organic substrates into the digester, it was only compared to similar WWTPs in the region. While the average biogas production per PE in the region in plants without external substrate addition was 20 L PE-1 d-1, Pomorzany WWTP had the one of the lowest results recorded of 13.5 L PE-1 d-1. When looking in-depth into the reasons, it was apparent that the inflow characteristics should not be the main cause, as the average annual influent biological oxygen demand (BOD5) concentration was 390 mg L-1 (around 64th percentile from benchmark) and average annual suspended solids (SS) concentration was 315 mg L-1 (around 44th percentile). Looking further we saw that the reason could be the total volume of digesters – when the average 50% of WWTPs in the region have the total digester volume of 28-55 m3 per 1000 PE, Pomorzany WWTP had a total volume of 23.7 m3 per 1000 PE.

As the existing 2 digesters in Pomorzany are almost fully loaded, the overall wastewater treatment system is operated with that as a possible bottleneck. One of the main recommendations from the sludge audit was to consider building a 3rd digester, which would also allow for more primary sedimentation (longer sedimentation period and therefore more primary sludge), accepting of other organic and biodegradable waste (flotation fat etc) and more overall biogas produced. As the CHP is not used on full load and total energy production values were one of the highest recorded in both benchmarks and audits the WWTP has very good potential to generate even more energy in the future.

2.2 Zdroje WWTP in Szczecin, Poland

Zdroje WWTP in the second WWTP in Szczecin, servicing the other side of the river from Pomorzany. Zdroje WWTP is smaller than Pomorzany with the PECOD,120 value of 137 000. While Pomorzany is a new WWTP built in 2009, Zdroje is an older WWTP, which has been renovated. As Pomorzany, Zdroje WWTP is operated well and the average audit results were very good. Zdroje WWTP had two main stages for sludge treatment – anaerobic digestion and drying. The biogas produced is mainly used for heating the sludge in dryers, which showed very high efficiency – together with partial cogeneration, Zdroje achieved a total energy production of 5.1 kWh per m3.

The main points of improvement were generally similar as well – Zdroje also had a low total digester volume (27.4 m3 per 1000 PE), which also resulted in lower biogas production per treated PE (18.1 L PE-1 d-1). Compared to the similar results in Pomorzany WWTP, Zdroje had much higher influent concentrations (BOD5 681 mg L-1 and SS 409 mg L-1), which explains why higher biogas production was achieved. Conveniently, there already exists a second digester in Zdroje WWTP, which is out of order at the moment awaiting renovation – one of the main recommendations here as well was to take it into use, as the WWTP had high overall potential for energy production.

Another smaller deviation from average in Zdroje concerned the sludge age in biological treatment. The average and recommended sludge age is around 15 days – making sure nitrogen removal works well while still having more easily degradable organics in the sludge. Keeping the sludge age higher is a very common practice in smaller WWTPs, especially in the colder climates, as it makes biological nitrogen removal safer even when temperatures drop under 12 °C. In Zdroje WWTP, the calculated simple sludge age was about 37.6 days, which based on ATV-DVWK-A 131E standard calculations could mean around 15% lower secondary sludge production. While lower amounts of secondary sludge can sound good for most plants, this 15% of reduction comes from easily degradable organics in the secondary sludge and indicates a large biogas potential, which is lost in the biological step.

Based on the results of the smart sludge management audit, it was recommended to look into the possibility of improving the biological treatment step (higher primary sedimentation time, lower secondary sludge age) and renovation of the second digester.

2.3 Wschod WWTP in Gdansk, Poland

Wschod WWTP is the largest audited treatment plant (874 000 PECOD,120), situated in Gdansk. In the IWAMA project, Wschod WWTP was supposed to be a part of only the energy auditing, as the sludge treatment in the WWTP is operated by a private company, but thanks to a very good reception at the site, a partial smart sludge audit was still completed. Wschod WWTP has advanced sludge treatment, consisting of three steps – anaerobic treatment, drying and incineration. The overall results of the WWTP were outstanding almost all viewed parameters showing good operation.

A highlight of the smart sludge audit completed in Wschod would be the electricity produced during cogeneration from the biogas – around 2.5 kWh of electricity was produced (2.3 kWh of heat) per m3 of biogas, exceeding the median 1.59 kWh m-3 in the region and 2 kWh m-3 of recommended value.

A minor point of interest found during the smart sludge audit would be the amount of heavy metals in the incineration ash – compared to kilograms of solid matter, both cadmium and mercury were a bit higher than average (2.1 and 1.4 mg kg-1 TS, respectively). It is difficult to compare these results with sludge recommendations, as total solids in ash are not well comparable with treated sludge (organics are incinerated and the heavy metals are concentrated). At the same time, the ash has very high phosphorus content (165 g of phosphorus in 1 kg of ash) and comparing heavy metal concentrations per kilogram of phosphorus, the heavy metal content is rather low. This incineration ash is deemed a very potent source for phosphoric fertilizer manufacturing, which the Wschod WWTP is already working on.

As with previous WWTPs, another recommendation of the audit was to accept more organic and biodegradable waste to the digester and to look into increasing the amount of primary sludge produced (longer sedimentation time, chemical dosing) in order to increase the amount of biogas produced as the digester still had free capacity to be used. During our communication with the operators we found out that extra source of organics is a problem in the region, while tests are being run to recover more organics from the primary sedimentation.

2.4 Grevesmühlen WWTP in Germany

Grevesmühlen WWTP is a very curious case – the treatment plant itself is small (34 000 PECOD,120), while the plant accepts a large amount of biodegradables and external sludge from the region. In many of the categories, Grevesmühlen WWTP is an outlier, especially concerning biogas and energy production. Grevesmühlen WWTP is an energy neutral or even energy positive WWTP, which means more energy is produced via anaerobic digestion and subsequent cogeneration than the whole WWTP uses. Anaerobic treatment is the only main sludge treatment process used, after which sludge is stabilized enough for direct usage.

As Grevesmühlen is an energy neutral WWTP, it was very interesting to see how WWTPs with very high synergy with the whole local region can be operated. We have previously looked at biogas production per WWTP PE, where the median value of all WWTPs, regardless of whether they accept external substrates or not, is around 25 L PE-1 d-1. Grevesmühlen WWTP in comparison achieved the highest value in both the figure data collection and smart sludge audit – with a value of 132 L PE-1 d-1. Due to the high share of organic biodegradable waste the biogas production per TS loaded into the digester was highest as well – around 0.5 m3 per kilogram of loaded TS per day (median value of 0.32 m3 kg-1 TS d-1).

As with all energy conscious WWTPs, Grevesmühlen WWTP also has a very good CHP with a higher than average electricity production efficiency. Around 2.6 kWh of electricity (1.85 kWh of heat) was produced per m3 biogas, similarly to Wschod WWTP exceeding both the regional median and the recommended value.

In terms of sludge usage, for the audited year the treated sludge was fully used in agriculture, both routine analyses and samples collected during audit visit showed no issues with heavy metal concentrations, which were significantly lower than required in the EU and even lower than the recommended limits discussed by HELCOM. No issues with the treated sludge quality was found within the smart sludge audit.

For an exceptional case as Grevesmühlen, the smart sludge audit had nothing important to recommend. The minor problems in the audit came from small gaps in data provided from the plant, while technical issues like that don't influence the operation and practices in the WWTP itself. Grevesmühlen WWTP is a very interesting and exemplary case with practices that are worth disseminating in the whole BSR region.

2.5 Kaunas WWTP in Lithuania

Kaunas WWTP is one of the largest municipal WWTPs in Lithuania with the size of around 305 000 PECOD,120. The sludge treatment in Kaunas consists of two main treatment steps – anaerobic digestion and drying. As dryers were just put into operation at the end of 2015 and not working fully on 2016, the smart sludge management audit had some parameters that couldn't be evaluated as precisely as with other WWTPs.

One of the highlights of the smart sludge management audit included high biogas production, both by PE (27.55 L PE-1 d-1) and per loaded TS (0.43 m3 kg-1 TS d-1). This is due to the WWTP accepting additional substrates – such as flotation fat and oil – increasing the easily degradable organic content going into digesters. Regretfully the total energy production couldn't be evaluated due to the fact that not all biogas going into either CHP for cogeneration or to the starting and testing of the drying was measured.

The Kaunas WWTP has some older equipment and infrastructure, which was not currently used, such as centrifuges and double the number of digesters and digested sludge silos used. This would make it possible for the treatment plant to substantially increase the amount of biodegradables and external sludge accepted, as investments to increase the size of the treatment should be significantly lower. The possibility is pointed out by the audit but may be difficult the realize as comprehensive synergy in the region is difficult to achieve.

During the audited period, the treated sludge samples showed high cadmium, chromium and mercury concentrations, which regarding the newer recommendations make it unable to be used as a direct fertilizer in agriculture. This is the result of Kaunas accepting around 30% of inflow water volume from various industrial wastewater sources. Due to that problem, the treated sludge was mainly accumulated in the WWTP. With newer analysis this problem is now solved, while the heavy metal concentrations are still higher than median values for the region, the sludge is suitable for usage in recultivation and greenery. Still one of the recommendations from the smart sludge management audit was to conclude heavy metal source tracking in for the WWTP influent, to identify largest point sources of heavy metal pollution. Once the sources are known, pre-treatment requirements or separate systems could be established to lower the concentration of heavy metals coming into the treatment plant.

2.6 Daugavpils WWTP in Latvia

Daugavpils WWTP is a medium size WWTP with around 95 000 PECOD,120 with external sludge treatment by a nearby company (anaerobic digestion). While some data was collected for the smart sludge management audit, no major evaluations were possible due to the lack of on-site treatment.

During the audit process, some highlights were found – as sludge is digested by another company, the sludge age and biogas potential are not used as important factors in the operating process. This is mainly due to the lack of returning information from the digesting company, as no constant evaluation is given on the quality of sludge. While the practice of having external sludge treatment/digesting companies is quite common in the region, this might be a good example on how external treatment might influence the amount of biogas produced from the sludge. To attain the maximal possible biogas potential in the sludge, communication needs to be very strong between two companies.

One recommendation given within the smart sludge management audit was to investigate the possibility of establishing on-site digestion and further sludge treatment. This is a large matter of investment and as the weighing of specific pros and cons was outside the scope of the audit process, the evaluation of financial feasibility should be conducted as a separate study.

2.7 Sloka WWTP in Jurmala, Latvia

Sloka WWTP in Jurmala, just outside of Riga is a small WWTP with about 28 000 PECOD,120. The WWTP mainly has large seasonal dependencies as Jurmala is a popular holiday resort, bringing considerable increases of wastewater generated in those periods. The smart sludge management audit could not be applied fully in Sloka WWTP, as no sludge treatment was done during the audit period. The dewatered sludge in the WWTP was transported to a landfill and establishing proper sludge treatment technology in Sloka WWTP was one of the investments done during the IWAMA project. Regretfully, the investment was just completed and first operational tests done during the end of the project, which made re-auditing the WWTP after the investment impossible.

Some smaller highlights from the partial sludge audit showed very diluted wastewater (average annual BOD5 of 236 mg L-1, COD of 493 mg L-1), while surprisingly the cadmium concentrations in the untreated sludge were a bit higher than median (1.2 mg L-1 in Sloka WWTP compared to the regional median of 0.82 mg L-1). This is especially surprising, as no industrial wastewater is accepted and background pollution from municipal sources is usually lower.

2.8 Tartu WWTP in Estonia

Tartu WWTP is the second largest municipal WWTP in Estonia with the size of 119 000 PECOD,120. The sludge treatment in Tartu consists of two main steps – anaerobic digestion and post-stabilisation in windrows (composting). The influent wastewater in Tartu WWTP is quite diluted (average annual BOD5 of 167 mg L-1 and COD of 520 mg L-1), being on the lowest 10th percentile compared to other WWTPs in the Baltic Sea Region. A separate stormwater collection system has been built during the last years after the audit, which will hopefully at least partially solve this issue.

Due to diluted inflow and quite cold temperatures during the winter period, the calculated simple sludge age in Tartu is quite high, around 34.5 days. This results in around 10% lower secondary sludge production, which as previously explained also results in a lower biogas potential. That can be seen when looking at biogas production as well – while biogas production per loaded TS is very high (around 0.4 m3 kg-1 TS d-1), the biogas production per PE is under the regional median (22.3 L PE-1 d-1 achieved with the median value for WWTPs accepting external substrates around 33 L PE-1 d-1). In discussion with the operators we found out that since the audited year of 2016 the amount of external biodegradable substrates accepted has increased substantially, therefore higher production is estimated for the current year.

When evaluating the total energy production Tartu WWTP perform close to the median values of the region, with electricity production of 1.53 kWh per m3 of biogas and heat production of 2.3 kWh per m3. While both of these values are near the regional average, the electricity production is around 25% lower than would be optimal with a newer CHP. This might also be a measurement error, so it was recommended as a result of the smart sludge management audit to check these values further to determine the possible bottleneck.

One of the main highlights of the concluded sludge audit was the quality of the treated sludge in Tartu. In both our own samples and regular samples the WWTP tests themselves, no significant issues with heavy metals have been detected – all heavy metal concentrations are under recommended values for even agricultural use. In the year of 2016 most of the treated sludge compost was used in agriculture, which as a direct way to reuse phosphorus and nitrogen is supported as long as the sludge doesn't pose any dangers to the environment (pathogens, heavy metals etc). The sludge compost in Tartu was also tested for pathogens and pharmaceuticals (ciprofloxacin (CIP), norfloxacin (NOR), ofloxacin (OFL), sulfadimethoxine (SDM) and sulfamethoxazole (SMX)), neither of which found any problematic results. Beforementioned pharmaceutical components were also tested in untreated sludge, showing significant reduction during anaerobic digestion (93% of reduction of SDM as highest, around 73% reduction for SMX, NOR and CIP). The only pharmaceutical residue with low degradation during digestion was OFL the concentration of which decreased around 33%. As all the concentrations were low compared to data collected from other samples (for example OFL concentrations around 20th percentile of collected results), these concentrations should not pose potential risk to the environment.

2.9 Türi WWTP in Estonia

Türi WWTP is a very small Estonian WWTP, with the PEBOD5 around 4800. The PECOD,120 couldn't be calculated unfortunately as the WWTP isn't required to measure influent COD concentrations. Similarly, many other parameters vital to the smart sludge management audit were not unfortunately measured at a WWTP with that low size. For that reason, the sludge audit couldn't be completed fully in the WWTP.

In Türi WWTP the secondary sludge is first thickened and dewatered, after which the humification process is applied. One of the main investments in the scope of the IWAMA project was the construction of humification fields to Türi and Oisu WWTPs, on which the process can be performed. Unfortunately, the investment in Türi WWTP was completed after the smart sludge management audit, therefore only preliminary results of the pilot humification field could be considered.

One of the results of the sludge audit in Türi WWTP was the concentration of heavy metals in the sludge humified for 3 years. Although no industrial wastewater is accepted as inflow, both the untreated sludge and humified sludge had elevated concentrations of cadmium, with untreated sludge having around 2 mg per kilogram TS of cadmium and humified sludge 1.05 mg kg-1 TS. As for Kaunas WWTP, cadmium source tracking was recommended in order to decrease the cadmium concentration under 1 mg kg -1 TS as recommended for agricultural use. Other heavy metal concentrations were all lower than the regional median values, corresponding to usual municipal background pollution levels.

CONCLUSIONS

The smart sludge management audit concept and self-auditing tool was developed within the IWAMA project with the help of 9 partner WWTPs. The audit data collection was proven to be easily done without very specific knowledge of processes, which means the self-auditing should pose no problem for WWTP operators to do themselves.

The main things evaluated in the audit concept were thickening and dewatering efficiency, biogas and subsequent energy production and treated sludge quality. Via appraising the data collected in these categories, primary evaluations regarding the operation of the WWTPs were done, highlighting some possible bottlenecks of treatment or showing possibilities of feasible changes within operation. One of the main conclusions seen as a result of the audit is the feasibility of interregional cooperation between different industries and the local WWTP – accepting biodegradables to the anaerobic digestion increased the amount of biogas considerably, to the point of making energy-neutral wastewater treatment plant model possible. At the same time, accepting industrial waste and wastewater might increase the concentrations of heavy metals or other pollutants in the sludge, which should be closely monitored. This is especially important to the WWTP who reach the agriculturally usable treated sludge quality as lower concentrations of pollutants in the sludge enable the direct use of phosphorus and nitrogen in the treated sludge. The extra heavy metals or pharmaceuticals in the sludge pose a smaller danger for WWTPs using incineration as the sludge is not directly used as a fertilizer. Phosphorus recovery from the incineration ash is very topical at the moment, with more and more novel technologies developed, therefore all WWTPs with incineration as the final sludge treatment step should consider the option.

WWW.IWAMA.EU

IWAMA project aims at improving wastewater management in the Baltic Sea Region by developing the capacity of the wastewater treatment operators and implementing pilot investments to increase the energy efficiency and advance the sludge handling.

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