MODERN BELT DRYING OF SLUDGE –

INNOVATIVE SLUDGE AND ENERGY MANAGEMENT

Heindl, A., Ostermann, S, Dürr, J
HUBER SE Waste Water Technology, Berching, Germany
Corresponding Author Tel. 0049 151 576 576 45 Email. hal@huber.de

Abstract

Belt Drying is an important step for further thermal processing of sewage sludge. It has the advantage of using exhaust energy at rather low temperature levels and from different sources, continuous drying to a defined final dry substance content and safe operation. Sludge has to be pre-processed either by extruding or by back mixing to create surfaces for sufficient heat and mass transfer and to promote even and effective drying. When sludge from external sources has to be dried a sludge management and an intelligent moisture control is essential for a successful belt drying process. Thus dryer capacity can be fully exploited in all operation conditions and undisturbed operation can be assured. The presentation is finished by a calculation of the specific energy demand of a waste water treatment plant with digester and belt drying, expressed in kWh / inhabitant and year.

Keywords

Belt drying of sewage sludge, sludge management, control of dry substance content, specific energy demand of a waste water treatment plant with anaerobic digestion and integrated belt drying

Advantages of Belt Drying

In general belt drying of sewage sludge has the following advantages:

- Constant output dry substance content and even drying,
- Highly automated continuous process with easy operation,
- Possible use of cheap, low temperature (waste) energy in the temperature range of usually 70 - 150°C,
- Operating with different temperature levels from different sources possible,
- Low footprint for a given water evaporation,
- Safe operation due to limited temperature in dryer,
- Low wear,
- Low amount of maintenance and cleaning work,
- Low specific electric and thermal energy demand.

Figure 1: Modern HUBER belt dryer in Lithuania with screw press for dewatering [HUBER SE 2012-2015]

Fig. 1 shows a HUBER belt dryer in Lithuania. In 2016 the waste water treatment plant of Meary Veg on the Isle of Man will install a HUBER belt dryer.

Pre-Processing of dewatered sludge: Extruding or back mixing

According to our experience 9 of 10 sludge cakes are suitable for extruding. These strains form an air-permeable bed and result in even drying and very lost dust generation. Fig. 2 shows an extruder to form endless sludge strains at dryer feeding.
Other sludge can be processes by back-transferring a portion of dried sludge and mixing with dewatered sludge to a dry substance content of more than 60%. The feeding is done by a distributing screw conveyor. This process has a high flexibility but leads to a higher dust formation in the dryer.

Figure 2: Extruder for dewatered sludge at dryer feeding [HUBER SE 2012-2015]

Extruding of sewage sludge prior belt drying [HUBER SE 2012-2015]

Sludge Management and Intelligent Moisture Control

Throughout the year the dry substance content of dewatered sludge alternates (summer/winter sludge). Some sludge drying plants handle additionally sludge from other sources. Therefore there is a bigger range of the dry substance content of sludge being fed to the dryer. As a consequence the dryer has to be able to compensate these fluctuations without exceeding the admissible dry substance content of dried sludge and with keeping the dryer always at its maximum water evaporation capacity. The solutions of these problems could be:
For a smaller range of different sludge: a sludge management including separated storing of dewatered sludge and controlled mixing of sludge before dryer is fed
Using an intelligent moisture control (IMC) by measuring feeding ds-content to compensate a dry substance - change of up to 5% per hour to get a sturdy operation at designed water evaporation. This is HUBER SE´s own development, HUBER SE has applied for a patent. Fig. 3 pictures the dry substance measuring probe at feeding point of belt dryer.

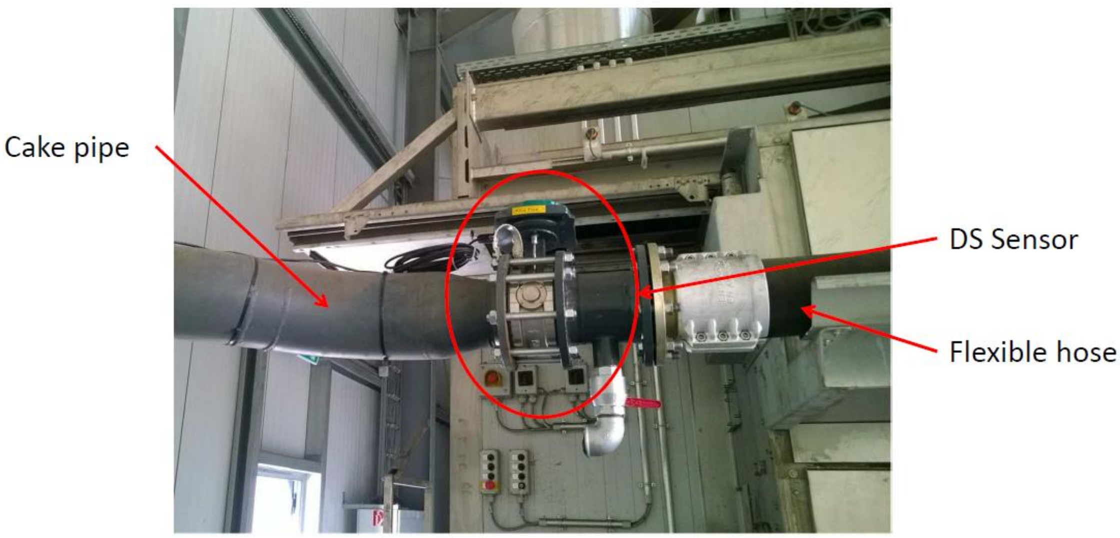
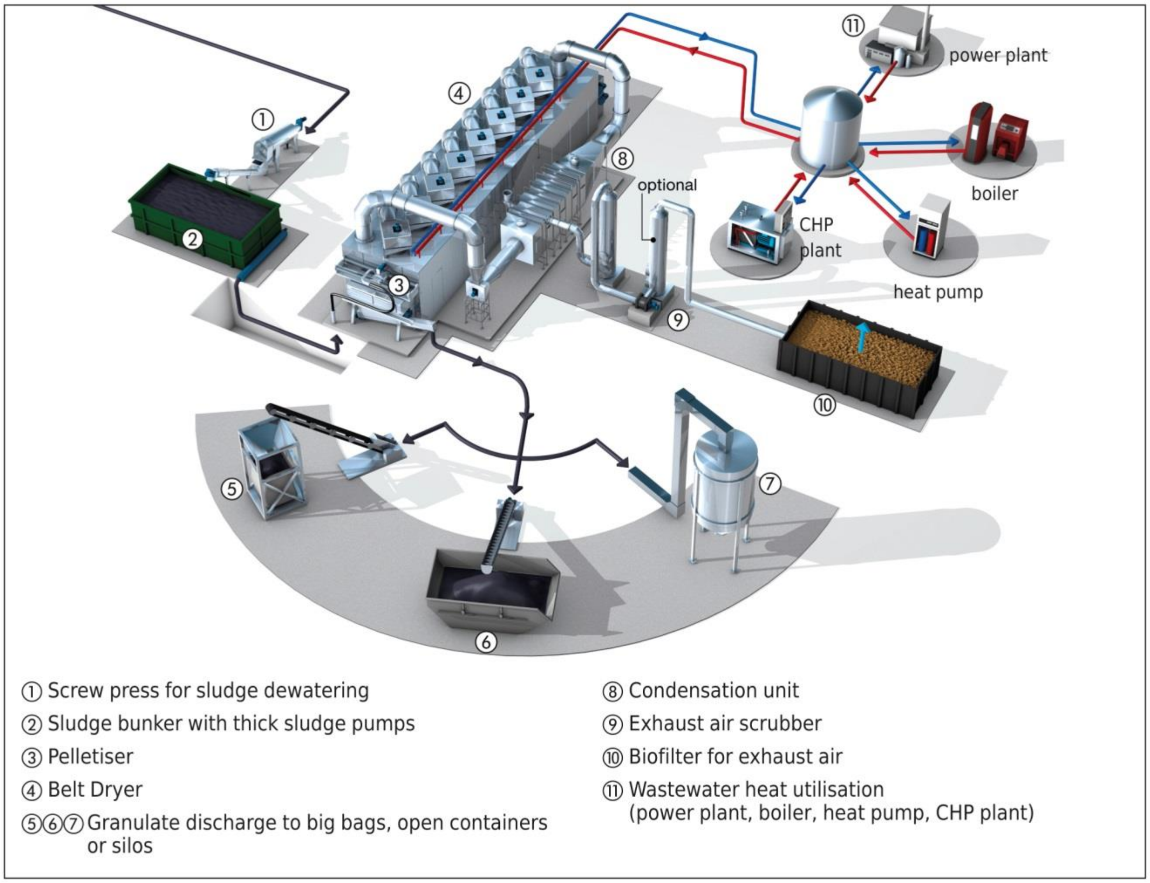


Figure 3: Measuring probe for dry substance of sludge at feeding point of belt dryer [HUBER SE 2012-2015]

Energy Sources and Management

Economics of thermal sludge drying is mainly influenced by costs of thermal energy. Waste energy on site or from nearby thermal plants are to be used preferably. Energy of condensing line of belt dryer can be used twice (60-65% of energy used for drying at lower temperature level) for sludge and digester heating. Of course it has to be considered that the lower the temperature level the larger will be the dryer at a given water evaporation thus rising investment costs. On the other hand only the belt dryer is capable of using temperature levels of waste energy below 150°C efficiently. Fig. 4 shows a complete belt drying line.



Our drying solutions are designed to meet specific customer requirements. HUBER Belt Dryers use various waste heat sources and are therefore ideal to be integrated into existing systems.

Figure 4: Belt Drying line with extruder, energy supply, exhaust air treatment, feeding of dewatered sludge and storing of dried sludge [HUBER SE 2012-2015]

Different (waste) energy sources have different temperature levels:

- Engine coolant of CHPs: flow 80-90°C / return 70°C
- Engine coolant of CHPs with succeeding heat exchange from flue gas of gas engine: flow 100-105°C / return 70°C with specially adapted heat exchangers
- Flue gas of micro-gas-turbines with internal heat recovery: 270-300°C
- Flue gas of gas turbines: 400-500°C
- Flue gas of gas engines: 450-480°C, minimum flue gas temperature after heat exchange approx. 150°C for avoiding condensate generation
- Flue gas of diesel engines: 350-400°C, minimum flue gas temperature after heat exchange approx. 180°C for avoiding condensate generation
- Cooling air of cement clinker cooling: 200-250°C
- Condensate of condensing turbines: 60-65°C
- Steam of back pressure turbines with absolute pressure of 1,2 to 4 bar: 105–143°C in saturated condition
- Warm water from cooling element of Organic Rankine Cycle-processes with biomass boiler plants supplying local heating net: flow 90-100°C

- Coolant of belt dryer condensing line: flow 45-55°C / return 35-45°C

Specific Energy Demand for an inhabitant waste water treatment plant of 200.000 inhabitants with belt drying of sludge [DWA 2008], [DWA 2014], [DWA 2015]

This short calculations relates to the electric and thermal energy demand indicated for a waste water treatment plant in kWh/(Inhabitant*year). The average energy input via waste water to the plant is theoretically around 122 kWh/(IN*y) according to COD of waste water feed.

The following assumptions for energy made available by biogas of digester under the conditions in Germany / Central Europe. The calculations are made according to DWA standard assumptions.

Annotations: The „-“ means energy demand, the „+“ means energy gain. “IN” means inhabitant.

- Two stage digester, 20 days of digestion, 50 % reduction of organics in digester and production of transferred into biogas of 22,5 l_N/(I * d) with 64 Vol-% methane content
- Digested sludge approx. 35 g dry substance DS / (IN*d) with 57% organic DS
- DS content of dewatered sludge approx. 27%
- Dry substance production: 2,560 t / y
- Water evaporation: 6,640 t / y
- Operation time: 8,000 h / y
- Belt Drying to 90% DS at air temperature of 85°C by using of coolant energy of CHP
- Assumptions for energy generation from biogas by CHP with piston engines 35% electric efficiency and 55% thermal efficiency

The resulting energy available from CHPs is therefore:

- Electricity: +18.4 kWh_e/(IN*y)
- Thermal energy: +28.3 kWh_{th}/(IN*y)

The following assumptions for energy consumptions (average yearly values) of a waste water treatment plant can be made:

The specific energy demands for waste water treatments inclusive dewatering and heating of digester, sludge and buildings can be estimated to:

- -17.5 kWh_{th} / (IN*y) and -31.0 kWh_e /(IN*y);

From condensing line, energy can be recovered at a lower temperature level:

- + 16.9 kWh_{th} / (IN * y)

The specific energy demand for belt drying with condensing line is calculated by:

- 28.2 kWhth/(IN*y) and – 2.2 kWh_e/(IN*y)

The **average yearly energy balance** is:

- **Thermal: -0.5 kWh/IN*y). That means that the thermal energy is nearly balanced in Germany. In UK it should be balanced due to higher average temperatures of surroundings.**
- **Electric: -12.6 kWh/(IN*y)**

Result: There is still a lack of energy to be filled by exploiting energy value of dried sludge via incineration, pyrolysis or gasification or by using natural gas in combination with additional CHP or by increasing biogas production with additional co-substrates or with a combined digester-THP-process.

Conclusions

An intelligent sludge and energy management in belt drying is a must on the way to an energy-self-sufficient waste water treatment plant. The Belt drying of sludge is a necessary step for further thermal processing of sludge. Due to economic reasons using of waste energy from different sources has to be done in many cases. The double use of energy by sludge and digester heating with waste energy of belt dryer condensing line improves the thermal energy balance. The challenge is that claims for sturdy operation and with low specific energy demands in belt drying have to be balanced. The thermal energy demand of a waste water treatment plant inclusive belt drying and energy transfer from biogas can be nearly balanced for a well-run 200.000 Inhabitant unit. Supplying of missing electric energy amounts by further exploiting of energy bound in dried sludge can be carried out by incineration, gasification or pyrolysis or increasing of biogas production. However the practical efficiency of such a process at lower capacities has to be observed.

Sources

[DWA 2008] DWA Merkblatt M-383 „Kennwerte der Klärschlammentwässerung“, Hennef 2008 (Figures of sludge dewatering)

[DWA 2014] DWA Merkblatt M-368 „Biologische Stabilisierung von Klärschlämmen“, Hennef 2014 (Biological stabilization of sewage sludge)

[DWA 2015] DWA-Themenband „Anaerobe oder gemeinsame aerobe Stabilisierung bei Kläranlagen kleiner und mittlerer Größe“, Hennef 2015 (Anaerobic or common aerobic stabilization of waste water treatment plant of small and medium size)

[HUBER SE 2012-2015] Unterlagen der HUBER SE zur Klärschlammbandtrocknung (HUBER SE documents of belt drying of sewage sludge)

DWA: German Association for water management, wast water and waste, Hennef