THERMAL TREATMENT OF SLUDGE

P. Rottenmanner*

* Sales Director, Thermal Systems, Sludge, ANDRITZ Separation, Austria  
(E-mail: peter.rottenmanner@andritz.com)

Abstract

Transport and disposal of municipal sludge is causing a lot of costs and emissions – and space for disposal is getting more and more reduced. With dewatering and especially drying of municipal sludge the volume of sludge to be transported can be dramatically reduced. But not only volume reduction is done – also a valuable fuel - pathogen free, if dried properly - is produced. This fuel can be used for example in cement factories, but dried sludge (where allowed) can also be used as a fertilizer. Depending on available heat sources and final purpose of the sludge (after drying), different technologies can be used to dry the sludge. In the presentation these drying technologies will be presented as well as a way to minimize the use of primary energy for sludge drying by using biogas produced on the WWTP and/or waste heat (hot water, low pressure steam or exhaust air).

Keywords

Sludge Drying, energy source, granulate quality

Introduction:

Producers of sludge do not want to run into any risks related to disposal or final use of sludge. In addition, for both municipalities and also industrial companies the costs for transport of sludge as well as costs for disposal are significantly growing and permissions for new disposal areas are more and more difficult to get. Therefore a proper dewatering and thermal treatment of the sludge can lead to significant benefits for the operating company.

This article is introducing and concentrating on 4 different drying technologies as well as the possibilities, to use the necessary thermal energy for drying of the sludge in an efficient way. These 4 drying technologies (see Figure 1) are drum, fluidized bed, paddle and belt dryer.

Figure 1 – Drying technologies
These drying technologies convert the sewage sludge into a product which is free flowing, can safely be stored and easily transported – at the end of the drying process a product suitable for further use is available. All four introduced drying technologies ensure full drying of the sludge (to dry substance contents ≥ 90 %). Furthermore the final product is fulfilling EPA 503 Regulations for Class A requirements (concerning pathogen reduction).

**The right drying technology**

Some factors directly influence the decision for the most suitable drying equipment.

- Operating costs
- Product quality
- Available space
- Capital costs

The operating costs are a main factor to decide for the most suitable drying technology – and amongst those the energy costs are a significant portion of the sludge treatment costs. Therefore the use of waste energy or cheap energy is preferred compared to the use of costly primary energy.

In principle you have to differentiate between direct and indirect heated dryers (see Figure 2). For the belt dryer sometimes also a combination of those two heating systems makes sense – see below.

**Direct heated dryers use**

- Natural gas
- Biogas
- Diesel

**Indirect heated dryers use**

- Thermal oil
- Middle or low pressure steam
- Hot water
- Flue gases
- ...
Amongst the four mentioned drying technologies, drum dryers request the highest drying air temperature ($\geq 350^\circ\text{C}$), most drum dryer installations are directly heated with primary energy like natural gas or Biogas.

Fluidized bed and paddle dryers typically are indirectly heated drying systems powered by thermal oil or steam. The requested temperature level for fluidized bed dryers is between 130 – 250°C, whereas the paddle dryer requests temperatures of 170 – 230°C.

Belt dryers can use low temperature heat sources like low pressure steam, hot water or flue gases. Of course also primary energy can be used, but clearly the possibility of using low temperature heat sources is a main advantage of a belt drying installation. Typically the drying air temperature in the belt dryers is between 95 – 135°C – depending on the available heat sources. As the specific evaporation capacity per m² of belt is mainly defined by the drying air temperature, the knowledge about available heat source(s) is necessary already in the designing phase. In addition due to safety reasons the maximum allowed drying air temperature is defined by the sludge to be treated.

**Belt dryer direct and indirectly heated**

As mentioned before, the belt drying system is able to use both direct and indirect heat sources at once.

If the use of gas engine cooling water (to produce “green” electricity from Biogas - which is subsidized in many countries) is possible, this waste energy use can significantly reduce the necessary additional primary energy amount – see case study below.
Assuming a yearly dewatered sludge amount of 35,000 t (dewatered to 25 % dry substance content) and full drying (to ≥ 90 % dry substance content) of the sludge, the use of engine cooling water (figures depending on the type of gas engine used!) from a gas engine can reduce the necessary natural gas consumption by approx. 10 % and this energy is free of charge!

Theoretically in addition also the flue gases from the gas engine can be used as heat source, but the characteristic of the flue gases (dew point!) have to be respected during the designing phase.

Quality of produced dried sludge

Depending on the final use of the product, operators request specific particle size distributions. For example automatic fertilizer spreading machines request even particle size distribution (to avoid blockages), whereas for landfilling or composting the sizing of the final product is of minor importance.
Emissions caused by the drying systems

One of the characteristics of sewage sludge are the entrained odours, therefore the dryers are operated in a way, that no odorous air is extracted to the environment, the complete quantity of exhaust air has to be treated in the exhaust air treatment equipment. The design of the exhaust air treatment is depending on local regulations; the bandwidth of necessary equipment can be from (simple) Bio filter to RTO (Regenerative Thermal Oxidizer) and a lot in between.

The exhaust air volume to be treated differs from the drying technology in operation, for Fluid bed dryers and paddle dryers the amount of air to be treated is significantly smaller as for drum dryers, the highest exhaust air volume has to be treated when belt dryers are used.

Dryer sizes, applications

All four drying technologies provide a wide range of capacities and applications. The most significant key parameters are the hourly water evaporation capacity and the specific thermal and electrical energy consumption.

Belt dryer:
Typical water evaporation capacity from 500 – 10,000 kg per hour per drying line, the particle size distribution of the dried sludge can be influenced by additional equipment like crusher and sieve.

Drum Dryer
High capacity Dryers with water evaporation capacities from 4,000 – 12,000 kg per hour per drying line, the drum dryers also produce the most homogeneous product, perfectly usable as fertilizer.

Fluidized Bed Dryer
Water evaporation capacity from 1,000 – 11,000 kg per hour per drying line, the fluidized bed shows a high flexibility in case different sludge properties have to be treated.

Paddle Dryer
Water evaporation capacity from 500 – 4,000 kg per hour per drying line, the paddle dryers are compact in design and enables besides full drying partial drying of sludge (dry substance content from 70 – 90 %).
Final use of dried sludge

Some of the possibilities (incineration in a cement kiln, landfilling as well as use as fertilizer) for the final use of dried sludge are shown in Figure 5.

Figure 5 – Sample pictures of dried sludge

Conclusion

Thermal Treatment of sludge enables the operator to convert waste to product, and the ANDRITZ Separation dryer portfolio ensures that the customers can choose the most suitable drying technology for their application. Significantly more than 100 references worldwide show the wide experience and know how. ANDRITZ is your Separation specialist able to propose complete range of thermal sludge drying equipment and the best solution considering project requirements.