General conditions for the use of disc dryers

Disc drying technology has proven itself over decades for the partial and full drying of sewage sludge. For an effective application of disc drying systems and the use of waste heat, certain basic conditions must be taken into account.

Figure 1: A disc dryer has been in operation at the Köhlbrandhöft sewage treatment plant in Hamburg for over 25 years

The basic concept of disc drying technology dates back to the 1960s, and was initially developed for drying fish meal. In the 1970s and 1980s, this contact drying system found a new area of application in the field of sewage sludge drying on large sewage treatment plants or fluidised bed mono-incineration plants. For more than 40 years, disc drying of sludge has proven itself in practice. Usual water evaporation capacities per unit are in the range of 2,000 to 6,000 kg/h.

Description of the dryer and its operation

The disc dryer consists of a heated rotor fitted with hollow discs, which rotates in a housing. It belongs to the category of indirect contact dryers. The material to be dried touches the heated discs, is heated up and dried. To increase performance, additionally the housing can be equipped with a heated double jacket. The heating media are usually saturated steam in the pressure range of 6 to 10 bar(a) and temperatures of 158 to 180 °C as well as thermal oil in the temperature range of 180 to 220 °C. For an effective utilisation of the contact heating surface, the use of saturated steam is advantageous compared to superheated steam. The pressure drop in steam pressure control should be kept as low as possible to maximise the effective pressure difference of the steam turbine for power generation.

The sludge is fed at one end of the dryer via a screw or a thick sludge pump and moves through the dryer. Due to the rotation of the discs, the sludge is mixed and transported further by conveying elements attached to the disc peripheries. The dried sludge is discharged via a screw mounted at right angles to the discharge end of the dryer. Fixed scrapers are mounted between the discs, which

prevent the sludge from sticking to the discs. The rotor speed ranges from 8 to 11 revolutions per minute depending on the disc diameter. Figs. 2 and 3 show the view and the internal structure of a HUBER Disc Dryer RotaDry®.

The discs are usually made of stainless steel 1.4307 or, if there is a higher risk of corrosion, 1.4571. If increased wear and tear due to special sewage sludge contents such as sand or crystals of magnesium-ammonium-phosphate is to be expected, the discs can optionally be designed in duplex steel.

Field of application of the HUBER Disc Dryer RotaDry®

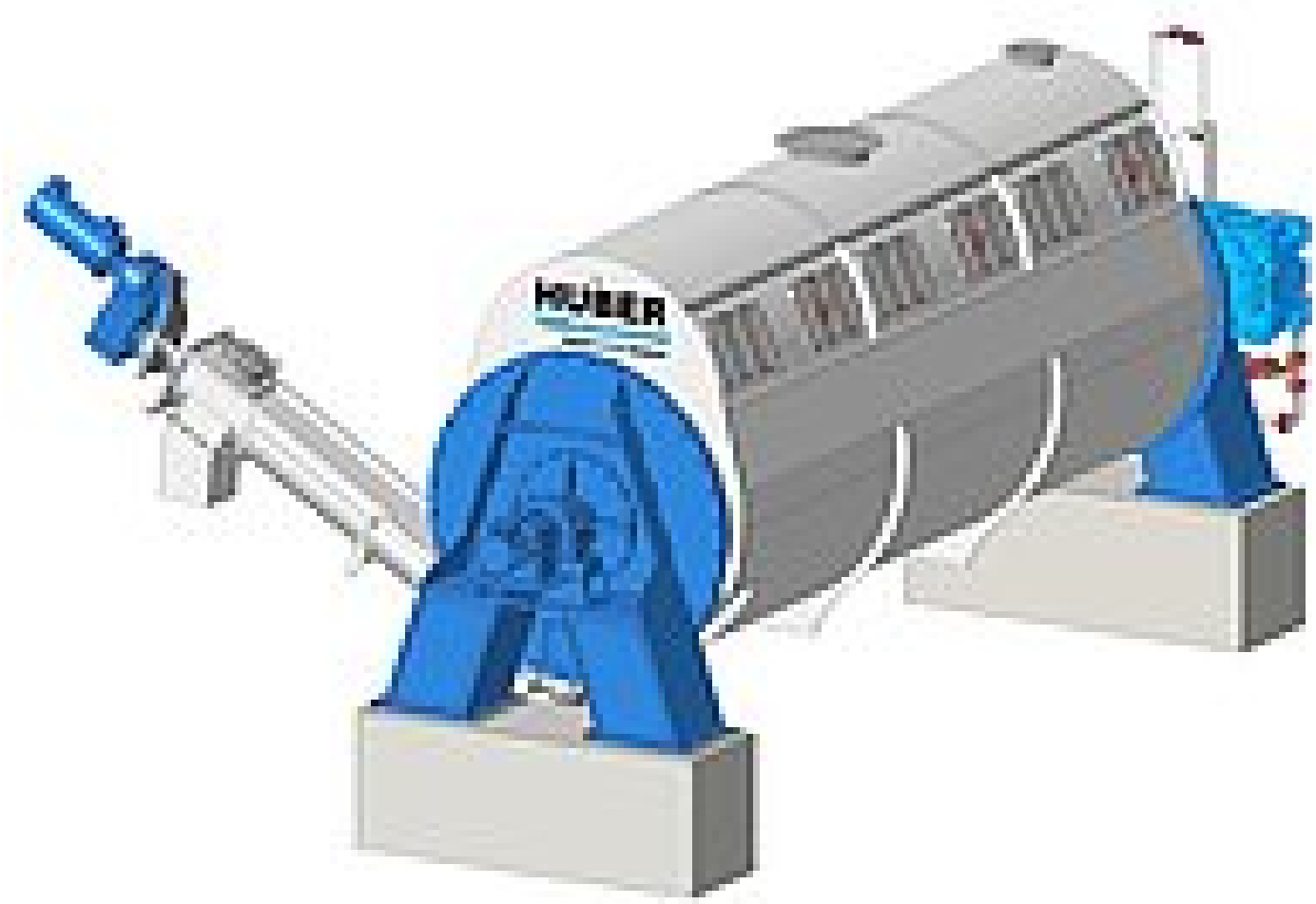

Figure 2: Schematic diagram of a HUBER Disc Dryer RotaDry® 2050

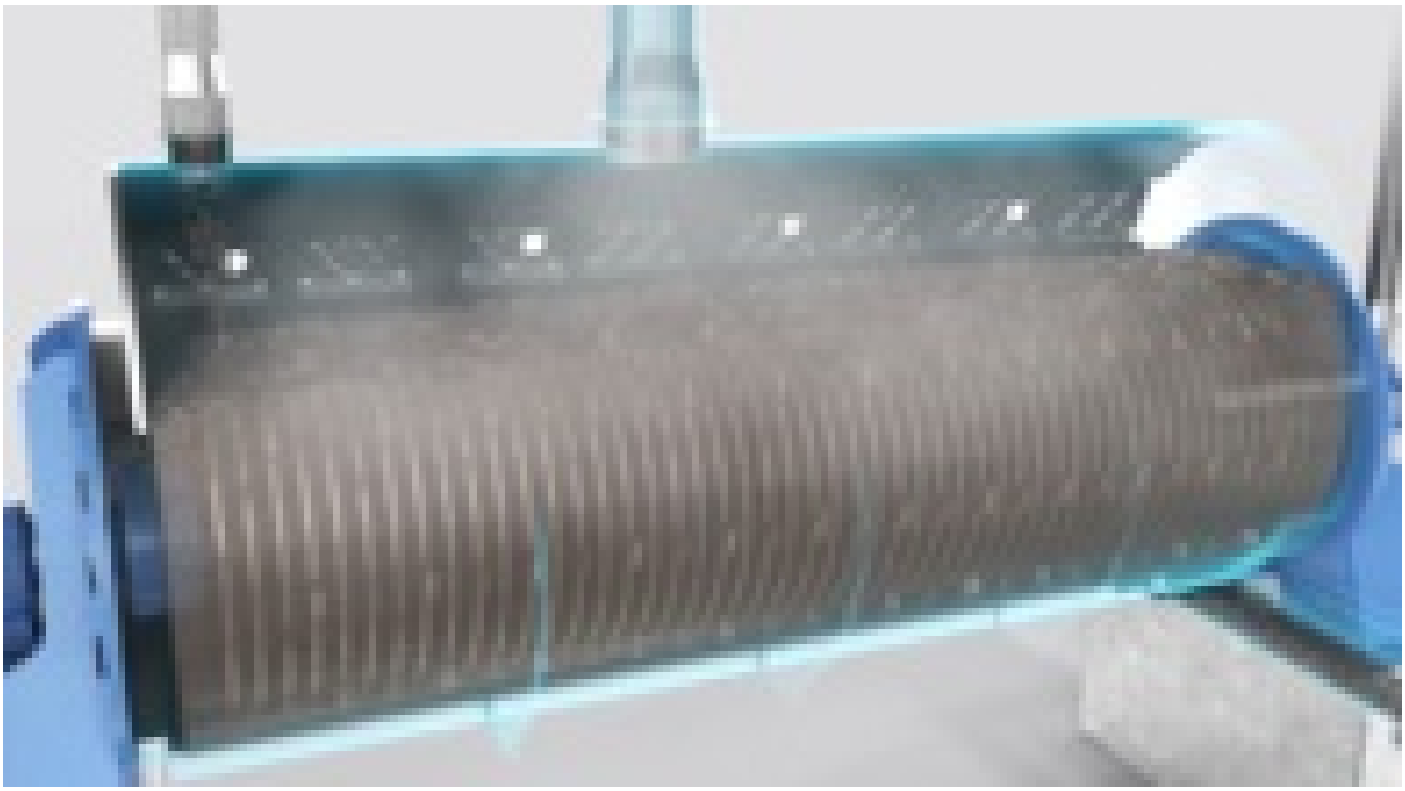

Figure 3: Cross section through the HUBER Disc Dryer RotaDry® during the partial drying of sludge

Partial drying

One of the main applications of the disc dryer is the partial drying of sewage sludge for a self-sustaining fluidised bed mono-incineration. In this process, the energy content of the partially dried sewage sludge must be adjusted to approximately 4,000 to 4,200 kJ/kg of original substance, whereby preheating of the combustion air is assumed. Depending on the type of sewage sludge and its degree of stabilisation, this means drying to a dry residue content (DR) of ~ 35 to 45%. In any case, the DR of the partially dried sewage sludge must remain below a critical dry residue level, which is characterised by the glue phase in a DR range of 40 to 60%. The sludge becomes sticky, pasty and difficult to convey. With low stabilised sludge the phase starts in the range of 40 to 45% DR, with well stabilised sludge the glue phase is only reached above a DR of 45 to 50%.

The partially dried sludge is then conveyed to the incinerator and shredded and fed into the fluidised bed of the incinerator via a throw-wheel feeder or steam lances. In mono-incineration plants, two disc dryers are usually used in parallel for redundancy reasons. In this case, each dryer is designed to handle about 50% of the total water evaporation volume. In extreme cases, however, one dryer must be capable of handling up to 70% of the total drying capacity even if the steam pressure increases, in order to maintain combustion in partial load operation. For redundancy reasons, each dryer is equipped with its own sludge feeding system.

As a result of the AbfallKlärV ordinance, which was passed at the end of 2017, more and more projects for partial drying and mono-incineration of sewage sludge are being planned and implemented. An economical operation with a corresponding size of the mono-incineration system can be more easily implemented through the delivery and acceptance of foreign sludge from the region. This has certain consequences for the operation of the plant.

On the one hand, the problem of foreign matter must be taken into account. Frequent transshipment processes during the sludge transport increase the risk that foreign matter such as stones, metal or wooden parts are mixed into the sludge and can possibly cause blockages or damage to the plant. If necessary, foreign matter separation in the form of a double-shaft roller separator or a screen for impurities must be provided in the sludge transport line.

On the other hand, dewatered sludge with widely varying dry residues and properties is delivered to the sites. When drying and incinerating on large sewage treatment plants with mainly own sludge, the sludge properties vary only to a limited extent between summer and winter operation. With a high proportion of foreign sludge, the operation of the sewage sludge mono-incineration plant is made considerably more difficult because the throughput of dewatered sludge must often be adjusted depending on the DR content of the sludge at the dryer inlet.

Each drying plant is designed for water evaporation capacity and not for sewage sludge throughput. A lower DR content of the dewatered sludge causes a reduction in throughput for the same water evaporation rate and vice versa. In this context it is advantageous for the operator to be able to rely on a DR measurement of the dewatered sludge and the partially dried sludge. In order to relieve the operating personnel, the throughput adjustment on the disc dryer should be fully automatic by means of a control system. This also improves the interaction with the downstream combustion, which requires partially dried sludge with a heating value that is as constant as possible for long-term stable operation.

The incineration of the partially dried sludge provides sufficient thermal energy in the form of steam for disc drying. From a thermal capacity of the incineration plant of around 3 MW, the use of a steam turbine for electricity generation can also become economical.

Full drying

In the 1990s, disc dryers for full drying to over 90% DR were installed at larger sewage treatment plants without their own incineration. In this case, however, part of the dried material must be mixed back into the dewatered sewage sludge to avoid passing through the critical glue phase in the dryer. This gives the mixed sludge a dry residue of 60 to 65% and it can be conveyed through the dryer without mechanical problems and dried in the usual way. Due to a lack of waste heat, however, primary energy in the form of oil or gas often has to be used for steam generation or for heating thermal oil. In the case of full drying, a dust separator must be connected between the dryer and the condensation stage, otherwise there is a risk of the condenser blocking and the condenser must be cleaned more frequently in any case.

Vapour condensation

The condensation of the vapours containing water vapour is carried out either directly by spraying vapour condensate or indirectly via a tube bundle heat exchanger. There is also the possibility of multi-stage condensation, in which, for example, thin sludge can be preheated in the first stage and used to increase the degree of dewatering of internal sludge. The second case of indirect heat exchange has the great advantage that waste heat can be used at a higher temperature level of up to 90 °C, e.g. for an external local heating supply.

The heat transfer during vapour condensation is significantly influenced by the leakage air portion in the vapours. The lower the leakage air mass flow, the more effective the condensation. The non-condensable parts of the vapour flow are generally used as secondary combustion air in partial drying with downstream fluidised bed combustion due to the high odour load.

The vapour condensate is polluted with ammonium and COD-bearing substances such as fats, white oils or organic acids and must be treated before indirect discharge to the sewerage system.

Summary

The HUBER Disc Dryer RotaDry® is a robust and compact dryer design with a high water evaporation capacity in relation to volume and footprint. It is ideally suited for the partial drying of sewage sludge and for the interaction with a fluidised bed mono-incineration plant.

Fully automated, it contributes to a relief of the operating personnel and an optimisation of the combustion of sewage sludge.

Effective disc drying supports sewage sludge mono-incineration. A high percentage of phosphorus can be recovered relatively easily from the ashes produced by acid hydroloysis. This is of great importance with regard to the future phosphorus recovery obligation for medium and large wastewater treatment plants.

Related Products:

- HUBER Disc Dryer RotaDry®

Related Solutions:

- HUBER Solutions for Sludge Drying

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