Is it Worthwhile to Measure the Sludge Level During Primary Treatment?

Using measurements of the sludge level and the dried solid content, the removal of primary sludge from the primary settlement tanks can be optimised to suit the hydraulic and weather-related conditions. Load-related removal facilitates more balanced charging of the digester and a more constant rate of gas production for downstream block-type thermal power stations (BTPS). If neither pre-thickeners nor mechanical pre-thickening are used, the volume of sludge can be significantly reduced. This is highly beneficial in terms of the savings in pump energy and in heat energy for the digestion process.

23 % reduction in volume of sludge through sludge level control

Function of the primary settlement tanks

In a conventional sewage treatment plant, the primary settlement tanks are a link between the biological and sludge treatment stages (*Fig. 1*). The primary settlement tanks are usually operated using two methods.

In the case of reduced operation with just a few primary settlement tanks, the aim is to shorten the time spent by the wastewater in the primary treatment stage. This means that there is a larger quantity of biodegradable carbon compounds available for the upstream denitrification.

In the case of sewage treatment plants with anaerobic digestion and utilisation of the digester gas for electricity generation, the trend is to maximise the number of primary settlement tanks in order to increase the retention of carbon compounds. These are then available for the production of digester gas.

The following explanation describes how the removal of primary sludge in a plant with a maximised number of primary settlement tanks can be adjusted to varying hydraulic and seasonal influences. This is achieved without static pre-thickeners or mechanical thickening methods.

Fig. 1: Link between biological treatment and sludge treatment – primary settlement tanks.

Federal Environment Agency

Increase in the energy efficiency of municipal sewage treatment plants

Heat balance

If the sewage sludge is not dried, the heat requirement derives mainly from the energy needed to heat the raw sludge for digestion (approx. 70 to 80 %) and from the heat radiation losses of the digester (approx. 10 to 20 %). The energy needed to heat the raw sludge depends largely on the necessary temperature rise and, above all, the volume of sludge. While the temperature rise can only be influenced to a very limited extent (e.g. by lowering the digester temperature in winter), the volume of sludge depends considerably on the degree of pre-thickening of the raw sludge.

The total solids content of the primary sludge can be reduced to about 5 % by static pre-thickening at the primary treatment stage.

[www.bundesumweltamt.de; Publikationen; Texts 11/08; Page 56 of 222]

Time-based control

If a sewage treatment plant has more than one primary settlement tank, the hydraulic distribution may be problematic. If the sludge is removed using only a time-based control programme, the sludge in one of the tanks either remains in the tank for too long (acidification) or is drawn off before it is sufficiently thickened. Another problem is that changes in the incoming sludge loads, e.g. as a result of a long period of dry weather, are registered too late.

Fig. 2 shows how the sludge level in the sludge hopper of a primary settlement tank rises as a result of the scraper operation and the variations in the incoming load. The level goes down again each time sludge is removed, but fluctuates widely during the course of the day. If the sludge level drops considerably, increasingly thin sludge is removed and an unnecessarily high volume of water is pumped into the digester.

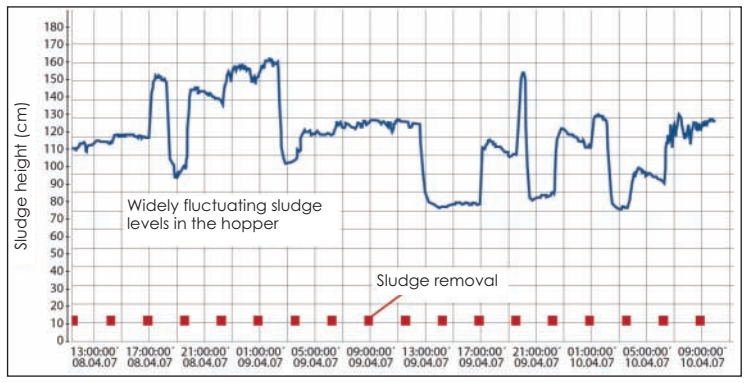

Fig. 2: Time-controlled primary sludge removal. When the level in the sludge hoppers is low, an unnecessarily large volume of water enters the digester.

Sludge level control

Measuring the sludge level in all the hoppers of the primary settlement tanks and removing the sludge automatically in line with the highest measured value results in all tanks having the same sludge level (*Fig. 3*). Primary settlement tank diagrams can then be used as a basis for determining whether the hoppers are full or whether they can accommodate more sludge.

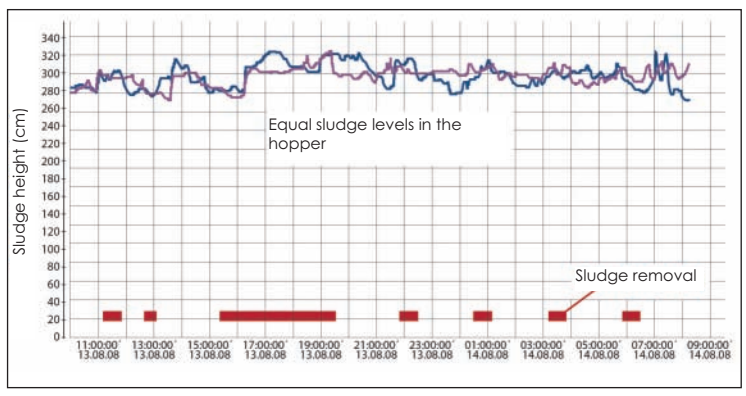

Fig. 3: The sludge level measurements ensure equal levels in the hoppers, constant rates of sludge removal, and constant rates of charging of the digesters.

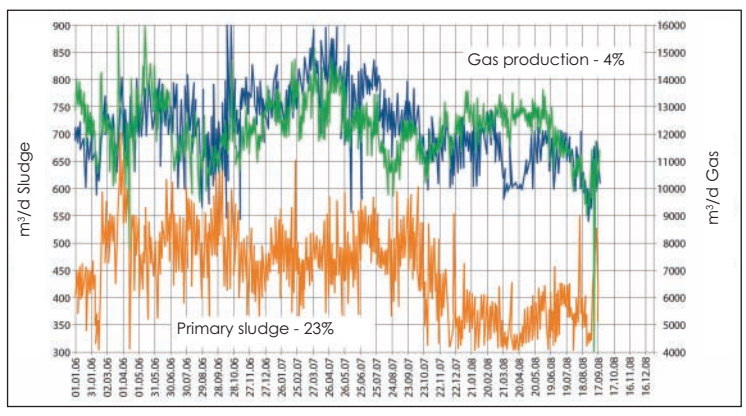

Fig. 4: There is virtually no change to either the dried solid content of the input to the digesters, or the digester gas production (blue line: primary + excess sludge)

With the help of an additional measurement of the dried solid content by a SOLITAX sc in the sludge removal line, the removed load can be calculated and adjusted to the actual inflow. Within limits, it is also possible (by utilising the storage volume of the hoppers) to even out the removed load. An increase in the dried solid content can even be achieved. If the storage in the primary treatment stage hoppers is

adjusted to downstream operations units, care must be taken that there is no impairment of the total digestion process.

In summer especially, the primary treatment stage must be monitored to ensure that there is no tendency to flotation.

Measuring the sludge level saves 100 kWh heat energy each day

Comparison

In the periods from 12.11.06 to 11.11.07 (time-switch-controlled removal) and 12.11.07 to 09.10.08 (sludge-level-controlled removal) there was

- a reduction of about 23 % in the primary sludge volume,
- an increase in the dried solid content of the primary sludge from about 5.1 % to about 6 % and
- almost no change in the production of digester gas (-4 %), see *Fig. 4*.

While the load remained constant, there was a significant decrease in the volume of removed sludge that has to be pumped to the dewatering facility. The heat energy required to heat the primary sludge to the digester temperature also fell by the same amount. If this heat energy is obtained directly from digester gas, the digester gas saved in this way can be utilised to generate additional electricity.

Conclusion

Yes, it is worthwhile to measure the sludge level during the primary treatment stage in Forchheim. Each day, 108 m^3 less primary sludge are removed from the four primary settlement tanks. The load remains the same, while the dried solid content was increased by almost 20 %.

As a result, the digesters use about 100 kWh less heat energy.

It is possible that the dewatering properties of the digested sludge are also improved.

Fig. 5: Simple installation thanks to variable fitting systems. The best measuring point depends on the hopper design and must be determined by carrying out comparative measurements.

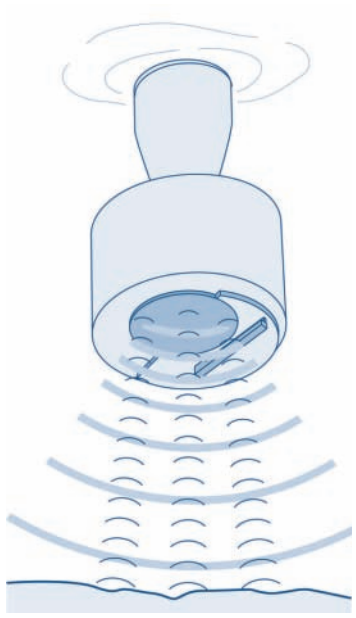

Fig. 6: The ultrasonic method and the mechanical wiper cleaning ensure reliable and stable measured values.

Literature

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