Manage your mass balance and biogas production with Metso TS total solids measurement

Our annual waste handling costs come to roughly one and half million euros – and that’s without transportation costs. When you manage to cut that down, we are soon talking about big savings.” – Jarmo Sundberg

Managing the mass balance became the solution for the capacity problems of Suomenoja wastewater treatment plant. The Metso TS total solids measurements based on microwave technology help to anticipate and optimize the progression of the process.

"Our biggest problem is without doubt the capacity of our sludge digestion,” says Jarmo Sundberg, the head operator of Espoo’s Suomenoja wastewater treatment plant for the Helsinki Region Environmental Service Authority, HSY.

The plant expanded beyond the original design load years ago. The waste water of over 300,000 inhabitants from Espoo, Kauniainen, Kirkkonummi and western Vantaa flow through the treatment plant. This population is growing, since all the municipalities are experiencing high levels of in-migration.

A new central treatment plant for the western metropolis region is being planned in Blominmäki, Espoo. It should be finished around 2020. However, ten years is a long time to wait
for the Suomenoja wastewater treatment plant. Basically they had two options: to increase the capacity of the plant either by expanding it or by making the process more efficient.

"The plant only has about ten years of active working time left, so large investments would not have been reasonable," Sundberg says. Such an investment would have meant a new sludge digestion to replace the two current ones. With all the equipment, it would have cost over a million euros.

They decided to make a smaller investment in the Suomenoja plant. This has called for mass balance management where the focus lies in five Metso TS total solids measurements, which are based on microwave technology. This exact and maintenance-free measurement method enables the optimization of total solids content in sludge through dewatering centrifuges and during the sludge digestion process in biogas plants.

Barely six months have passed and the investment has already recovered its costs.

The solids content of sludge digestion increased significantly

To put it simply, the process at Suomenoja progresses as follows: After chemical coagulation, the sludge is removed from the pre-treatment pools as mixed sludge. The sludge goes through pre-thickening. Then it is heated up and pumped into the sludge digestion. During the sludge digestion process, the sludge gives out biogas, which is then turned into electricity and heat. The remaining sludge is dried and then transported for composting.

Next we reach the sludge digestion building, where Metso TS measures the total solids content of the arriving sludge. By increasing the solids content, the efficiency of the sludge digestion process also increases.

"The results of this half-year monitoring period have been very promising. We have managed to increase the solids content by 10 percent compared to last year’s average, and, as far as I can see, we are able to gain another 10 percent, maybe more. This is a significant increase, both in terms of saving capacity and delay," says Sundberg.

With regard to the biological process, the delay is vital.

"At the moment, we are aiming for a delay of 12.5 days. The bacteria does not have time to do its work if we don’t have at least that much time. When the digestion process does not reach the end, the production of gas is disturbed. The increase in the solids content gives us valuable time," Sundberg explains.

Pre-thickening before the digestion process is made more efficient by using a small amount of polymer. However, before using it, it is important to know how much solids content is going through the pipes. In the past, this information was based on laboratory measurements carried out once a week. Now the continuous measurements enable changing the polymer dosage as required.
After this six-month monitoring period, Sundberg believes that the capacity of their plant will be sufficient for the next ten years.

**More gas, less costs**

From the sludge digestion building the biogas is transported to a heating center which is equipped with three heating boilers. The plant also has a gas generator that produces electricity and heat. Almost all of the treatment plant’s heat is produced with this biogas. If more heat is needed, it is produced with light fuel oil. In terms of electricity production, the Suomenoja treatment plant is around 40 percent self-sufficient.

"We produce roughly 3.5 million cubic meters of biogas annually. This investment has brought a growth of approximately 8 percent in six months. That is the equivalent of 125,000 liters of light fuel oil," Sundberg calculates.

At the same time, the heating costs of the plant are decreasing, since sludge digestion takes up most of the heating costs. In one day, 950 cubic meters of sludge is transported into the sludge digestion building, and is heated to an average of 15 degrees Celsius, depending on the season. When the total solids content of the sludge goes up, the volume goes down. Water is not heated unnecessarily.

"A rough calculation is that if we need 10 percent lower volume flow rate for the input of the mass, we need 10 percent less energy to heat it up," says Sundberg.

In practice, the solids content measurements have covered their costs simply with the increase in gas production. However, managing the mass balance of the whole plant is such a complicated process that it is difficult to calculate the benefits in financial terms. For example, it is difficult to find a monetary indicator for the quality of cleaned waste water released into the water system.

Sundberg also highlights that these measurements are just one, albeit important, part of the investments. The pumping equipment in the sludge digestion building was replaced, and free flow was turned into forced drainage pumping. When more solid content is pumped into the sludge digestion, it must also be removed.

**More stable process – less disturbances**

Jarmo Sundberg feels that mass balance management has an important role, and it is even more vital in an overloaded plant.

"To keep everything together, we need to know how much solids content we have in our active sludge pools and how much is going through the digestion process into drying and then transported from the plant," he says.
If there is a disturbance in the mass balance, sludge will flow out. When gas production and the operation of the sludge digestion building are interrupted, the balance of the whole plant becomes disturbed. This creates a chain reaction, or a "chain of craziness", as they say at the plant. An interruption like this can cause a serious and long-term process disturbance.

"Without a reliable solids content measurement we cannot predict early enough which way we are going. For a plant this big, the delay is lengthy," Sundberg says.

The digestion process is particularly vulnerable. Any changes in the amount of solids content or temperature have an immediate effect on it. If the process becomes more inefficient, gas production suffers. Worst-case scenario is that the sludge escapes and blocks the pipes. Every significant disturbance costs money.

Sundberg feels that mass balance management has had a distinct impact. During the first six months there have been no process disturbances, whereas previously five or six disturbance situations occurred each year.

### Drying brings significant savings

In the reactor the solids content of the sludge changes again. It comes out four times more diluted after the biological process. The better the digestion process produces gas, the less sludge is transported to the dryer.

Polymer is used to improve the results of drying. When determining the polymer dosage, it is important to know the amount of total solids content of the sludge. In addition to the sludge digesting building, Metso TS Total Solids Transmitters were also installed to all three dewatering centrifuges.

Optimizing the drying process is financially significant, since the continuation process of the sludge is expensive. After drying, the sludge is transported to Nurmijärvi to be composted. The annual amount of 22,000 cubic meters equals 600 full truckloads.

The drier the end product is, the less water is needed to be transported and processed further. Currently, the average value of dry solids content is 28.5 percent. Sundberg thinks that in the future it is possible to achieve a level of 30-31 percent.

A few percentage points can mean big financial savings. Optimizing this area of operations at Suomenoja has just started and the results are not yet available. The general rule is that a one percent increase in dry solids content equals several percent in terms of total cost savings.

“Our annual waste management costs come to roughly one and half million euros – without the transportation costs. When you manage to reduce that, we are soon talking about big savings,” Sundberg says.
Metso TS – Reliable wastewater management

The Metso TS is based on microwave technology developed by Metso. It is a total solids measurement system designed for community applications. The transmitter measures the time it takes the microwave signal to go through the processed matter. The more solid matter there is, the faster the signal moves.

In the paper industry the equivalent measurement system is known as the Metso MCA. There have already been a few generations of these appliances and approximately 4,000 installations. "The community application was first introduced in 2006. Now we have installed about 400 transmitters, and the annual growth is about 20 percent," says Product Manager Marko Heikkinen.

Heikkinen feels that microwave technology beats the earlier optical measuring method on all possible counts. "Optical measurement is based on a diffusion of light. The transmitter system suffers from staining and demands constant cleaning. Color and texture may cause measurement errors, especially in treatment plants where liquids are polluted. Optical measurements have always been problematic."

Microwave transmitters are not dependent on the texture of the matter or the changes in the process circumstances. The appliance is calibrated during installation. After this, it is practically maintenance free.

The microwave-based measuring technology enables extremely precise results. For example, in Espoo’s Suomenoja plant the results have been compared to those received by laboratory measurements, and they have been the same.

"Metso TS measures the total solids content. In addition to the dry matter in the liquid, the transmitter detects solid matter that has dissolved into it," Heikkinen explains.

Typical users of the transmitter are wastewater treatment plants and biogas plants. At the moment, the Metso TS total solid measurement transmitters are in use in seven biogas plants in Finland, including another wastewater treatment plant owned by Helsinki Region Environmental Service Authority in Viikinmäki. It total, Metso Endress+Hauser has supplied instruments to more than ten sludge digestion plants in Finland.

Metso TS – technical specifications

- measuring range* 0...35 TS %
- sensitivity 0.001 TS %
- repeatability 0.001 TS %
The effects of mass balance management

- The total solids content of the sludge going into sludge digestion has increased by 10 percent (3.6 % > 4.0 %)
- The production of biogas has increased by 8 percent (annually 250,000 m3 of gas equals 25,000 liters of heating oil)
- Approximately 10 percent of savings in digestion process heating costs
- No disturbances in gas production during the first six months (previously 5-6 disturbances/year)
- An opportunity to save a significant amount in transportation and continuation process costs. Usually, a one percent increase in drying output equals savings of several percent in handling costs.

A monitoring period of six months, compared to the results of year 2010.

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