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Solid performance

Efficient sludge dewatering in an underground sewage plant

Municipal wastewater treatment currently faces a range of challenges characterised by factors like global and regional changes in climate and demography, more stringent legislation, and an ever-increasing demand for greater resource efficiency, capacity utilisation and cost coverage. The ARA Tobl Sewage Plant in St. Lorenzen, South Tyrol, Italy, exemplifies an effective response to modern demands on wastewater treatment facilities for flexible, sustainable and at the same time economically viable solutions. Because of its scenic location in the middle of the Alps, the ARA Tobl sewage plant has been housed in underground caverns. The plant is connected to a sludge dewatering and thermal utilisation facility based on a forward-looking, energy-efficient sewage sludge disposal concept. With an average of 25,000 tons of sludge to deal with each year, maximum plant reliability and maximum dry substance content of the output are absolutely crucial for the cost-effective operation of the works. For this reason, ARA Tobl has chosen the low-temperature belt dryer BDSLC I-RT-C-2.1 from the company Andritz 3SYS equipped with a PPS 5099 process belt manufactured by GKD – GEBR. KUFFERATH AG.

The ARA Pustertal AG serves a network of 28 communities in the eastern half of South Tyrol and operates a total of five wastewater treatment facilities. The largest of these five plants is the ARA Tobl, established in 1996 and, in view of its topographical location, housed in three parallel underground caverns. 220,000 cubic metres of rock and soil, 740 kilometres of tunnelling and 220 tons of explosives provide a fair idea of the scale of construction work involved. The complete system of wastewater treatment lines and



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digester towers were installed 200 metres into the mountainside. A ventilation system supplies the underground sewage plant with oxygen and ensures adequate air exchange. The sludge line, with its dewatering, drying and incineration stages, and the plant's modern administration building are located above ground at the foot of the mountain. The ARA Tobl plant services an area of 1,150 square kilometres that encompasses 14 communes. Per year, it treats six million cubic metres of wastewater and processes 25,000 tons of sewage sludge, 7,000 tons from its own production, the rest sourced externally. A first sewage sludge dewatering plant was installed just two years after the sewage works went into operation. The thermal utilisation plant – a rotating drum pyrolysis unit – was added in 2004. In 2008, the previously deployed drum dryer was replaced with a low-temperature belt dryer of the type BDSLC I-RT-C-2.1 from Andritz 3SYS equipped with a PPS 5099 dryer belt manufactured by GKD – GEBR. KUFFERATH AG.

Crystal clear

The underground wastewater treatment plant consists of three parallel lines and is twice the size of a motorway tunnel. Wastewater flows into the plant at a rate of 1,100 litres per second. Apart from one milk factory that counts as the plant's largest industrial emitter, the wastewater inflow comes mainly from municipal sewerage. The physical treatment is carried out on two lines. Sand and other heavy minerals are separated in the grit collector; coarse and fine screens remove objects that could block the system. Then, in the preliminary sedimentation tanks in the side tunnels, the heavy sludge is separated over an average retention time of 90 minutes. After this, the wastewater goes through biological treatment. The denitrification chamber reduces the nitrate content without addition of dissolved oxygen. In the nitrification stage, oxygen is added in the form of air to biologically oxidise



the ammonium nitrogen present in the wastewater. The phosphorus compounds not biologically degraded are bound by means of chemicals during simultaneous precipitation. In the secondary clarifier, the microorganisms are separated from the purified wastewater through sedimentation of the activated sludge. Finally, the treated wastewater goes through measurement control. On-line measurements improve the quality of the purification process. Residual concentrations of carbon compounds, ammonium nitrogen, nitrate and phosphate are measured and recorded. The clear water is then fed into the river at the foot of the mountain, the Rienz.

Quick and convenient

A rotating screen drum dewateres the primary sludge from the preliminary sedimentation stage, a filter belt the excess sludge from the secondary clarification stage. After being heated to a temperature of 38 degrees Celsius, the stabilised sludge is fed into the two underground digester towers, each 20 metres high and with a capacity of 2,000 cubic metres, where it ferments under exclusion of air for about 20 days. During this process, the organic contents of the sludge are converted by bacteria into carbon dioxide (CO₂) and biomethane. The biomethane is collected in a temporary storage facility for reutilisation in the sewage plant's three combined heat and power units. The electrical energy generated there covers some of the plant's power requirements, while the thermal energy is used to heat the administrative buildings and the sludge in preparation for the digesters. In 2012, a deammonification stage was added to eliminate the high nitrogen content of the digested sludge under anaerobic conditions. After the sludge leaves the digesters, three screw presses reduce its water content to between 72 and 75 percent. Then, the low-temperature belt dryer, measuring 18 metres long, 4.7 metres wide and 4.6 metres high, dries the sewage sludge produced in the ARA Tobl together with the externally



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sourced sludge down to a water content of just 4 to 8 percent. The dryer thus achieves an average reduction of water content and sludge volume of around 77 percent.

Extra dry

Every week, the above-ground low-temperature belt dryer processes 40 containers full of sewage sludge at 12.5 tons each, amounting to about half of all sewage sludge produced in the whole of South Tyrol. In 2008, the previously deployed drum dryer was replaced with a low-temperature belt dryer. The system change took 14 weeks to complete. During that time, the wet sludge from the wastewater treatment plant was taken to the landfill. Since the low-temperature belt dryer went into operation in 2008, the dewatering process has been running to the complete satisfaction of plant manager Wolfgang Kirchler. Thanks to flexible pressure control, the low-temperature belt dryer deals perfectly with sludge of varying levels of dry substance, producing a reliable output with over 90 percent dry substance content. The end product is practically dust-free, so no pelleting of the substrate is required. This means considerable savings on energy. The sludge charging rate is 2.9 t/h, well over the design specs of 2.5 t/h. Water evaporation also exceeds expectations, clocking 2.24 t/h instead of the specified 2.0 t/h. The reliably high dry substance content and the considerably lower water vapour content of the sludge coming out of the dryer mean a corresponding reduction of energy consumption during its subsequent incineration.

A major factor in this high level of efficiency is the PPS 5099 dryer belt, manufactured by GKD – Gebr. Kufferath AG. Measuring 36 metres in length and 3.8 metres in width, it runs through three dryer zones with temperatures ranging between 160 and 80 degrees. Woven out of robust monofilaments in



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a 3/2 twilled weave pattern, the belt is specially thermoset and stretched for this particular application. Its smooth surface ensures optimal product detachment. Special plastic coating on the edges prevents any damage to the sides of the belt. The 2.2 mm thick woven mesh weighs 1.20 kg/m² and durably withstands the heavy surface loads it is subjected to. With a mesh opening of 510 µm and air permeability of 690 cfm, the belt is optimally tailored to the drying process. The PPS material used ensures that the belt keeps its form at temperatures up to 200 degrees Celsius and is resistant to chemicals up to a pH of 14.

Clean air

About 75,000 kilograms of sludge are loaded onto the belt every day at the ARA Tobl sewage works. The wet sludge is spread evenly onto the belt by a roller in a layer eight to ten centimetres thick. Two ventilation fans produce hot air which is drawn through the sludge layer by lower pressure under the belt, thus drying the sludge. The belt moves continuously forward at a speed of 0.4 to 0.6 m/min. The air below the belt, now cooled and saturated with moisture, is led outside by an extractor fan via a spray condenser. In this process, the majority of the odour-intensive ammonia (NH₃) is washed out. A downstream biofilter of torn burl wood reduces the remaining NH₃ from about 50 ppm to 0 ppm. The cycle time of the sludge layer in the low-temperature belt dryer is about 30 to 50 minutes. About half of the dry substrate is transported back to the dryer entrance by screw conveyers, where it is mixed in with the wet sludge to pre-dry it before it enters the dryer. The daily dry sludge output of 13,920 kilograms indicates a reduction in weight of about 80 percent. The drying process reduces the volume of each 100 cubic metres of dewatered sludge to 31 cubic metres of dry sludge. For Wolfgang Kirchler, the GKD belt is a significant factor in this high performance: "Equipped with this belt, the dryer is easy to control and very reliable. In spite of the heavy



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load on its surface, it maintains an extremely high degree of air permeability." The people at ARA Pustertal AG are also very satisfied with the service they get from GKD. Plant manager Kirchler still remembers well: "The cooperation began with a belt repair job that our previous partner wasn't able to perform. But it was no problem for GKD. We were totally impressed by the speed and competence of the belt experts, and we've been working together successfully ever since."

Top notch

Since 2006, the ARA Tobl sewage plant has closed the sludge cycle with a downstream thermal utilisation plant. Screw conveyers transport the dry sludge granulate to the pyrolysis unit. There, it is heated without oxygen, and the resultant pyrolysis gas is piped into the secondary combustion chamber, the so-called "Turaktor", where it is incinerated at >850 degrees Celsius. The sludge granulate is incinerated under addition of oxygen into mineralised material in a second part of the unit. The flue gas produced in this process is also incinerated in the Turaktor. "Sludge incineration reduced our annual carbon footprint by 2,200 tons of CO₂ alone in terms of the 311,000 kilometres of truck mileage we no longer need to incur," says Wolfgang Kirchler, calculating the advantages. Incineration into inert material drastically reduces the weight and volume of the residue even further: 25 kilograms of dry sludge ends up as 6.5 kilograms of mineralised material, equivalent to a volume reduction from 31 to 12 cubic metres. The thermal energy produced through incineration is recuperated by means of thermal oil heat exchangers and used to run the dryer. Currently, the ARA Tobl plant is already covering around 45 percent of its daily power consumption of 20,000 kw/h from its own energy production. The plan is to increase this share to 60 percent in the next few years by acquiring another gas engine and by renewing the gas line – providing the state approves funding for the



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upgrades. The plant is also considering the possibility of increasing its energy production through the addition of co-substrates in the digester towers. Research is also underway into another optimisation potential: recovery of the 19 percent phosphorus content in the inert material.

Excellent prospects

The outstanding plant availability factor of 97 percent of the low-temperature belt dryer BDSLC I-RT-C-2.1 from the company Andritz 3SYS with its PPS 5099 dryer belt from GKD – GEBR. KUFFERATH AG underlines the efficiency of sludge drying with this system. Plant manager Wolfgang Kirchler, who has been resolutely pressing ahead with the forward-looking strategy of the ARA Tobl sewage plant since it was built in 1996, is delighted with the benefits so far achieved: "Dry substance content consistently over 90 percent, lower energy consumption, dust-free end products, minimal maintenance overheads and maximum operational reliability – these all give us the assurance of secure waste disposal and requisite cost-efficiency." All in all, excellent prospects for further energy-efficient and climate-friendly optimisation of this – in all respects – exceptional wastewater treatment plant.

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