PRODUCT

Reduction in the Load of a Municipal Sewage Plant by Preliminary Treatment of Liquid Slaughterhouse Waste in a Flotation Unit

by Günter Müller-Czygan

Due to the amount of waste water they produce and the substances contained therein, it frequently happens that certain industrial processes negatively affect the operation of municipal sewage-treatment plants. This is especially the case where high degrees of organic pollution (e.g. from abattoirs) place excessive strain on the biological purification processes. As an alternative to expanding the capacity of the sewage-treatment plant, specifically adapted pre-treatment processes can significantly reduce the load on the municipal treatment plant.

A sewage-treatment company operates a municipal sewage works with an extension capacity of 130,000 EW. One of the town's largest producers of industrial waste water is located directly opposite the sewage works. In the past, the waste water produced on the site was piped to the sewage works through a central pump shaft after treatment with a screening grid. From there, the organically highly polluted waste water produced by the slaughter of 1.76 million pigs per annum was stored temporarily in a mixing and equalising tank before undergoing biological purification. The organic content of the waste water piped into the treatment plant at an average rate of 70 - 100 m^3 per hour is characterised by a high proportion of lipophil substances. These substances have a very high fat content and are only partially decomposed by normal processes of biological clarification. In addition to this, the high fat content of these substances caused further processing problems such as damage to the mixing and equalising tank and excessive formation of bulking sludge at the following biological stages. Another problem faced by the sewage-treatment plant was the high phosphate content of the waste water. The operators of the treatment plant were only able to comply with the statutory Pges limits by adding large quantities of ferric chloride. For economic reasons alone, it was therefore essential to find another method of treatment.

Flotation Technology as the Process Selected

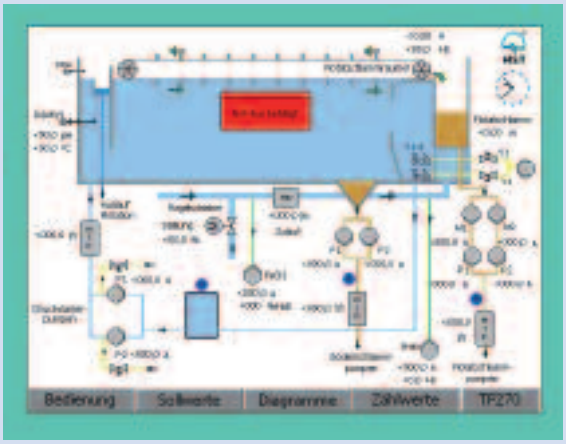
Following a detailed analysis of the situation, the engineering office commissioned by the sewage works recommended treating the industrial waste water by flotation and then piping the treated fluid to the mixing and equalising tank. The main aim of this preliminary treatment was to remove the high proportion of fatty substances from the abattoir waste water, thereby effectively reducing its high phosphate content. The process recommended was that of dissolved-air flotation (DAF). In order to operate the projected flotation at a suitable working point, it was designed for a maximum inflow of 135 m^3 per hour, which, according to past operating data analysed, is sufficient in 90 % of all cases. On the occasions where the amount of inflow exceeded 135 m^3 per hour, a bypass slide was designed to open to allow the excess to flow directly into the mixing and equalising tank. A further specification was to design the unit in such a way that the lipophil substances could be reduced to between 30 and 70 % by varying the amount of chemicals added (monitored via the CSB value during flotation).

The existing carbon deficit was compensated by adding the CSB content still remaining after flotation to the denitrification of the sludge-activation process.

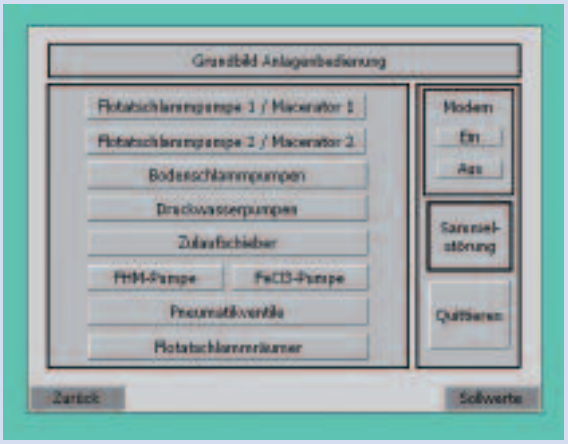
Efficient Fat Reduction by Dissolved-Air Flotation

A physico-chemical treatment process and separation of the flaked impurities by dissolved-air flotation was used for the precipitation of the lipohil and suspended substances in the waste water coming from

Overview of process



Example of operating menu



Flotation unit with pressure tank

the abattoir. Besides the transport process, the destabilisation of the substances contained in the waste water is an essential precondition for the accumulation of the solid particles into a flake. The destabilisation process can be divided into coagulation and flocculation and is achieved by the addition of ferric chloride. The formation of a macroflake with good precipitation characteristics is then achieved by a polymer flocculation aid.

The auxiliary substances are introduced into the pipe at a suitable point. The waste water then flows into the flotation unit where the flaked solid substances and fats are separated. Part of the matter produced is deposited. The lower the amount of precipitation and flocculation agent added, the greater the amount of matter deposited.

During the dissolved-air flotation process, the waste water or a component current of the water for clarification is generally saturated with air at a pressure of between 4 and 5 bars and then fed into the flotation tank through special release valves. After pressure release to atmospheric pressure, the excess air is released in the form of fine bubbles. In the contact and mixing zone, the gas bubbles form an agglomerate with the solid matter, which, due to its low density, then rises to the surface of the tank where it can be skimmed off. The following are the main components of the dissolved-air flotation system installed in Coesfeld:

1. high saturation of waste water and compressed water with air,
2. creation of an optimum gas-bubble spectrum,
3. accumulation of the gas bubbles on the solid matter,
4. geometry and current configuration of the flotation tank suited to the task in question.

The air is forced into the waste water and compressed water in a pressure chamber. According to the literature on the subject, the best flotation effect is achieved with bubbles measuring 50 to 80 µm in diameter. Apart from the type of gas and water, the size of the gas bubbles generated depends on the saturation pressure, the pH value, viscosity and surface tension of the water, and especially on the design of the release valve. Measurement of the gas-bubble spectrum has shown that these small bubbles can be generated best with jets, needle valves or plug valves. In designing the valves, care was taken to avoid the formation of large bubbles because

Sludge skimming system and pressurised water supply

these entrain the desired smaller bubbles upwards before they can combine with the solid matter, thereby substantially reducing the flotation effect. In this complex process, the surface charge of the flakes has a decisive effect on the agglomeration. This is best when the charge on the particles is neutralised.

The flow configuration of the flotation tank has an important effect on the reliability and durability of the unit. This is determined by the geometry of the tank, the location of the inlet, outlet and baffles.

The mixture of water and sludge rises upwards in the contact and mixing zone and flows through an opening in the wall of the flotation chamber. The actual separation of the mixture of water and sludge takes place in the flotation zone. Due to the large area, a slow, even downward flow of water develops in the flotation chamber. The speed at which the sludge flakes rise is greater than that of the downward flow of water. Following its separation from the water, the flotation sludge on the surface is further dehydrated in a second stage of the process. It is skimmed into the sludge chamber by the sludge skimmer. The water, which is now substantially free of undissolved particles, flows under a weir into the clarified-water chamber and from there over a height-adjustable weir into a channel which takes it to the mixing and equalising tank of the sewage-treatment plant.

Good Results after only a Short Period of Operation

The precipitated flotation sludge is conveyed directly to the septic containers of the treatment plant. Fatty sludges such as those produced by the treatment of abattoir waste water are ideal for anaerobic treatment in septic containers because of their very high content of organic matter.

Example of settings

Only a few days after the flotation unit was put into service, a significant increase in the production of methane in the septic containers was observed. The deposited substances are pumped by ground-sludge pumps to the grit chamber of the sewage plant for further treatment.

The analyses carried out during the start-up phase also showed that, on average, the CSB reduction achieved the desired 30 to 50 % depending on the amount of auxiliary agents added, and that the Pges values at the outlet of the sewage-treatment plant were within the prescribed limits. The process is also capable of achieving a greater CSB reduction if required.

Dissolved-air flotation units are admirably suited for the preliminary treatment of waste waters containing high levels of fat, such as those produced by the foodstuffs industry. Important criteria in selecting the most suitable flotation system are the optimum generation of gas bubbles, the layout of the destabilisation phase and the formation of macroflakes. In order to meet these demands, both technical know-how and knowledge of the chemical composition of the waste water are required, as well as the criteria for selection of the correct chemical agents.

In designing the flotation plant, HST was assisted by Prof. Claus Schuster of the Fachhochschule (scientific college) Südwestfalen.

Flotation-sludge pumps