Professional Article

Turning whey into energy

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***Sweden, Umea**. Olof Wallin stared at the official letter on the desk in front of him and thought hard. Under his management the dairy in Norrmejerier produced more milk products every year, cheese production too was on the rise, and now this. The public canalization could no longer handle the whey which was a waste product of the daily cheese production and disposed of with the dairy's process waste water. In addition, the sludge resulting from the organic content of the water required expensive disposal and was a strain on the environment. It was no wonder that the local officials were again threatening to significantly raise the dairy's disposal fees.*

Should they turn the whey into concentrate? That would be very expensive. Or sell it as feed? They produced far more than they could sell and demand was already decreasing. But there must be something they could do with the organic contents in the waste water besides let them turn into sludge. Maybe even something which could benefit the dairy. But what?
Olof Wallin picked up the phone and called an acquaintance at the University of Uppsala. After some discussion he commissioned a study. The waste water issues had to be thoroughly considered in their entirety.

The study soon lay on Wallin's desk and showed that energy could indeed be recovered from whey and other organic contents. This energy could then be used for fuel in the dairy. This was just what he had hoped for. But there were still questions. Who could come up with the kind of innovative energy recovery concept the dairy needed and put it into practice? Wallin sent his environmental protection officer Olle Sjöstedt around Europe to find out. Sjöstedt toured companies in Belgium, Switzerland and Germany before he finally settled on a wastewater specialist. And that company was EnviroChemie in Rossdorf, Germany.

“The engineers at Enviro-Chemie developed a plant for us which ideally combines wastewater treatment, whey disposal and energy recovery,” explained Wallin.
“The Biomar process not only reduces the ecological and therefore also the economic problems caused by the surplus whey, it also greatly reduces the need for primary energy sources. The anaerobic treatment of the process wastewater produces biogas. We use this biogas as an energy source in the dairy's steam vessel, which significantly reduces our fuel costs.”

After twelve weeks of construction it was ready: in June 2005 the Swedish Minister for the Environment Lena Sommested officially opened the plant and it started operations.

Full view of the biological wastewater treatment plant Biomar

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Treatment of the dairy's waste water produces biogas which can be used as a source of energy for the dairy's operations. The emergency gas flare stack can be seen in the foreground.

"Working with Enviro-Chemie was really an enjoyable experience," said project manager Toni Bäckström. "With such an innovative project there are of course some issues to resolve at the beginning. But when there was a problem, for instance with the optimal process pre-acidification setting or adjusting the circulation in the methane reactors, an engineer was with us right away and advised us competently and reliably. And the construction was finished right on schedule."

Meanwhile Norrmejerier treats whey and whey permeate from other dairies in northern Sweden. "We are extremely pleased with the high recovery rate of biogas," remarked Wallin. "We produce 8000m³ of it and save €2500 every day. Those are phenomenal results."

The plant cost approximately €4 million and should be amortized in about 5 years. The project was subsidized by the European Union because it is a model of the goals put forth in the Kyoto Protocol.

Environmental protection officer Olle Sjöstedt of Norrmejerier explains why: "The Biomar wastewater treatment purifies and disposes of industrial wastewater and produces energy as part of the process. Because we use the resulting biogas as an energy source for producing steam for dairy operations, we save primary energy sources and reduce costs. You can't find a more ecologically and economically sensible solution."

Up to 1250m³ of process wastewater and 250m³ of whey and/or whey permeate are produced each day in Umea. In the mechanical phase of the Biomar process this is fed through a self-cleaning drum sieve plant. Slivers of glass, remains of paper labels, pieces of aluminum and other large pieces of waste are removed from the wastewater and collected in a small container. This protects pumps, vents and plant fixtures from blockage and early wear.

Food or beverage producers do not constantly produce waste water and the water's quality can vary. For instance far less is produced on weekends than from Monday to Friday. Rinse water is sometimes strongly acidic, other times strongly basic and its temperature can vary. This is why the wastewater treatment begins with mixing and homogenization. Wastewater, whey and/or whey permeate flow through the drum sieve into the mixing and homogenization tank. Strong fluctuations are neutralized naturally without significant addition of chemicals (biochemical autoneutralization) and variations in quantity are leveled out. Facultative bacteria then acidify and hydrolyze the organic contents of the wastewater. The duration of the pre-acidification depends on the quality of the wastewater and its contents. The pre-acidified wastewater flows continuously through the flotation phase. This flotation removes the non-emulgated drops of oil and residual fats which are then hydrolyzed and turned into biogas in a special fat-methane reactor. One kilogram of fat produces about 1.5 m³ of biogas.

Project manager Toni Bäckström was initially concerned that the exhaust from the pre-acidification and flotation would cause unpleasant odors. But "it doesn't stink in Umea," he assures with a relieved smile.

In the flotation phase, non-emulgated drops of oil are separated from residual fat.

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"The new process is a closed system. The exhaust is vacuumed up and put through a biofilter. The odorous contents are removed naturally using tree bark mulch as a filter."

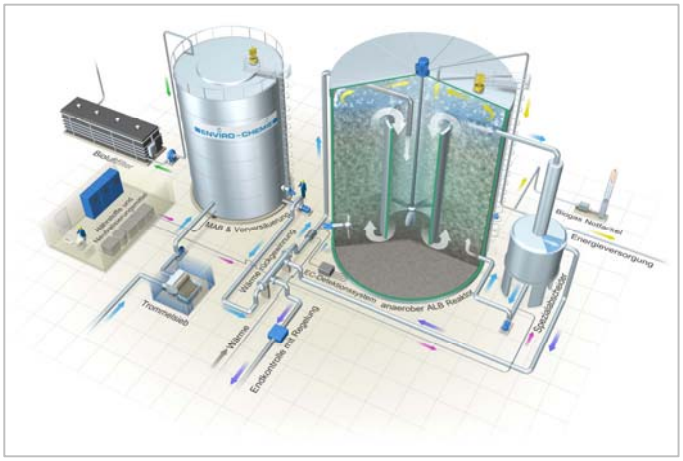
Before the pre-acidified wastewater flows into the Biomar methane reactor it is conditioned, meaning the temperature and pH values are adjusted to create ideal conditions for anaerobic treatment. It is then combined with some recycled filtered water and pumped into the Biomar methane reactors with a specially developed distribution system. Each reactor can hold 2500m³.

Step 1, the pretreatment of the wastewater, is then finished
Step 2, the anaerobic treatment which produces biogas, occurs in the methane reactors.

The main contents of the wastewater in the reactors are sugars, alcohols and lactic acids. The metabolic functions of the acetogenic bacteria turn these contents into acetic acids, which are in turn metabolized by methane bacteria.

In the methanogenic phase the acetic acids are then turned into energy-rich methane and carbon dioxide. In the calm separation zones of the reactors the microbubbles combine to form larger biogas bubbles which rise into the reactors' integrated gas containers. The biogas is collected, fed into the steam vessel using an explosion-safe fan and burned, meaning the recovered energy is immediately available and consumed. The heat from the discharged wastewater is also recovered with a heat pump and used to prepare the temperature for anaerobic treatment in the mixing and homogenization tank.

The chemical oxygen demand value of the water in the methane reactors is reduced by 60-90%. It then has the contaminant load of household wastewater and can be fed into the communal treatment plants.



Sketch of the Biomar process

Biomar is also a solution for clients who would like to return wastewater directly into a river or lake. In a third step the pretreated wastewater from the methane reactors is biologically treated – it gets "aired out". Aerobic bacteria in an aerated tank consume oxygen and oxidize the organic contaminants. This step brings the chemical oxygen demand and biological oxygen demand down to the required concentration for this type of disposal. The process also reduces the amounts of phosphorus and nitrogen. The treated water is extremely clean; if it is filtered and disinfected it could even be reused immediately.

The modular construction concept of the Biomar wastewater treatment process is an excellent solution for midsize dairies (1000-5000 tons of milk processed per day) as well as for other food and beverage industries. Biomar will dispose of the organic contents of these types of process waste water and recover a valuable source of energy.

For further information please contact

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