CASE HISTORY

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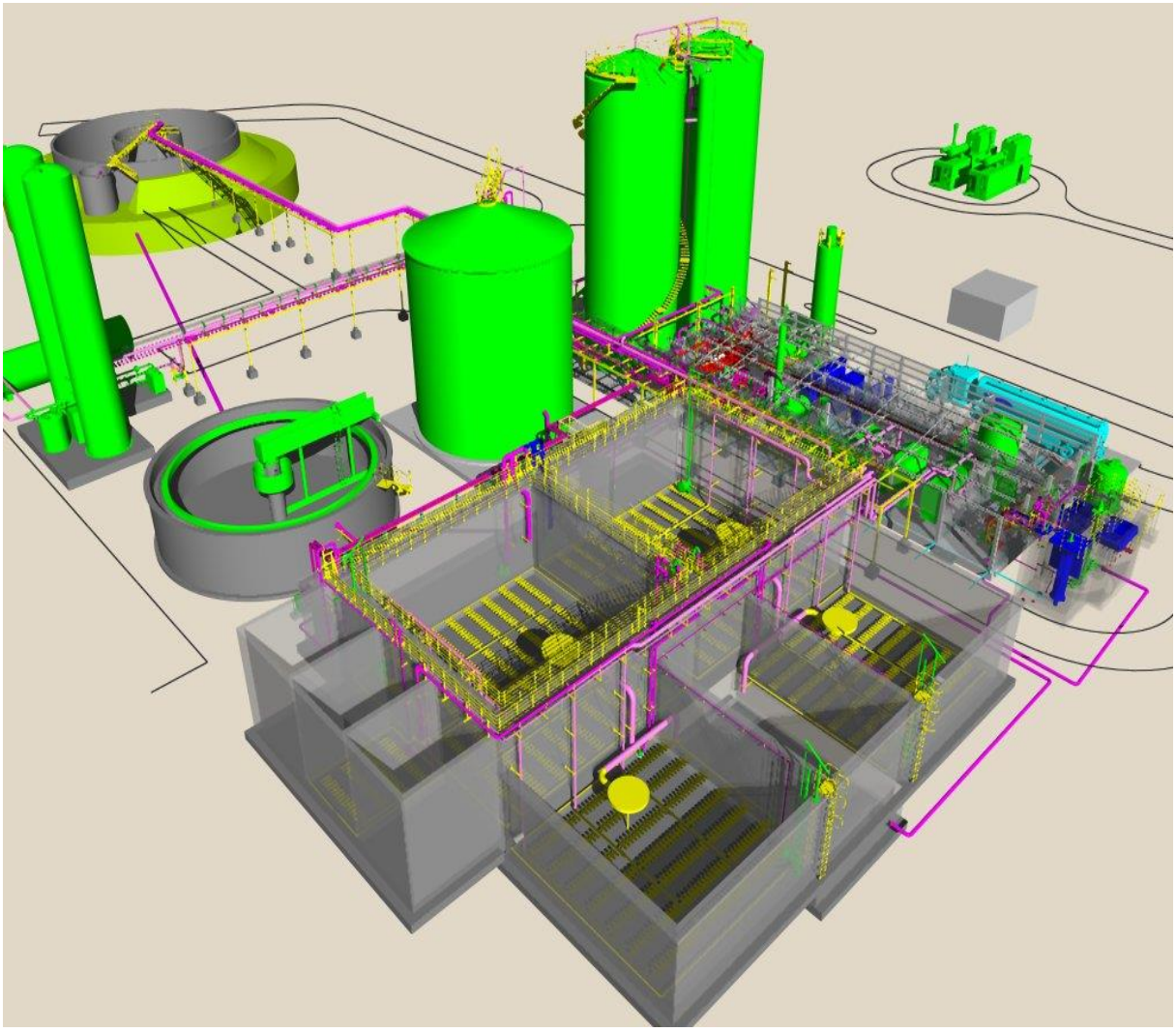
HAGER+ELSÄSSER

An aquarion Group Company

Yeast Production Plant - Serbia

Anaerobic / Aerobic Wastewater Treatment



From waste to energy: sustainable waste water treatment produces an energy surplus while reducing carbon emissions.

Production site

The Alltech-Fermin yeast production site in Senta, Serbia, is a food grade facility producing natural yeast-based products. The company caters for the Serbian and the Southern European market.

The product lines range from fresh baker's yeast, dry baker's yeast, baker's yeast for frozen dough, yeast extract (powder and paste) and yeast cell wall, to yeast-based dietary supplements.

The waste water from the production process is treated in a central waste water treatment plant (WWTP) and is then discharged into the river Tisza, a tributary of the Danube.

The existing WWTP was built in 1979 and was unsuited for use with the latest technologies for energy efficient and low cost operation.

As the direct discharge of treated waste water to the river Tisza requires more advanced treatment technology, Alltech-Fermin decided to build a new WWTP to comply with European Union direct discharge regulations

New treatment plant

In 2008, HAGER + ELSÄSSER were awarded a contract to build the new WWTP for the yeast production site in Senta, Serbia. The picture below shows the anaerobic treatment stage during construction.

Mechanical assembly began in September 2009 and was completed prior to the start-up of the new plant in spring 2010.

The treatment concept consists of the following main steps:

- Heat exchanger (heating up to 37 °C)
- Anaerobic treatment **ANAFIT®** (including buffer and pre-acidification tank, conditioning tank, and two reactors)
- Biogas line (storage, biological and chemical desulphurisation, drying, co-generation plant and emergency flare)
- Phosphorus removal (Bio-P stage)
- Activated sludge treatment
- Final sedimentation
- DEMON® treatment for removal of nitrogen (SBR process)
- Polishing stage (SBR + FLOCOPAC)

Design values for WWTP

Waste water from yeast production is characterised by high COD and BOD concentrations as well as considerable nitrogen and phosphorus contents.

The exact nature and composition of the waste water in a yeast production plant depends mainly on the type of the growth substrates, e.g. molasses, and the additives used in the production and cleaning cycles.

The anaerobic reactors **ANAFIT®** are high load EGSB type reactors. The anaerobic stage is designed for a maximum daily COD load of 44 t and a COD removal rate of 70 to 80 %. Biogas production is 12,000 m³/d.

The DEMON® process is designed for a nitrogen load of 2.5 t/d.

Effluent limit values

- BOD_5 25 mg/l
- N_{inorg} 15 mg/l
- NH_4-N 10 mg/l
- P_{total} 2 mg/l

Benefits of the anaerobic process **ANAFIT®**

The organic pollutants in the waste water represent a considerable energy potential that can be used to provide the energy demands of the WWTP or even to produce surplus energy

In aerobic waste water treatment, low energy end products such as CO_2 and H_2O are produced. Most of the potential energy is transformed into biomass, which results in excess sludge production rates of 20 – 50 % of the converted COD load.

However, in anaerobic waste water treatment, 85 % of the potential energy is transferred to the end product methane (CH_4) and can be recovered as both electrical and thermal energy in a co-generation unit. The biogas produced in anaerobic treatment consists of approx. 65 % CH_4, 35 % CO_2 with traces of H_2O, H_2S and NH_3. Additionally, the energy demand for the anaerobic process itself is considerably lower due to the fact that no blowers are needed for aeration.

Since most of the potential energy is transformed into biogas instead of bacterial growth, excess sludge production in the anaerobic process is only 2 – 5 % of the converted COD load. In other words, sludge production is only about 10 % of that in the aerobic process and consequently costs for sludge treatment and disposal are greatly reduced.

In addition, anaerobic waste water treatment reduces greenhouse gas emissions, since the biogas can be used to provide the energy demand of the WWTP that would otherwise be provided by burning fossil fuels.

For highly polluted, but easily biodegradable waste waters, such as those from yeast production, the two-stage treatment concept as employed for Alltech-Fermin is an economical as well as a sustainable option:

- Anaerobic stage for energy recovery (removal of 70 – 90 % COD and use of the energy potential for biogas production)
- Aerobic stage for polishing treatment (removal of the remaining pollution and the nutrients)

Benefits of the DEMON® process

After removing the bulk of organic pollution with anaerobic treatment, ammoniacal nitrogen has to be removed in an aerobic stage. The DEMON® process is an innovative method for ammonium removal, which requires only a minimal supply of aeration energy and no addition of an external carbon source to feed the bacteria.

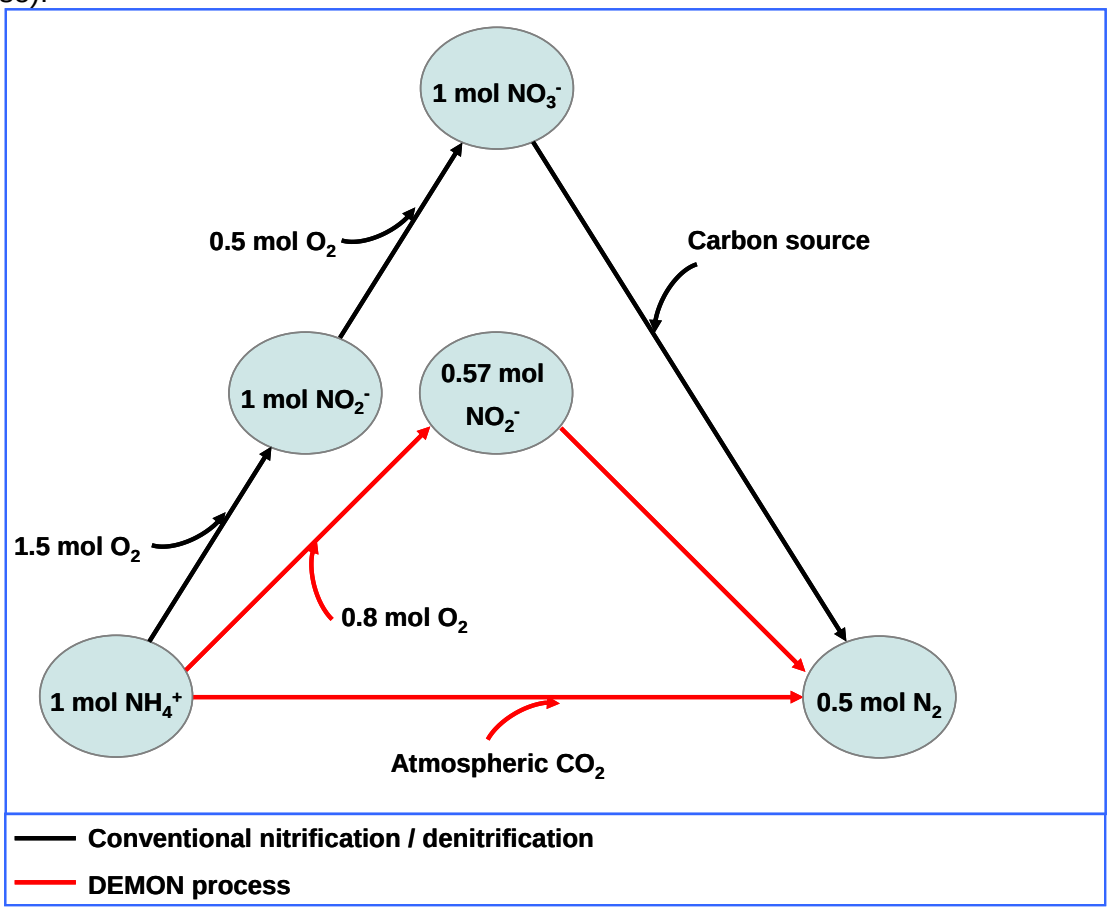
The principle of the DEMON® process is a partial oxidation of ammonium to nitrite (aeration phase), which is followed by an autotrophic nitrite reduction by the residual ammonium to produce nitrogen (mixing phase).

As can be seen in the diagram on the right, the DEMON® process (red reaction pathway) reduces the oxygen demand considerably compared to normal nitrification and denitrification (black reaction pathway).

The DEMON® treatment is carried out as a batch process in cycles of several hours duration. Each treatment cycle consists of several sub-cycles (aeration + mixing phases) as well as sludge sedimentation and decanting steps.

During the aeration phase, O_2 concentration is kept at a low level, resulting in the partial oxidation of ammonium to nitrite. This leads to a decrease of the pH value, which is used by the DEMON® control to determine the length of the phases and to avoid toxic effects due to high concentrations of nitrite. In the following mixing phase, the nitrite produced is reduced by ammonium.

The phases are repeated, with some raw waste water being added at the beginning of each phase, thereby avoiding high nitrite concentrations that are toxic to the bacteria.



DEMON® process versus nitrification and denitrification:

Ammonium is not oxidised completely to nitrate, only partially, hence the energy demand for aeration (oxidation) is considerably reduced.

Reduction to N_2 is carried out by autotrophic bacteria, which use CO_2 as their carbon source. Therefore the addition of a carbon source as practised for conventional denitrification is not required.

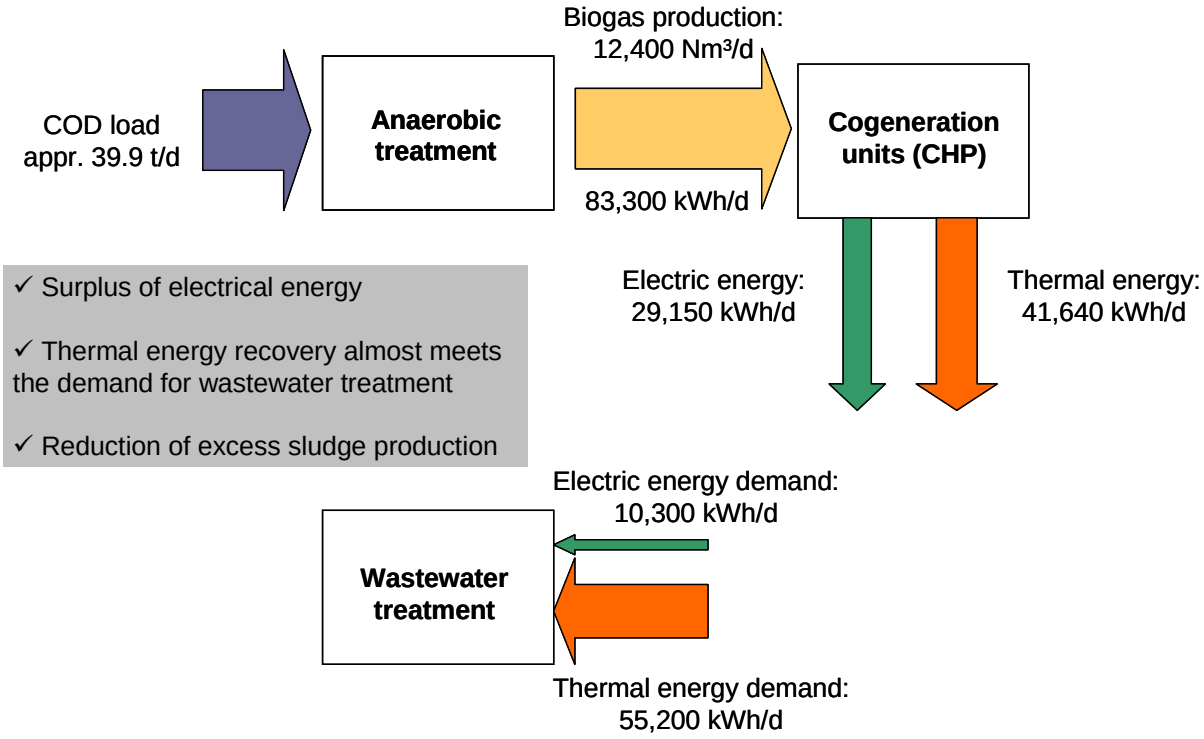
Autotrophic bacteria have a very small growth rate and therefore excess sludge production is very low.

Energy balance

The diagram below shows the energy balance for the anaerobic treatment step, based on the daily average COD load of the yeast plant in Senta.

The methane produced is transformed into electrical and thermal energy in co-generation units. The energy yields depicted in the diagram are based on an electrical efficiency of about 35 % and a thermal efficiency of 45 – 50 %.

Compared to the overall electrical power demand for the WWTP there is an **electrical power surplus** of about 180 %. The thermal energy produced during the cooling of the co-generation machine can be used for process heating demands in the WWTP, **reducing the thermal energy demand** by 74 %.



Moreover, the use of the DEMON® process for nitrogen removal significantly reduces the energy demand in the aerobic stage. Compared to the conventional nitrification and denitrification process with a specific energy demand of 2.8 kWh/kg N the DEMON® process has a specific energy consumption of less than 1.1 kWh/kg N.

There are **additional reductions** to the energy demand due to the significantly reduced excess sludge production in the anaerobic and the DEMON® treatment stage.

Summary

For an energy efficient treatment of waste water containing high organic and nitrogen loads, the combination of organic carbon removal with an EGSB-type anaerobic process (**ANAFIT®** reactor) and nitrogen removal via de-ammonification with the DEMON® process represents a highly economic and advantageous treatment concept.

The advantages include:

- Biogas production in the anaerobic stage supplies most of the plant's thermal energy demand and significantly exceeds the electrical energy requirements of the WWTP.
- Use of biogas instead of fossil fuels leads to the reduction of greenhouse gas emissions.
- Use of the DEMON® process reduces the energy demand for aeration substantially.
- Application of the DEMON® process makes the addition of raw waste water as a carbon source for denitrification redundant; this leads to higher biogas yields in the anaerobic stage.
- In the DEMON® process, CO_2 from the air is fixed in the biomass by autotrophic bacteria, thereby actually helping to reduce atmospheric CO_2.
- Cost benefits due to the reduced excess sludge production in both processes (lower costs for sludge treatment and sludge disposal).

Anaerobic treatment with EGSB reactor systems (like **ANAFIT®**) is a well proven and reliable technology for industrial waste water. Therefore the number of plants in industrial waste water treatment is increasing continuously.

The DEMON® process is a new and innovative treatment system that has been employed successfully in a variety of plants in Europe.

The combination of anaerobic treatment (**ANAFIT®**) with the de-ammonification process (DEMON®) is a new concept providing an ideal, economic and simple to operate, solution for highly polluted waste water.

For certain high strength waste waters, the implementation of this process can enable provision of the entire energy demand of the WWTP and supply surplus electrical energy to the grid.

H+E ranks among the world's leading suppliers in the fields of: water & wastewater treatment, and energy efficiency. Based on its global presence, the **H+E GROUP** has completed projects in over 50 countries.

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