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Biological Waste Water Treatment

Esso Slagen Refinery

Norway

The Esso refinery in Slagen / Norway has been treating its effluents in a Sepaflot flotation plant (dissolved air flotation) built by Lurgi.

The plant was extended by adding a biological stage designed, built and commissioned by Lurgi to achieve further biodegradation. The project comprised an open-type Lurgi Bamag deep tank bioreactor made from concrete with nitrification and denitrification zones in one single reactor. The design was based on Lurgi Bamag's extensive experience in treating refinery effluents and building deep tank bioreactors.

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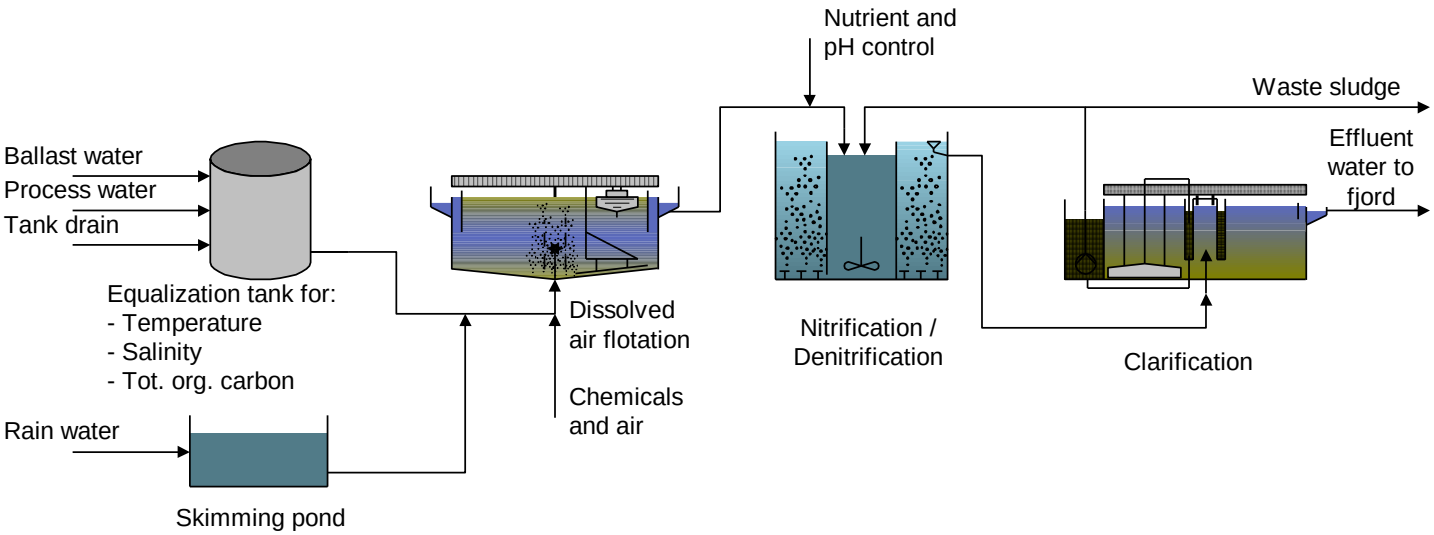

1. Objective

Treatment of refinery effluents.

- Design data

Bioreactor feed	
Effluent throughput	150 - 260 m³/h
BOD_5	600 kg/d
TOC	337 kg/d
Phenol	38 kg/d
NTK	100 kg/d
Oils and fats	70 kg/d
TDS	13,000 mg/l

- Treatment criteria

Hydrocarbons	5 mg/l
Phenols	1 mg/l
NH_4-N	10 mg/l
Sulfides	0.5 mg/l

2. Plant concept

- Process steps

  Lurgi Bamag Sepaflot dissolved air flotation for physico-chemical treatment.

  Lurgi Bamag deep tank bioreactor with integrated nitrification/denitrification and circular secondary clarifier.

- Brief description

  Process effluents, ballast water and effluents from tank draining are routed to a buffer tank to ensure uniformity with regard to temperature, salt and organic pollutant concentrations. At the same time, the storm water is routed to a buffer pond equipped with facilities to remove supernatant oil.

The effluents from the buffer and collecting tanks are jointly treated in a Sepaflot dissolved air flotation (DAF) tank. Oil, solids and those contaminants that can be separated by flocculation or precipitation are removed here.

The water pretreated in the DAF unit is routed via a pumping station to the deep tank bioreactor where the organic contaminants are biodegraded with activated sludge and where nitrogen compounds are simultaneously removed by nitrification/denitrification.

The Lurgi Bamag deep tank bioreactor technology combines the DN and N zones in one reactor. The denitrification zone is located in the center of the plant unit described and equipped with an agitator. The nitrification zone where organic carbon compounds are to be degraded and ammonium nitrogen is to be oxidized to nitrate is arranged in a circle around the inner denitrification zone. The atmospheric oxygen required for nitrification is provided by fine bubble aeration.

In the downstream round clarifier, the waste activated sludge settles and is removed from the treated effluent. The treated water is discharged via a pump station into the Oslo fjord.

The quality of the treated effluent water is continuously monitored by a measurement station.

3. Characteristic plant data

- 1 Lurgi Bamag deep tank bioreactor

$Ø_{total}$	22.5 m
$Ø_{DN\ zone}$	12 m
depth of water	6 m
total volume	appr. 2,300 m³
aeration system:	fine bubble aeration

- 1 secondary clarifier

Ø	20 m
clarification area	appr. 300 m²

4. Operating experience

The customer commented as follows:

The bioreactor in the Esso refinery in Slagen shows a very good and stable degradation efficiency. All applicable discharge limit values were met.

Stable operation and acceptable degradation are also ensured in case of variations in the organic load, salt concentration and temperature which may occur during operation.

The fine bubble aeration used achieved high oxygenation capacities.

The removal of nitrogen compounds from the waste water with the formation of gaseous nitrogen reaches values above 90 %.