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Bamag deep tank bioreactor

Hüttenwerke Krupp-Mannesmann Duisburg

Biological wastewater treatment of coke oven wastewater including nitrification and denitrification

Wastewater contaminated with organic (phenol) and nitrogen/sulfur-containing (NH_3, SCN^-, CN^-, H_2S) components forms during the coking of pit coal.

This wastewater is treated in a specially designed three-stage (Lurgi) Bamag deep tank bioreactor and discharged into the receiving water, the river Rhine.

The treatment plant built on a very limited space is characterised by the almost complete elimination of COD and/or N and low operating cost.

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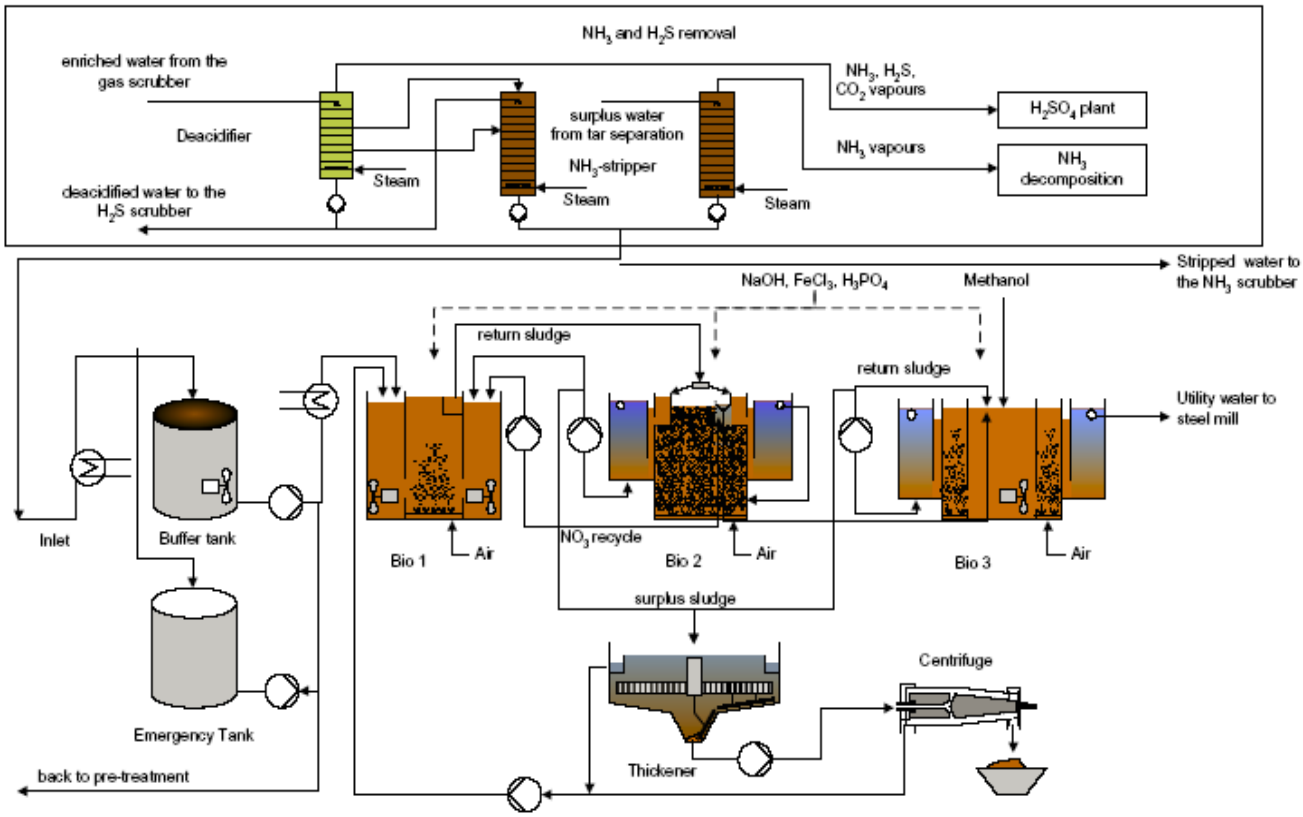

1. Objective

Cleaning of coke oven wastewater

- Design data

  Feed to the biotreatment stage

waste water	80 m³/h
COD, max.	5,800 kg/d
Phenols, max	2,300 kg/d
TKN	720 kg/d

- Treatment efficiency

COD (> 90 % degrad.)	≤ 200 mg/l
Phenols	≤ 0.3 mg/l
N (NH_4, NO_2, NO_3)	≤ 20 mg/l

2. Plant concept

- Process steps

  Cooling, buffering and equalisation, three-stage Bamag deep tank bioreactor with nitrification / denitrification stage and integrated secondary clarification, sludge thickening and dewatering

- Brief description

  The coke oven waste water is composed of the gas condensate from coking (carbon humidity and water from the chemical reaction), water from the gas scrubber (NH_3, H_2S) as well as condensate from steam distillation.

The process water is pretreated in separate distillation columns, i.e. the components NH_3, H_2S and CO_2 are transferred into the gaseous phase by means of steam.

In the sump of the deacidifier column, deacidified liquid enriched with NH_3 collects and is in part used for H_2S absorption in the gas scrubber.

A partial stream of the washing water stripped in the NH_3 column is used in the NH_3 gas scrubber, the balance is routed as waste water to the three-stage biological treatment unit.

From the buffer tank, the waste water is conveyed together with the NO_3 recycle from the downstream nitrification and the return sludge of the intermediate clarifier into the denitrification zone of the first bioreactor. Here, approx. 80 % of the NO_3 is eliminated under anoxic conditions. Through openings at the tank bottom the waste water/sludge mix flows into the aerobic COD degradation zone at the center of bioreactor 1. Following the almost complete elimination of the residual COD, the waste water/sludge mix flows to the intermediate clarifier arranged around the nitrification of the second bioreactor for lack of space.

While the sludge is returned to the denitrification of bioreactor 1, the supernatant water flows gravimetrically into the nitrification unit.

Nitrification is designed as a biotreatment stage with plastic carrier materials floating on the solution to immobilise the microorganisms.

Sessile microorganisms oxidise and/or nitrify the nitrogen compound to NO_3 provided there is sufficient air available.

Perforated plates in the discharge of the nitrification unit prevent the loss of carrier material.

While four times the amount of total waste water is returned to the denitrification stage, a volume equivalent to the normal effluent volume flows to the downstream denitrification by gravity.

In the downstream denitrifcation zone arranged at the center of bioreactor 3, the residual NO_3 load is eliminated using methanol as an H donator. To degrade any excess methanol, the waste water/sludge mix flows from the post-denitrification into the aeration zone arranged concentrically around the denitirification stage. The activated sludge is separated in the secondary clarification constituting the outer ring of bioreactor 3.

While the cleaned effluent is returned to the process as service water, the return sludge is routed to the downstream denitrification.

The excess sludge is thickened, dewatered in a centrifuge and added to the coal feed.

3. Characteristic plant data

- Heat exchanger
- 3 buffer and emergency tanks
  volume 5,000 m³
- 3 Bamag deep tank bioreactors
  total volume 4,800 m³
- 2 integrated secondary clarifiers
  total clarification area 440 m²
- Sludge treatment
  1 sludge thickener 160 m³
  1 centrifuge