Research Institute:

PTS München
Heßstr. 134
80797 München

Internet: www.ptspaper.de

Head of the research institute:

Dr. A.-B. Kerkhoff

Project leader:

Dipl.-Ing. Benjamin Simstich
Tel: 089 / 12146-388
Fax: 089 / 12146-36
E-Mail: benjamin.simstich@ptspaper.de

Research area: General aims

Environmental technology // Water

Key words:

membrane, tertiary treatment, nanofiltration, concentrate

Title: Study to ensure the reliable operation of a biological effluent treatment plant supplemented by nanofiltration as a tertiary treatment step and recycled concentrates

Background/Problem area

Membrane technology, especially nanofiltration, can be used as tertiary treatment stage after conventional biological effluent treatment for a further reduction of residual COD, colour, micro organisms, suspended solids and even divalent ions. The treated water is utilized for further closure of the water circuit or to meet discharge requirements. The problem involved in the use of nanofiltration for tertiary treatment concerns the utilization or disposal of filtration concentrates. Since the concentrate material, especially the refractory “hard COD” cannot be further degraded, its recycling would lead to undesirable accumulation in the biological treatment stage. Consequently, these refractory COD compounds have to be either removed or chemically cracked in a special treatment step before being re-circulated in the biological treatment process.

Objectives/Research results

The objective of this project was to investigate treatment methods for an economical and effective pre-treatment of the NF concentrates before recycling them into the biological stage. Two approaches have been studied in the research project:

1. Direct elimination of pollutants by means of flocculation/precipitation:

This method offers a COD removal of up to 50 %, leaving the rest in the concentrate. The procedure may be particularly useful if NF is only applied to a partial stream and concentrate volumes are small. The precipitation process entails the drawback of extra cost for sludge disposal.

2. Oxidation:

COD compounds are cracked by means of oxidation processes as concentrate treatment. After the residue-free direct oxidation of residual COD, biodegradation of cracked molecules is possible in the biological stage. Different oxidation processes have been considered: Ozone treatment, Fenton’s process (hydrogen peroxide oxidation with Fe^{2+} ions as catalyst), wet oxidation with H_2O_2 supported by UV light, electrochemical oxidation. COD elimination rates of 40-80% can be obtained by direct oxidation plus follow-up anaerobic or aerobic treatment.

The success of direct COD oxidation depends on operating expenditure, especially on the concentration of chemicals used, retention time or electric energy (UV light, electrochemical process). COD elimination rates range from 10-30% (electrochemical oxidation) or 20-45 % (ozone and wet oxidation) up to 60% (Fenton’s process). But due to the high costs of COD reduction via oxidation, direct COD elimination is not the aim of the process. For an economical use, the generation of BOD has to be maximised in the oxidation stage. Then it is possible to cost effectively biodegrade the COD compounds.

Trials showed that the aerobic biodegradation rates after the treatment vary between:

- 0 – 10 % electrochemical oxidation, precipitation and untreated concentrate
- 25 – 35 % ozonation
- 20 – 50 % Fenton’s process and wet oxidation

The anaerobic degradation was between 5 and 20 % in most experiments.

Application/Economic benefits

The pressure on the European paper industry to further close its water circuits has increased significantly during the past decade. Since the technologies of the past can no longer meet the requirements of the future, new water treatment methods have become necessary. A constant rise in the interest in membrane technology expressed by the European paper industry confirms that in future this method will evolve into a key technology for continued water savings. However, the remaining technical problems and drawbacks have yet to be investigated. The research results of this project will be used by German paper mills and they will have an impact on the future trend of German SME (small or medium-sized enterprises) in the membrane and environmental industries. Nanofiltration in this application could evolve into a totally new market for German enterprises. Membrane processes will certainly be chosen by more mills in future, when more stringent discharge limits necessitate the use of new treatment technologies.

Project period: 01.08.2007 – 31.07.2009

Remarks

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