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**Research area: General aims**
Environmental technology // Water

**Key words:**
Membrane, tertiary treatment, nanofiltration, fouling control

## Title: Identification and control of fouling on nanofiltration membranes for tertiary treatment of paper industry wastewaters

### Background/Problem area

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. Membrane technology, especially nanofiltration or reverse osmosis are suitable processes for the tertiary treatment of fully biologically treated effluents. A reduction of more than 90 % in the concentrations of COD, AOX, colour, nitrogen, phosphate and conductivity is possible. Permeates not only permit better discharge values, but can also be reused for production. A further closure of the water circuit can be reached when membrane permeates are used as fresh water replacement.

Drawbacks of this emerging technology are the formation of a concentrate stream, which must be disposed of or treated before recirculation (studied in completed IGF 15290N), and high costs or low plant performance due to fouling and scaling processes. Modern membrane modules already employ special design details to reduce the precipitation of substances on membrane surfaces to a minimum. However, a significant flux decrease due to the build-up of a fouling layer on the membrane cannot be prevented. The consequences are decreased flow rates and increased operating costs because of cleaning tie-ups.

### Objectives/Research results

Aim of the project is to gain detailed knowledge of the fouling chemistry during membrane treatment of paper mill wastewaters. Highly sophisticated analytical methods, such as FTIR, LC-OCD, SEM or ICP-MS are elaborated to elucidate the composition of the fouling layer. A fully automated laboratory nanofiltration plant was procured and adjusted to the specific boundary conditions in order to perform the trials. Recommendations on pre-treatment and membrane cleaning will be worked out as results of the project. Studies have been conducted with different cleaning chemicals. A continuous membrane trial performed on-site in a paper mill for several weeks was intended to prove the results of short-term laboratory tests and to investigate the stability of the process in a longer operating period. During the continuous trials in the paper mill, the $BOD_5$ remaining after biological treatment led to biofouling problems and flux decrease in the membrane module. A $BOD_5$ content of 10 to 15 mg/l resulted in operational problems and slime formation at the spacer grid of the module.

So far three different effluent samples from paper mills have been investigated in lab trials. The analysis of different membrane layers after short term filtration trials of 48 h showed the presence of inorganic as well as organic compounds. Further chemical investigations are underway. Results show calcium, carbonates, sulfates and also sodium as the main inorganic scaling components. Typical of paper industry waste water is a rather high water hardness which leads to calcium precipitation on the membrane. Due to feed concentration this effect increases with high permeate yield.

The analysis of organic foulants by LC-OCD showed the presence of mainly hydrophilic polymeric matter, especially humic substances and also biopolymers. Especially the high-molecular biopolymers with a molecule size of > 20,000 g/mol have the tendency to foul on the membrane surface. An effective pretreatment could be attained by ultrafiltration or precipitation/flocculation methods.

### Application/Economic benefits

Paper mills will need reliable and economically efficient technical solutions if discharge limits force them to improve their effluent quality or reduce their wastewater volumes. Fouling problems cause uncertainty regarding the dimensioning and operation of new membrane plants. A detailed knowledge of the chemical processes involved in membrane filtration is essential for applications in the paper industry. The project is intended to ensure the stable operation of membrane plants and reduce their costs as a basis of future applications.

For SME in the environmental technology sector, economic benefits will emerge from a broader use of membrane technology in the European paper industry.

**Project period: 01.12.2008 – 30.11.2010**

### Remarks

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