Research institute:
PTS München
Heßstr. 134
80797 München

Internet: www.ptspaper.de

Head of the research institute:
Dr. Frank Miletzky

Project leader:
Dr. Hans-Jürgen Öller
Tel: 089 / 12146-465
Fax: 089 / 12146-36
E-Mail: hans-juergen.oeller@ptspaper.de

Research area: General aims
Environmental technology // Water

Key words:
Waste water treatment, critical trace compounds, reduction

TITLE:

Studies on reducing organic trace compounds in paper industry effluents with the help of advanced treatment technologies

Background/Problem area

To an ever greater extent, German paper mills must have their effluents examined for organic trace compounds in order to then take measures to reduce them. The reason for this is a large number of regulations, guidelines and set targets whose declared aim it is to reduce or even totally eliminate the discharge of certain organic trace compounds. The most criticised trace substances in paper mill effluents include, among others, complexing agents as DTPA and EDTA, polycyclic aromatic hydrocarbons (PAH) and chlorinated aromatic compounds (CAH), bisphenol A (BPA) as well as per- and polyfluorinated chemicals (PFC). Although as much as 80 % of some of these compounds can be eliminated abiotically or by biological degradation in effluent treatment plants, measurable concentrations are still found in the treated effluents. Previous R&D studies on reducing these compounds have always concentrated on certain species or on other media, e.g. municipal wastewaters. The extent to which advanced treatment methods are capable of reducing several of these substances in paper mill effluents at one and the same time is unknown.

Objectives/Research results

The objectives of the project are to determine the concentration of organic trace compounds relevant to the paper industry and to develop effluent treatment concepts to reduce them economically. The desired research results include:

- A procedural regulation will be created for the species PAH, chlorinated aromatic compounds, chelating agents (EDTA, DTPA), phthalates as well as BPA, so that these trace compounds can be reliably quantified in paper mill effluents.
- Determination of the trace compound concentrations: the concentration levels in the effluents from recovered paper processing paper mills will be cited for the organic trace substances listed above.
- Development of reduction concepts: the efficiency of advanced treatment methods (O_3, UV, UV/H_2O_2, Fenton's reagent (H_2O_2/Fe^{2+}), Photo-Fenton's reagent (H_2O_2/Fe^{2+}, UV), nanofiltration) to simultaneously reduce different kinds of trace compounds will be evaluated by a comparison process, jncluding investment and the working capital costs.

A group of 8 paper mills were selected for investigation within the project. All of them use recovered paper as most important raw material and they produce graphic, packaging or tissue papers (p.). Conventional parameters of the biologically treated effluents covering following ranges: COD = 120 (graphic p.) - 300 mg/l (packaging p.), TOC = 32 - 85 mg/l (both graphic p.), TN_b = 3.4 - 11 mg/l (both graphic p.), $P_{total} < 0.5$ mg/l (one value at a newsprint mill is close to 2 mg/l), AOX $\leq$ 200 µg/l for all mills. The screening of the conventional parameters of all effluents shows normal composition. Identification of critical compounds was performed by stir bar sorptive extraction (SBSE) for a selective accumulation of polar and nonpolar organic compounds. By means of thermodesorption of the stir bar loaded with the absorbed compounds directly to the chromatographic system trace amounts of organic compounds in the range of 10 - 100 ng/l can be determined.

Due to the fact that some trace compounds are only present in low concentrations in paper mill effluents it was decided to add trace compounds in order to better compare different treatment methods. The following levels were selected: chelating agents = 5 mg/l, phthalates = 1 µg/l, BPA = 100 ng/l, PAH and CAH = 200 ng/l. The assessment of overall elimination capacity for the different kinds of trace compounds results in the following semi-quantitative order of decreasing elimination: chelating agents > Pentachlorophenol (PCP) > BPA > PAH. If for example BPA is the primary compound to be eliminated, processes which use H_2O_2 as oxidizing agent work better than O_3 or UV. If PCP is the envisaged target compound in these matrices, processes including UV radiation will be advantageous. To improve economics of the advanced treatment an investigation of combined oxidative and subsequent aerobic degradation will be performed in the final experimental section.

Application/Economic benefits

The complexity of the interdisciplinary issues to be examined makes it virtually impossible for small and medium sized enterprises to develop strategies and concepts designed to reduce trace compounds in effluents at an acceptable expense. Hence, there exists especially in small and medium sized enterprises a great need for central ideas and knowledge transfer which is met by the findings accruing from the project on how to reduce or eliminate trace compounds in biologically treated effluents. It is absolutely necessary to make economical concepts for the advanced treatment available to small and medium sized enterprises. These concepts will not substantially increase the operational costs of existing effluent treatment plants that range from 0.03 to 1.28 (averaging 0.40) €/m^3. Only in this way, an important contribution can be made at an early stage to secure site locations in future in the light of the EU Water Framework Directive and its ambitious goals.

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Remarks

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