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Research area: General aims

Environmental technology // Water

Key words:

Ozone, control, economic efficiency

Title:
Prediction-based O_3-dosage to comply with COD limits at minimized operating costs

Background/Problem area

Mill modernisations and enlargements result in increased wastewater volumes and concentrations of harmful substances in the circuits, which in many cases can no longer be handled by the mills' existing biological waste water treatment plants alone. This has created a growing need for innovative treatment processes for paper-industrial effluents. The combination "biological stage – ozonation – biological stage" has become an important solution for the further treatment of biologically treated effluents. The key operating parameter of an ozone reactor is the amount of ozone used.

In research project IGF 13095N a control strategy was established which provides constant COD concentrations. Compared to an uncontrolled ozone supply up to 20 % of costs for oxygen and energy can be saved. But many paper mills have to comply with load limits. To achieve this without economic losses, a control strategy is aspired which brings the COD loads actually discharged as close as possible to the limit values. Main part of such a concept is the reliable prognosis of the COD loads to be expected in the in- and outlet of the wastewater treatment plant (wwtp).

Until this project, no comprehensive experience or information exists about which production events have an effect on the COD loads into the wwtp, about the levels of resultant COD loads and about the extent to which they will be found in the outlet of the wwtp.

Objectives/Research results

The objective of this project is to establish a control strategy which enables paper mills to safely comply with load-based limit values whilst minimising the operating costs of ozone stages. In addition, the COD load shall be predicted from production events for the first time.

Biologically treated wastewater samples taken from two paper mills were subjected to continuous laboratory ozone trials. Based on the results for each tested paper mill the control concept was programmed and tested. In control trials the control programme required 1 to 6 volume exchanges to reach the set point.

Production and wastewater relevant data from two mills over a period of one year have been evaluated, to get information about production events which might have an influence on the COD load. In addition, considerable samplings and measurements were performed in the mills and the wwtp. Daily curves of flow rate and COD load were drawn. It was found that the produced paper grade is the main influence on wastewater composition, especially on biodegradability and therefore on the residual COD entering the ozone stage.

A model for a reliable prognosis of the COD loads to be expected in the in- and outlet of the wastewater treatment plant was set up. Cascades of Support-Vector-Machines are used to give a prediction of wastewater treatment for the next hours. Based on this prediction a cost-optimal control strategy of ozone consumption is calculated.

A control strategy to keep load limits was established. It was found that it is economically most efficient, to keep the ozone concentration in the feed gas constant. A function was created to calculate and thus optimize the costs of an ozone treatment from the predicted COD in the inlet of the ozone plant and the aspired COD elimination.

A dynamic model was created by using the simulation software IDEAS, which shows the main waste water streams. The given data over a period of one year from the mill had to be processed to a consistent time period type for further analysis. Not consistent data were removed. Data from three quarters of the year were used for model parameterisation, the fourth quarter was used for verification. Not all events in the production, e. g. web breaks, which influences the waste water amount, were obvious from the data. Additional the varying COD input from raw materials were unknown, which made it difficult to control the COD input in the model in a correct manner. The results from simulating the daily waste water curve were not satisfying but the sum of daily waste water amount. Around 90 % of the results from daily COD-load and waste water amount from the simulation were within a corridor of 20% from the real data.

Application/Economic benefits

Controlling the ozone production based on wastewater characteristics and expected loads will lower the operating costs of an ozone stage. Reduced COD loads and thus ozone consumption will in turn reduce the costs of energy and oxygen. Using the load-based control strategy costs can be reduced by 4 - 5 % compared to the manual strategy performed in mill A at present and by about 40 % compared to uncontrolled ozone production. In addition to the paper industry, especially SME suppliers from the measurement, control and automation sectors, suppliers of ozone plant manufacturers as well as the textile and clothing sectors typically dominated by SME will benefit from the research results.

Project period: 01.03.2007 – 31.05.2009

Remarks

The research project IGF 15173BG was funded by the German Federal Ministry of Economics and Technology BMWi and performed together with Gesellschaft zur Förderung angewandter Informatik, Berlin.