

**PULP AND PAPER MILL WASTEWATER TREATMENT THROUGH
CONSTRUCTED WETLAND TECHNOLOGY**

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CONSTRUCTED WETLAND TECHNOLOGY**

By
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Submitted
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DEDICATED
TO
MY LOVING DAUGHTER

CERTIFICATE

This is to certify that the thesis entitled, “PULP AND PAPER MILL WASTEWATER TREATMENT THROUGH CONSTRUCTED WETLAND TECHNOLOGY”, being submitted by Ms. Neetu Rani to Indian Institute of Technology, Delhi for the award of Doctor of Philosophy is a record of bonafide research work carried out by her under our guidance and supervision in conformity with the rules and regulations of Indian Institute of Technology, Delhi. The research report and results presented in this thesis have not been submitted in part or full to any other university for the award of any degree or diploma.

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ABSTRACT

Pulp and paper industry is an important contributor to the world's economy. The industry supports the production of various qualities of paper and at the same time releases huge amount of waste material in the environment. An effluent released from industry contains high BOD, COD, Organic Halides and Color etc.

A study was performed to evaluate the effectiveness of constructed wetlands for the pulp and paper mill wastewater treatment. Wastewater was characterized over the period of study. It had very high BOD up to 300-400 mg/l, 1000-1150 mg/l of COD, 1200-1780 mg/l of TS and 1800-2100 of color. Wastewater from industry was directed to the Department of Paper Technology, Saharanpur where wetland beds were constructed for the treatment. The treatment potential of Constructed Wetlands was carried out on two types of effluents namely (i) E1-Overflow of primary clarifier (ii) E2-Effluent after partial aerobic treatment of primary clarifier wastewater. Wetland beds were planted with two macrophytes namely *Typha angustifolia* and *Canna indica* during a total operation of two years. The Study was carried out at different HRT's i.e. 1.5, 2.0, 2.5, 3.5 and 6.5 days to calculate the optimized HRT on the basis of results and to collect the adequate data for seasonal variation. This study was carried out continuously for two years. The effect of aerobic pretreatment in case of both macrophytes was also studied. The field study bucket experiments were also carried out to compare the efficacy of *Typha* and *Canna* as well as the relative change in biomass of the two macrophytes. After physical modifications of the site, reductions in pollutants were consistently achieved in field experiments. The average removal of TS was found to be 87.6%, BOD up to 80.1%, COD up to 86.5% and color up to 89.4% during summer 72.15 % for TS, 72.07% for

BOD, 70.94% for COD and Color up to 74.9% during winters for E1 type of effluent at optimized HRT i.e. 3.5 days. Similarly in the case of E2 type of effluent results obtained showed the average removal of TS 82.27%, BOD 84.58%, COD 84.43% and Color 88.9% during summer and 73.93% of TS, 74.15% of BOD, 71.27% of COD and color up to 74.97% during winters. Also the data collected during summer and winter shows a relative change in the removal of efficiency in TS, BOD, COD and color. It proves that biological activities are more prominent during summers. The Study carried out for aerobic pretreatment of wastewater shows that only in case of *Canna* significant change was observed after removal of efficiency but in case of *Typha* there was no impact of aerobic treatment on the performance except of BOD removal.

Same results were also achieved during bucket experiments. Overall results obtained from the bucket experiment show that *Typha angustifolia* has good potential in case of BOD, to remove color, COD, and Total Solids in comparison to *Canna indica*. Also for observing the macrophyte potential, relative change in the biomass and root to shoot ratio for both species was calculated and it was observed that *Canna indica* shows relatively higher change in the biomass in comparison to *Typha angustifolia* in both HRT's and effluent type. Meanwhile, root to shoot ratio study indicates that the underground structure of *Typha* is stronger than *Canna*.

The Constructed wetlands proved effective in the treatment of pulp and paper mill wastewater. The continuous operation of the system at industrial level will be proved as environment- friendly and cost effective technique for effluent treatment. Hence, on the basis of the research work, the area has been calculated to design a wetland system for integrated pulp and paper mill.

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