A GENERIC APPROACH FOR TREATMENT OF COMBINED WASTE WATERS OF SMALL SCALE INDUSTRIAL CLUSTERS OF DELHI

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by

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Dedicated

to

My Teachers and My Family Members

CERTIFICATE

This is to certify that the thesis entitled "**A generic approach for treatment of combined waste waters of small scale industrial clusters of Delhi**" being submitted by Mr Asheesh Kumar Yadav to the Indian Institute of Technology, Delhi for the award of Doctor of Philosophy is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis. To the best of our knowledge the results contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

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(Asheesh Kumar Yadav)

ABSTRACT

Present study is an attempt to develop a suitable low cost strategy for treatment of combined wastewaters of small scale industrial clusters of Delhi. Most of the small and tiny industries do not have their own effluent treatment plants because of technical, economical and space constraints. Realizing this practical problem, a few Common Effluent Treatment Plants (CETPs) have been installed as a cost effective option for compliance with the discharge standards for small scale polluting units in industrial clusters, which cannot afford the burden of installing costly pollution control system. The combined wastewater of the Delhi industrial area is very complex in nature due to large numbers of industries and the heterogeneous nature of production in these industrial units.

To begin with, an overview of common effluent treatment with special reference to Delhi's industrial areas is discussed. Characterization as well as study of changes in quantity and quality of combined waste waters of small scale industrial clusters of Delhi was performed. Principal component analyses for characteristics of wastewaters were also performed. It was found that source of various pollutants were not same in cluster, they comes from different industrial sources. Finally, combined wastewaters of three industrial areas of Delhi namely Wazirpur, Mayapuri and Okhla industrial area were treated with two unit processes i.e constructed wetlands (CW) and electrocoagulation. The main idea behind these unit processes selection was their treatment suitability to these and low cost of CW.

Electrocoagulation treatment study was started with Ni removal from aqueous solution using iron and aluminium electrode in order to see the effect of different initial conductivity, treatment time and initial metal concentration. It was found that higher initial conductivity and treatment time produce best results. Treatment of wastewater from Wazirpur industrial area by electrocoagulation using Al-electrodes 100 % Cr, 98.71% of Zn removal in 40 minutes, 83.94 % COD, 62.33 % of TDS and 83.66 % of sulfate removal was also achieved in a treatment time of 80 min. Similarly, electrocoagulation of Okhla and Mayapuri wastewater also produced significant results within a treatment time of 80 minutes.

In constructed wetlands, three plant species namely *Canna indica, Typha angustifolia* and *Cyperus alternifolius* were used. Constructed wetland planted with different plant species were tested for their heavy metal (Cr, Ni, Cu, Zn and Co) removal potential from aqueous and all three were found to be potent plant species for these heavy metal removal. However, their heavy metal accumulation capacities were found to be different. Maximum heavy metal were accumulated in roots followed by stem and leaves in all three plant species. The best results were produced by *Canna indica* as it accumulate Cr, Ni, Cu, Zn and Co at concentrations of 1.06, 1.48, 2.02, 2.46 and 1.35 mg/g in its roots, Also, increased height of gravel bed in CW increased the performance of CW, for instance in case of 5 feet (150 cm) gravel bed height in CW, removal of Cr, Ni, Cu, Zn and Co were found to 68.47, 97.29, 82.14, 98.76 and 63.81% while it was 51.85, 74.37%, 61.69, 77.29% and 42.05% respectively in case of 1 feet (30 cm) bed height CW.

Three types of CW i.e normal CW, sulfate reducing bacteria enriched constructed wetland (SRB-CW), sulfate reducing bacteria and iron shaving enriched constructed wetland (SRB-IS-CW) planted with the three plant species were investigated for treatment of Mayapuri, Wazirpur and Okhla industrial area wastewaters. The later two types of constructed wetland were innovative type developed in this study. Performance of SRB-CW and SRB-IS-CW were found to be much better than normal constructed wetland in every case which is significant contribution coming out of this study.

Finally, based on the experimental findings, a generic model for the treatment of combined wastewaters of small scale industrial clusters of Delhi is proposed. It is hoped that the newly developed innovative constructed wetlands using SRB and Iron shaving coupled with electrocoagulation treatment would provide a pragmatic cost-effective solution to the problem of small scale industrial effluents in Delhi.

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CHAPTER 5: TREATMENT OF INDUSTRIAL WASTEWATER IN CONSTRUCTED WETLANDS