TERTIARY TREATMENT OF DISTILLERY WASTE BY NANOFILTRATION

by

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waste treatment
Distillation

CERTIFICATE

This is to certify that the thesis entitled, **TERTIARY TREATMENT OF DISTILLERY WASTE BY NANOFILTRATION** submitted by Umesh Kumar Rai has been prepared under my supervision in conformity with rules and regulations of the Indian Institute of Technology, Delhi. The results contained in it have not been submitted in part or full to any other university or institute for award of any degree/diploma.

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ABSTRACT

In the last few decades, environmental problems have become one of the major issues all over the world. Particularly the water pollution due to effluent generate form different sources has been the major focus of attention all over the world. A major development in this scenario is the shift of emphasis from treatment and disposal to the concept of reduction of effluent generation and reuse of treated wastewater.

Problems associated with wastewater reuse are linked with qualitative and quantitative requirements of particular application & may include the removal of suspended and dissolved solids (both organic & inorganic) substances, nutrients and toxic compounds. Conventional primary and secondary treatment processes remove substantial amount of these components. However, in most cases the degree of removal is not sufficient for its reuse. In such cases tertiary treatment using advanced wastewater treatment facilities becomes an integral part of the system.

The wastewater treatment system for every industry throws a new challenge to the scientists/ engineers, because of the problem of its unique characteristic and specific end use requirement. In this regard distillery wastewater poses extreme problem due to high contaminant concentration of both organic and inorganic solutes.

Biological treatment processes like anaerobic and aerobic processes are not sufficient for highly polluted effluents like that released form distillery plant. Primarily it is because of the difficulty in oxidizing the residual organics after the biodegradation, which are quite refraction in nature. Several tertiary treatment processes such as Carbon adsorption, Advanced Chemical oxidation and Membrane filtration may be used either by itself or in combination of two or more to achieve the disposal and reuse criteria.

Membrane filtration is a broad term used to describe the separation of various soluble components because of their molecular sizes and affinity towards membrane surfaces. This system is applicable in wastewater treatment to achieve high quality water free of most components dissolved or otherwise.

There are several membrane separation systems available like micro-filtration; ultra-filtration, reverse osmosis, electrodialysis & nanofiltration. The effluents with high level Organic/ Inorganic contamination may be treated with a combination of biological and membrane separation process to get reusable treated water. A suitable combination of the membrane separation processes along with the biological treatment systems for effluent with high pollutant levels such as the one discharged from distillery plant has the most potential for solving the complex problem. The presence of organic and inorganic solutes in distillery waste makes it imperative to use nanofiltration system for the membrane separation.

In this study aerobically treated distillery effluent has been processed through a nanofiltration set up consisting of spirally wound membrane module operating in the pressure range of 1-5 bar. The experiments were carried out at different inlet concentration of organics and inorganics, measured by COD and TDS respectively. The membrane was characterized by operating with distilled water and brine solution to determine pure water permeability and standard % NaCl separation. A theoretical model for the separation of solutes by nanofiltration has been developed to explain the separation system.

Separation of COD and TDS represent two different systems. While COD represents the organic separation that of TDS indicates the separation of combined organic and inorganic solutes.

Experiments were carried out in a specially fabricated nanofiltration membrane setup consisting of high-pressure pump, micron filter and membrane module. The nanofiltration membrane module used was supplied by hydranautics and is a spirally wounded composite membrane. The initial characteristics showed the membrane to exhibit high permeability and high salt rejection rate (>95%).

Results of experiments with aerobically treated distillery effluent show that the percent separation of organic by nanofiltration represented by COD, it was quite high and was within the range of 90-98 %. In comparison the percent separation

of total dissolved solids showed somewhat lesser extent of separation being in the range of 70-90 %. This indicates a separation, of inorganic solids to the extent of only 50-70%. The colour removal observed during the operation was in the range of 99-99.5% in all cases.

Results of experiments with varying circulation rate of the feed, show that the permeate flow rate, % COD and % TDS removal increases with the increase in circulation rate. This was mostly due to the effect of concentration polarization caused by mass transfer resistance.

Effect of pH variation on the membrane separation showed maximum permeate flow rate near the neutral pH range. This flow rate gets reduced as the pH range is changed to either acidic or alkaline. The reduction is more pronounced for alkaline range.

The presence of inorganic and organic solutes makes the distillery waste system a complex one, the existing model by nanofiltration system are mostly based on either organic or inorganic. In this project a relatively more generalized model based on the combination of Kimura-Sourirajan Model for organic solids and Nernst-Plank model for the inorganic solutes has been developed. The model was applied to the experimental data observed. The predicted values were found in good agreement with the experimental data.

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