SYNOPSIS

Rapid industrialization leads to environmental pollution to a considerable level. Among these textile industries is one of the major pollution causing industries. The textile dyeing industry consumes large quantities of water and results in large amounts of wastewater streams from different stages of dyeing and finishing processes. The wastewater from printing and dyeing units in a textile plant is often rich in colour, containing residue of reactive dyes and chemicals, and needs proper treatment before letting into the environment. Among the dyes used for the dyeing purpose reactive dyes are occupying 60-70% of the total share. In the dyeing of reactive dyes only 70% of the dye used is fixed with the fibre. Remaining part is getting hydrolyzed and discharged along with other pollutants. Because of the complex nature of the dye substances, the effluent treatment methods such as chemical, physico-chemical and biological methods are not providing satisfactory results.

I have adopted three different techniques were carried out namely i) Electrochemical oxidation, ii) Chemical or electro chemical coagulation followed by ion exchange process and iii) Electro chemical ion exchange membrane process for the treatment of waste waters generated in textile dye industrial processes namely i) Dye bath wastewater ii) Wash wastewater and iii) Mixed wastewater.

The chapter I deal with the general introduction on various wastewater treatment methods in particular electro chemical methods and their principles, advantages etc.

The chapter II was studied the efficient electro chemical treatment of Procion Black-5B- a pilot plant study (mixed effluent). Experiments were conducted at different
current densities and selected electrolyte medium using Ti/RuO₂ as anode, stainless steel as cathode in a cylindrical flow reactor. By cyclic voltammetric analysis, the best condition for maximum redox reaction rate was found to be in NaCl medium. During the various stages of electrolysis, parameters such as COD, colour, FTIR, HPLC, UV-VIS spectra studies, energy consumption and mass transfer coefficient were computed and presented. The experimental results showed that the electro chemical oxidation process could effectively remove colour and the chemical oxygen demand (COD) from the synthetic dye effluent. The maximum COD reduction and colour removal efficiencies were 74.05% and 100% respectively. Probable theory, reaction mechanism and modeling were proposed for the oxidation of dye effluent. The results obtained reveal the feasibilities of application of electro chemical treatment for the degradation of Procion Black-5B.

The chapter III was examines the use of chemical or electro coagulation treatment process followed by ion exchange process of the textile dye effluent (wash water). The dye effluent was treated using polymeric coagulant (cationic dye fixing agent) or electro coagulation (iron and aluminium electrode) process under various conditions such as various current densities, effect of pH, efficiencies of COD reduction, colour removal and power consumption were studied for each process. The chemical or electro chemical treatment are indented primarily to remove colour and COD of wastewater while ion exchange is used to further improve the removal efficiency of the colour, COD, Fe concentration, conductivity, alkalinity and total dissolved solids (TDS). From the results chemical coagulation, maximum COD reduction of about 81.3% was obtained at 300 mg/l of coagulant whereas in electro coagulation process, maximum COD removal of about 92.31% (0.25A/dm²) was achieved with energy consumption of about 19.29
kWh/kg of COD and 80% (1A/dm²) COD removal was obtained with energy consumption of about 130.095kWh/kg of COD at iron and aluminium electrodes respectively. All the experimental results, throughout the present study, have indicated that chemical or electro coagulation treatment followed by ion exchange methods were very effective and were capable of elevating quality of the treated wastewater effluent to the reuse standard of the textile industry.

The chapter IV deals with “Dye destruction and simultaneous generation of sodium hydroxide with an electro chemical reactor-(dye bath effluent)”. The textile dye bath effluents contain high concentration of organic dyes, sodium chloride and other chemicals. These inhibit the activity of microorganisms during biological oxidations. Hence high concentration of organic dye and Total Dissolved Solids (TDS) that are not removed by biological treatment must be eliminated by an electro chemical treatment. In this paper, degradation of dye effluent and simultaneous generation of caustic soda with an electro chemical membrane process was studied. In this process an electro chemical cell separated into two compartments with a cation selective membrane was used. Experiments were carried out at different current densities and different flow rates at 10, 25, 50, 75, 100 and 125 ml/min using Ti/RuO₂/IrO₂ as anode and stainless steel used as cathode. During the various stages of electrolysis, the parameters such as, effect of operating conditions on degradation of dye, chemical oxygen demand (COD), colour, recovery of caustic soda, energy consumption, HPLC data, cathode materials, current efficiency and mechanism were monitored. The experimental results showed that the electro chemical process could effectively remove colour, COD and generation of caustic soda from the dye effluent. The maximum COD reduction, colour removal and caustic generation were 92.16 %, 100% and 210.28gpl respectively.
The chapter V deals with summary and conclusions

1. The experiments were carried out in cylindrical flow cell (single pass) reactors, the decrease in flow rate and increase in current density significantly increase the reduction of COD. Both mass flux and mass transfer coefficient are higher in the case of flow cell reactor method. This method is also economical. For the industrial application, flow cell method can be recommended with two or more reactors in series at a current density of $1\text{A/dm}^2$-$2.5\text{A/dm}^2$.

2. The chemical or electro coagulation followed by ion exchange process. In the case of chemical coagulation, maximum COD reduction of about 81.3% was obtained at 300 mg/lit of coagulant whereas in electro coagulation process, maximum COD removal of about 92.31% ($0.25\text{A/dm}^2$) was achieved with energy consumption of about 19.29 kWh/kg of COD at iron electrode and 80% ($1\text{A/dm}^2$) COD removal was obtained with energy consumption of about 130.095 kWh/kg of COD at aluminium electrode. To further elevate the water quality to the reuse standard, ion exchange using cationic and anionic exchange resins was found necessary. Experimental results indicated that 20ml of cation exchange resins and 40ml of anion exchange resins were needed to treat 400 ml of treated wastewater containing 5200 μmho/cm effectively. The water quality of treated wastewater was observed to be consistently excellent, comparable to that of deionized water.

3. The experimental results showed that the electro chemical membrane process could effectively remove colour, COD and recovery of caustic soda from the dye effluent. The optimization of simultaneous recovery of caustic (~99% of current efficiency) as well as COD removal (~66.67%) could be achieved at a current density about 2.5 A/dm$^2$ during the electrolysis with minimum energy consumption. The results of the study show that electro chemical membrane process offers an interesting alternative method for the treatment of the dye bath effluents.