CHAPTER V

SUMMARY AND CONCLUSIONS

5. Introduction

Synthetic dyes have been used extensively in tanning and dyeing industries because of their ease and cost effectiveness in synthesis, firmness and variety in color compared to natural dyes. Azo dyes are the largest and most versatile and play prominent role among synthetic dyes. Those industries which use dyes often generate wastewater that is highly colored and needs treatment before disposal. Previous studies have shown that various combinations of biological and physico-chemical treatment generate huge quantities of sludge. The electron withdrawing nature of azo linkage obstructs the susceptibility of the azo molecule to oxidative reaction. Only some algae and fungi were found to be capable adsorbing and decolorizing azo dyes. The present study employed the decolorization of azo dyes using two different techniques i.e., biosorption and biodecolorization for simulated and dye house effluents. The salient features and conclusions thereof of the present studies are as follows:

5.1 Biosorption

The azo dyes Orange G, Acid blue113 and Acid Red 66 which were used in textile industries were selected for the present study. These azo dyes have been sorbed effectively onto two different marine algae. It is observed that orange G gave maximum % of adsorption (91 and 80) at pH 6.7 and AR66 at pH 4.5 by Hypnea valentiae and Ulva fasciate at 30 0C. The maximum adsorption per gram capacity had
also been optimized for both biosorbet with both azo dye molecules and it was found that 25 g/l for Hypnea valentiae and 20 g/l for Ulva fasciate. The biosorption also depends on the agitation of adsorption systems. The agitation during biosorption was varied from 0 to 200 rpm. The maximum biosorption found to occur at 200 rpm in both the dyes with both the sorbents respectively.

The experimental data have been extensively analysed by Langmuir, Freundlich, and Lagergren rate equations. Langmuir adsorption coefficient, $X_m/K$ of Ulva fasciate nearly four times higher in the dye concentration from 3 to 100 ppm when compared to Hypnea valentiae for Or G, AB113 and AR66. Moreover, Ulva fasciate removed large amount of dyes from solution, and also binds to remove more dye molecules per gram of substrate. It is also showed good filterability capacity than Hypnea valentiae. The rate constant decreases with increases in concentration.

Biosorption of AR66 by Hypnea valentiae has also been studied by continuous column adsorption processes. Breakthrough time and volume of biosorption of dyes were calculated and reported.

5.2 Biological decolorization

The biological decolorization of chromophores of simulated dye bath and original dye house effluents using the white rot fungi Trametes sp which is isolated from contaminated soil samples were reported in detail.

The effect of independent variables such as carbon, nitrogen sources, pH, nutrients, temperature, and agitation etc., for specific microorganism needed for each dye molecules and dye house effluent on biological decolorization were completely examined. The kinetics of biological decolorization had also been carried out. It was observed that the optimum pH for both the fungi was found at 6.5. The maximum
fungal biomass production was enhanced by glucose as carbon source and urea as nitrogen source with an optimum temperature of 30 °C under static aerobic conditions. Kinetics of decolorization process was carried for azo dye molecules by the fungal species.

The pH value declined more by addition of glucose alone than other sources for both the isolated fungi. The fungi Phanerochaete sp and Trametes sp decolorized the dyes in the presence of co-substrates and these fungi responded more to glucose and fructose than starch. The assay of enzymes laccase involved in ligninolytic system of Phanerochaete sp and Trametes sp was assessed in the crude cell extract of the culture and the maximum laccase activity was observed for both the fungi.

Biosorption and biodecolorization have been successfully applied to the treatment of raw dye house effluent, it was observed that in both the processes above 90 % biosorption and decolorization occurred in 25 % of diluted effluent and also there was significant reduction COD, TSS and TDS

A nation’s development depends heavily on its industrial and technological innovations. There is hardly any industry that does not add wastes into the environment. The introduction of contaminants through effluent and sludges to different environmental compartments, can often overhelm the self-cleaning capacity of recipient ecosystems and thus result in the accumulation of pollutants to problematic or even harmful levels. The realization of the high cost of waste treatment by physico-chemical methods has opened the door for the investigation of new methods. Bioremediation is an alternative method which does not have the disadvantages associated with the sludge. In fact, it is more advantageous due to its eco-friendly and cost effective nature. Hence, an attempt has been made to exploit the potential of fungi, algae and weeds for effluent and soil treatment along with
production of laccase enzyme and extraction and amplification of specific laccase gene for further investigations on decolorization.

We find that increased competition in the international market, environmental regulations and the availability of subsidies in the technology modernization scheme were the main reasons for the introduction of new technologies. The salient findings and conclusions that emerged out of the study are summarized below:

1. India’s Textile industry is concentrated in a handful of locations. The industry is dominated by a large number of small firms. Only a handful of firms are large. The small firms have very limited financial capability to introduce environmentally friendly technologies and treatment methods.

2. The technology used by Indian Textile firms is, by and large, outdated and inefficient. Their environmental performance is poor. They do not use environmentally friendly technologies and produce large amounts of effluent with a high load of pollutant. The also have limited capacity to treat effluent, and in many cases these facilities are not effective.

3. The adoption of new technology has three important motives.
   - a need to meet the environmental standards in the importing countries
   - a need to comply with the environmental regulations in India and
   - a need to improve decolorization efficiency (all of which will have positive environmental impact).

4. We find that the industry’s motivation to introduce environmentally friendly technologies and production methods is strongly influenced by the lax enforcement of environmental regulations. The other important factors which discourage the industry from investing in environmentally friendly technologies are
the high cost of machines and high cost of capital. Not surprisingly, we also find that strict enforcement of environmental regulations and the conventional treatment processes are considered to be important factors which will motivate to adopt environmentally friendly treatment methods.

5. The restrictions imposed by the importing countries on the use of certain hazardous chemicals for the effluent treatment have led to a complete substitution of these chemicals with environmentally acceptable substitutes. Our case studies suggest that the almost smooth changeover to new biosorbent and isolated fungi was possible for two reasons: firstly, the availability of biosorbent and fungi. Secondly, the use of new treatment method did not require new capital investment; the firms could changeover without incurring large capital expenditure. The adoption of environmentally friendly technologies and treatment methods, on the other hand, may require capital investment and managerial changes. Most Indian Textile industries are small and have a conservative attitude to change. They lack both the financial resources and openness to new ideas, which could lead them to adopt environmentally friendly treatment methods.

5.3 SCOPE FOR FURTHER RESEARCH

Clearly, there is a need for further research especially in the area of real effluent treatment for reuse. It is very important to consider that there can be no universal process to suit all kinds of effluents. The same is applicable for the process of biosorption. However, modification of the biosorbent and pretreatment of the real effluents prior to treatment can increase the compatibility of the biosorbent for the process. Moreover, successful reproduction of the biosorption process on a commercial level as well as the ability of biosorbents to maintain constant dye uptake also need to be explored.