CHAPTER 3

SCOPE AND OBJECTIVES OF THE INVESTIGATION
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3.1 Scope Of The Investigation

Recognition of color as a priority pollutant and promulgation of environmental regulations limiting the effluent color levels have prompted several investigators to orient their research towards the color removal from dyeing plant effluents.

Various physical, chemical, physico-chemical and bio-chemical processes like sedimentation, equalization, neutralization, flotation, chemical oxidation / reduction, chemical precipitation, coagulation and flocculation, adsorption, ion-exchange, reverse osmosis, electro-chemical coagulation etc., have been investigated for the treatment of dyeing industry effluents (Porges et. al., 1939; Jorgensen, 1974; Brandon, 1990; Mckay, 1982; Barton, 1987; Karthikeyan, 1990; Allen et. al., 1995; Venkata Mohan, 1997; Robinson et. al., 2001; Robinson et. al., 2002; Pala and Tokat, 2002; Armagan et. al., 2002; Kim et. al., 2002; Xiong et. al., 2001; Li et al., 2002; Szpyrkowick et. al., 2001; Ledakowicz et. al., 1999; Gomes de Moraes et. al., 2000). Color removal by physical process like equalization, neutralization, sedimentation and flotation is negligible. (Boudreau et. al., 1981). Biological treatment process employing activated sludge process,
trickling filters, and aerated lagoons were extensively studied for color removal and are found to be effective only in some cases (Chang et al., 2002; and Feitkenhauer and Meyer, 2001). The biological treatment is affected by the concentration and non-biodegradable, toxic and inhibitory nature, alkalinity, and elevated temperature of the dye effluents. Attempts are being made for the removal of coloring matter by biosimulation employing specific strains of different types of bacterial, algal, white rot fungus, etc. (Davis, 1978; Wang and Yuen, 1990; Kirby et al., 2000; Balan and Monteiro, 2001; and Assadi et al., 2001). However, the ability of biological treatment processes for decolorization of industrial effluents is ambiguous, different, divergent and undependable (Waters, 1984; Karthikeyan, 1988; Kirby et al., 2000; Shah et al., 2001; Manu and Chaudhari, 2002; and Fontenot et al., 2002). One of the most preferred methods for color removal in use today is chemical coagulation. A number of existing facilities utilize this process as their primary color reducing technique. Like wise, numerous studies have dealt with the use of inorganic metal salts and organic polymers for the removal of color from various textile dyeing wastewater (Porges et al., 1939; Karthikeyan, 1990; Weiner et al., 1967; Crowe et al., 1978; Niranjan, 1986; Sailaja, 1996; Sreedhar Reddy et al., 2002). Although chemical coagulation was often applicable for color removal, the addition of large amount of chemical results in the production of significant quantities of chemical sludge, which requires careful disposal in the secured land filling. Activated carbon adsorption is the most commonly used color removal technique, but it simply transfers the dye from water phase to carbon phase. Carbon adsorption treatment is not effective for some dyes and pigments, but very effective for other dyes in particular those, which are not removed by coagulation (Mantell, 1951; Rye and Digiano, 1979; Venkatamohan, 1997). The performance of an activated carbon treatment process, apart from the operating conditions, depends on the
type of carbon and nature of dye present in the effluent (Venkata Mohan, 1997). Though activated carbon demonstrates its potentiality in removing the dyeing industry effluent color, the high initial cost of carbon, coupled with problems associated with regeneration / reuse necessitates search for suitable low cost alternate adsorbents. In this realm, various low cost materials originated from natural sources such as coal, silica, clay minerals, peat, wood etc. and industrial sources like fly ash, slag, cake, began pith, orange peel, bamboo pulp, cotton waste, tea dust, coconut husk and shell and rice husk etc., have been widely studied for color removal and found to be effective (Thornton and Moore, 1951; Dave, 1979; Mckay and Allen, 1980; Mckay et. al., 1981; Ramprasad, 1983; Manivannan, 1985; Mckay et. al., 1986; Khare et. al., 1987; Karthikeyan, 1987; Ahmed and Ram, 1992; Venkatamohan, 1997; Robinson et. al., 2002; Pala and Tokat, 2002; Graham et. al., 2001; Armagan et. al., 2002). Though low cost sorbents have been found to be reliable in removing color from dye wastes at batch studies, the size and amount of materials available retards its usage. Reverse osmosis and ultra filtration are very effective for the removal of all types of color from dye house discharges, decolorization on the order of 95 - 100 percent are readily obtained (Brandon, 1990; Akbari et. al., 2002; Chang et. al., 2002). However, clogging of the membranes with concentrated dyes after prolonged usage is a problem. About 10 - 25 percent of the original volume of the wastewater treated become concentrate, which cannot be reused, has to be disposed of by incineration. Chemical oxidation technologies, however seems to have the most potential for future use in the dyeing wastewater treatment. The potential of various advanced chemical oxidation processes such as UV/O₃, UV/H₂O₂, UV/ H₂O₂/O₃ and FeSO₄/ H₂O₂ has been proven in treatment of various effluents including dyeing industry effluents (Balcioglu and Arslan, 2001; Kunz et al., 2001; Koch et. al., 2002; Gomes De Moraes et. al., 2000; Hung et. al., 2001,and
Ruppet et al., 1994). Although these processes are technically sound, they are quite expensive and have doubtful economic viability, especially small scale sector of the dyeing industry in developing countries (Davis et al., 1994; and Lin et al., 1993).

In view of the above limitations, in the present investigation, the following four methodologies have been viewed from technical, economic and operational point of view to bring the final quality of effluent to the regulating authority standards. The four methodologies includes:

1. Natural aging followed by chemical coagulation (FeSO₄ / Lime / Bentonite clay) and sludge utilization in brick manufacturing.

2. Pre-oxidation with Photo Fenton process followed by Lime flocculation and sludge utilization in pavement block manufacturing.

3. Decolorization with Solar / TiO₂ / H₂O₂ processes.

4. Decolorization with adsorption by sewage and tannery sludge derived activated carbons.

The main objective of the present investigation is to assess the amenability of dye color removal by different techniques from dyeing plant effluent and to develop a technically feasible and economically viable treatment technique.

To achieve the above goal the following are the objectives of the study.

1. To characterize the structural properties of simulated dying plant effluent by infrared spectrometry before and after natural aging.
2. To study the effect of natural aging on decolorization of simulated
dyeing plant effluent by chemical coagulation.

3. To study the effect of coagulant aid on decolorization capabilities
and sludge setting characteristics of chemical coagulation.

4. To study the feasibility of brick manufacturing from coagulant
sludge.

5. To study the effect of lime flocculation on stiochiometric
requirements of photo-Fenton’s process for the decolorization of
simulated dying plant effluent.

6. To study the feasibility of sludge utilization, which is, generated
during decolorization of simulated dying plant effluent by photo-
Fenton’s process followed by lime flocculation in pavement block
manufacturing.

7. To assess the capability of solar/TiO$_2$/H$_2$O$_2$ methodology for the
decolorization of simulated dying plant effluent.

8. To prepare and characterize the activated carbon form sewage and
tannery sludge.

9. To study and analyze the decolorization capabilities of sewage and
tannery sludge derived activated carbon for simulated dying plant
effluent.

10. To evaluate the adopted decolorization methodologies for simulated
dyeing plant effluents in terms of their economics.