CHAPTER 1

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Dyeing is the process of coloring the fibers, yarns or fabrics by using a liquid containing coloring matter for imparting a particular hue to a substance. Small-scale dyeing industries have been set up in an unplanned manner in many cities of India. Most of the small scales dyeing units are being operated in the residential premises as cottage industries. Many of these industries did not have treatment plants due to lack of space and economic reasons and discharge their untreated effluent in to sewer systems or near by watercourses. Dyeing process effluents contains several classes of dyes (reactive/vat/direct/naphthol), alkalis, acids, sodium salts (NaCl), detergents (surfactants), softeners, etc (Swades K. Chaudhari et. al., 2000). They exert high pH, total dissolved solids. Sodium chlorides and color to the effluent. The concentration of these substances mainly depends upon the dye employed and auxiliary materials used in the dyeing process.

The chromophores in an ionic and non-ionic dye are mostly azoic groups or anthraquinone types (Joannebell et. al., 2000). Anthraquinone based dyes are the most resistant to degradation due to their fused aromatic structure and therefore remain colored for a longer period of time in waste water (Razo-Flores et. al., 1997). Basic dyes have high brilliancy and intensity of color, which create problems in color removal.
The metal complex dyes are mostly based on chromium metal. Even a small concentration of chromium metal in water is unacceptable because of its carcinogenicity in nature (Miller and Miller, 1953; Little et. al., 1974; and Sturmer, 1993). Due to high amount of copper sulfate recommended for the after-treatment of direct dyes, dyeing mills face problems in meeting copper effluent limit. The alkalis – reducing system with vat dyes causes discharge of aqueous solutions of sulfide in the effluent, which give foul smell and contaminate receiving watercourses resulting in destruction of aquatic life. Besides, dyes have a tendency to chelate metal ions and thus become micro toxic to the aquatic life (Miller and Miller, 1952; Allen et. al., 1972; and Shenai, 1995). Dyes degrade very slowly and continue to consume oxygen even after 30 days (Kotaiah, 2000).

Color acquired by a water body through the discharge of dyeing plant effluent inhibits growth of the desirable aquatic biota necessary for self-purification by reducing penetration of sunlight and consequent reduction in photosynthetic activity and primary production. Color being a visible pollutant, attracts the concern of even an environmentally indifferent person. Aesthetically it renders the colored effluent receiving water bodies unacceptable and causes public resentment. Water works and industries situated on the downstream of colored outfalls receiving colored wastewater may be forced to go in search of alternate sources of water supply. Thus it is imperative that color must be removed from dyeing industry effluents prior to disposal.

Removal of color from dyeing plant effluent is more complex than any other industrial waste purification problems because of the fact that no two dyeing effluents are alike in character, nor can any two effluents be purified by exactly the same type of treatment. The combined effluent from each dyeing unit continuously changes with the introduction of new
dye shades or with change in market demands. Dyeing unit wastes are as varied in character as the kind and colors of the good produced within the mills. Each problem must be studied carefully in order that its solution may confirm to sound economic principles of conservation.

Infact, the most consistent thing about dyeing effluents is the fact that they will consistently change, more over a dye responded to a particular treatment may not be effectively treated by other methods. Adsorption, chemical precipitation or coagulation, chemical oxidation and reduction, membrane separation and bio-oxidation are generally used for color removal (Mrinal Thakur et. al., 1998). However all these methods have limitations in terms of removal efficiency, specialty, volume capability, operation and maintenance and economy (Kotaiah, 2000).

Tentatively, four methodologies have been viewed from technical, economical 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 from simulated dying plant effluent by different techniques and to develop a technically feasible and economically viable technique.