Literature Review:

A dye is a colored substance that has an affinity to the substrate to which it is being applied. Dyes may be natural or synthetic in origin. It may be soluble or insoluble in water. It imparts specific color when applied or mixed to the matter such as textiles, food, pharmaceuticals, leather, plastic paper, etc. Dyes are known to ancient peoples. At that time all the dyes used were of natural origin. At present, from total uses of dyes contribution of natural dyes is negligible. First organic dye was synthesized by English chemist William Henry Perkin in 1856. From that time number of synthetic dyes were discovered and entered into market (Khan et al., 2004).

Today most of the dye used in textile, leather, food and pharmaceutical, paper, plastic, automobile industry, etc. are synthetic organic compounds. Organic dyes are classified by two ways: according to their chemical structure and areas of application. Some of the dyes according to chemical classification are azo dyes, anthraquinone dyes, acridine dyes, indophenols dyes, rhodamine dyes, fluorone dyes, etc. According to another method some of the classes of dyes are acid dyes, basic dyes, mordant dyes, direct dyes, vat dyes, reactive dyes, azoic dyes, sulfur dyes and dispersive dyes. India is one of the largest producers of dye. Total production of dyes and pigment in India is around 80 thousand tones. India’s dye and pigment export business is high. Among the developing countries India is second largest exporter of dyestuff and intermediates, among the developing countries (Mathur et al., 2005).

Among the different dyes production of azo dyes is proportionally high. Azo dyes consist of substituted benzene rings and they are joined through -N=N-. Azo dyes are structurally diverse group of chemicals and about 2000 azo dyes are in use. Azo dyes are widely used in textile, leather, paper, food and cosmetic industry. The estimated azo dye production all over the world is about 1 million tons. In cotton dying mainly reactive azo dyes are preferred and today more than half cotton textiles are tinted with reactive azo dyes (Ndasi et al., 2011).

Dyes are the important pollutants in water. Dyes discharged into natural water bodies from industrial effluents mainly from the cloth dyeing processes. Dyes are highly colored and toxic in nature to aquatic life (Oyama et al., 2004).

Dyes are natural or synthetic colorants used in various industries like pulp, paper, textile; paint etc. dyes are highly visible due to their characteristic properties i.e. high molar absorptivity.
As a result even if a small amount of some dyes (less than 1 ppm) are highly visible and makes appearance of water undesirable. During the dying processes about 10-15% dye of the dye is lost in the effluent (Ravikumar et al., 2005).

Some dyes are carcinogenic in nature so required the separation and advanced treatment before introduced into the conventional water sources. Reactive dyes are most used azo dyes in combination with different reactive groups. They bind to textile fibers by formation of covalent bonds. They have favorable characteristics such as bright color, easily water soluble, simple application technique and low energy consumption (Basava Rao et al., 2006).

Azo dye gives rise to the major problem due to their intense color. The human eyes detect up to 0.005 mg/L reactive dye concentration in water, and therefore exceeding this limit of concentration would not be permissible on the basis of aesthetic group after reactive dyeing process about 800 mg/L dye remains into the dying bath (Steankenrichter and Kermer, 1992).

Many of the dyes used for variety of purpose were identified to toxic in nature. Not only was this, but degradation products of many dyes identified to be carcinogenic and toxic in nature. The International Agency for Research on Cancer (IARC) has classified many dyes is referred as carcinogenic in nature; e.g benzidine is carcinogenic to a different mammalian species, including humans. By laboratory testing on animals observed that Direct Blue-6 and Direct Black-38 these two benzidine dyes has been reported as effective carcinogens and. Dyes decreases penetration of light through water and thereby affects photosynthetic process. This reflects in terms of adverse growth of phytoplankton’s (Yu, et al., 2004).

An additional problem is that ordinary and hydrolyzed form of reactive dye not easily biodegradable and thus, after extensive treatment still effluent has color. Reactive dyes are not easily removable by simple conventional methods of waste water treatment, since they are stable towards heat, light and oxidizing agent and are biologically non- biodegradable. So they are problematic compound in textile effluents. Hence, their removal is also of great importance (Sun and Yung, 2003, Ravikumar et al., 2005, Ozdemeir et al., 2004).

A technique for dye removal includes coagulation, ozonation, adsorption and advanced oxidation processes. Among these adsorption and advanced oxidation processes yields a best result for the removal of an azo dye from the waste. In adsorption there is various adsorbing
material can be used. They are going to be best due to its low cost and adsorbing efficiency. From its activated carbon have these two characteristics. Conventional oxidation treatment has found to difficult oxidize dyestuff and textile waste. To ease stated problems advanced oxidation processes (AOP’S) have been developed to generation of hydroxyl free radicals from different techniques (Tan et al., 2000).

In adsorption process suitable adsorbent is used to remove dye from the effluents. This is attractive method only when adsorbent utilized have low cost. Electrochemical methods are relatively new methods and are adventitious over other methods as they do not requires chemicals and do not produces sludge. It shows efficient and economical removal of dyes and a high efficiency for colour removal and degradation of recalcitrant pollutants (Pelegrini et al., 1999).

Use of NaOCl result into cleavage of azo bond and results into release of aromatic amines into treated effluents. Aromatic amines are toxic in nature. In photochemical method degradation of dyes is attempted in presence of ultraviolet radiations and H₂O₂ or/and photocatalyst. In this method dyes are broken to form CO₂ and water as final products. The extent to which degradation of dye take place in this method depends upon pH, intensity of light, reactor design, structure of dyes and composition of effluents (Slokar and Le Marechal, 1997).

Ozonization is relatively old technique in which oxidation of dye takes place due to strong oxidizing nature of ozone. Oxidation by ozone is capable of degrading chlorinated hydrocarbons, phenols, pesticides and aromatic hydrocarbons. However ozonization is not cost effective process due to high cost of ozone, less half life period of ozone (which requires continuous ozonization). Fenton method utilizes Fe and H₂O₂ and it is one of the economic options to the treatment of effluents containing toxic and non-biodegradable dyes. Adsorption of soluble and insoluble dyestuff is another method for removal of dyes from effluents but in this method large amount of sludge is generated and disposal of sludge poses the problem on these methods (Pak and Chang, 1999).

Although many methods are reported for removal of azo dyes feasibility of many of this process were not studied for large scale removal. One of the objectives of our study is that to carry out bench scale study on known and different methods on selected azo dyes and to select
best and cost effective method for removal of selected azo dyes. In next step scaling up of best process will be carried out from bench scale to large scale such as 200 litres for removal of selected azo dyes. Another objective of our study is to introduce new catalytic methods for removal of azo dyes from aqueous solution. In our present work we also study the kinetic and thermodynamic parameters of selected dyes.