

**Coagulation Using Ecofriendly Natural Coagulants**

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IN THE HIERARCHY of human needs, clothing has the second top most priority next to food. Dyeing units discharge highly coloured waste water. These waste water prior to discharge should comply with standards prescribed as per the water (prevention and control of pollution) Act 1974 as amended in 1988 framed by the government of India, so as to prevent the receiving water bodies from pollution. Biological treatment processes are found to be ineffective for removing colour from the effluent. Consequently effluent after biological treatment may contain appreciable amount of colour. Discharge of highly coloured waste in to natural water bodies prevents photosynthetic activity. In addition many dyes may be micro toxic to the organisms and may cause destruction of aquatic biota. It is thus imperative that colour must be removed from the effluent before disposal. Conventional metal coagulants such as alum, and iron salts are proved to be effective in the removal of colour, from the dyeing effluent but with limited success because of some disadvantages. (i) Production of a large sludge volume which do not readily settle, making the process slow and expensive, (ii) Effectiveness in coagulating only a few dyes and (iii) Increase of TDS in the treated effluent. Use of natural coagulants in conjunction with the conventional coagulants would improve the efficiency of treatment and reduce the cost of treatment. The objective herein, is to study the performance of natural coagulants nirmali (strychnos potatrum) seed, Drumstick (moringa oleifera) seed, Tamarind (tamarindus indica) seed, and chitosan in removing colour from the dyeing effluent, also in conjunction with conventional (metal) coagulant alum.

The characteristics of the composite waste water generated from a moderately maintained and reasonably managed textile processing industry as follows.

1. pH - 8.0-10.0
2. TDS - 5000-10000 mg/l
3. TSS - 100-700 mg/l
4. BOD - 50-550 mg/l
5. COD - 250-8000 mg/l
6. Chlorides - 100-500 mg/l
7. Sulphates - 50-300 mg/l
8. Sodium as Na + - 200-1000 mg/l

Nirmali Seed - Nirmali seed (strychnos

potatorum) is commonly known as "clearing nut". *Strychnos potatorum* is one of the group of trees which belong to the family of loganiaceae and grows profusely in various parts of India and south-east Asia. The seed has been recognized for its medicinal properties.

Moringa Oleifera Seed - It is a seed of a tropical plant *Moringa oleifera* belonging to the family of Moringaceae. *Moringa oleifera* is the most widespread species which grows quickly at low altitudes in the whole tropical belt including arid zones. It is generally known in the developing world as a vegetable, a medicinal plant, and a source of vegetable oil.

Tamarind seed - It is seed of a tree species *Tamarindus indica*. *Tamarindus indica* seed is a naturally occurring non ionic polyelectrolyte.

Chitosan - Chitosan is derived from chitin. It is the second most abundant organic material on earth and is found in the exoskeletons of arthropods such as insects and spiders, some fungi, and in crustaceans such as crabs, shrimp and fishes.

Preparation of Synthetic Dye solution - The dye effluents for the experimental work were prepared synthetically in the laboratory. This was done by adding dyes with a concentration of 25 mg/l and 150 mg/l in the soft water. The sample was heated for 60 minutes at an interval of 20 minutes. Common salts (NaCl) was added. Which acts as an exhausting agent in the dyeing operations, finally to a salt concentration of 2.5 gm/lit. Direct, acid, and reactive dyes were used for the study. Prepared samples were poured in containers and allowed to settle for 12 hours. After settling the supernatant was taken for the experiment.

Color removal studies were conducted for the following dyes.

Sl. No.	Commercial name	Type of dye stuff	Maximum wave length λ max	Application of Dyes
1	ATUL-Acid Fast Red Dye (C.I. Acid red S 8)	Acid	507.0	Wool, Nylon and Silk
2	Erio Orange II HST (H/C) Dye (C.I. Acid Orange 7(2))	Acid	484.5	Wool, Nylon and Silk
3	ATUL Direct Brown MR	Direct	411.5	Yarn
4	ATUL Direct bordeaux BW	Direct	513.0	Yarn
5	Procion TBlue MGN	Reactive	616.5	Cloth

Results and Discussion

The results of the studies on colour removal of the dyeing effluents using natural/conventional coagulants like nirmali seed, moringa oleifera seed, tamarind seed, chitosan and alum are discussed as follows. Natural seeds have been found to act as coagulant because natural seeds are naturally occurring polyelectrolytes (bio colloids). In waste water in act as polyvalent ions, this polymer chain carries a very large number of ionic sites along its length. Coagulation takes place by the neutralization of charge on the Electronegative colloids particles by these ionized centre or by hydrogen among the charged surfaces. Electro static cross linkage also binds the linear chain together. Studies were conducted on two synthetically prepared acid dye effluent. (i) Acid red dye and (ii) Acid orange dye with 25 mg/lit, 150 mg/lit concentration.

Acid red dye - When the concentration of the dyeing effluent was increased to 150 mg/ lit. it has been observed that maximum colour removal was achieved by moringa oliefera seed and chitosan compared to nirmali seed, tamarind seed and alum. Also it has been observed that with progressive increase in the dosage of coagulants, removal efficiency also increases gradually and reaches a maximum value (optimum colur removal) beyond which further addition of coagulant does not result in increased colur removal due to excess gel released by the natural coagulants.

Acid orange dye - The colour removal efficiency is less than 20% when the concentration of the dye is increased in the ratio 70:30 for the dyeing effluent 150 mg/lit. The removal efficiency is slightly in the higher side as compared to when the natural coagulant are alone used as prime coagulant. Of the above, results indicates that the response of acid orange dye effluent towards natural coagulants is less as compared with acid red dye. It is due to the reason that the acid orange dye is soluble (disperse) in water than the acid red dye.

ATUL direct brown MR dye - With increase of concentration of the dye the removal efficiency is about 60 to 80% for all the coagulants. In combination with metal congulants (Alum) higher colur removal efficiency of 95% is achieved with moringa oleifera seed, lower the removal efficiency (50%) in the case fo nirmali seed and chitosan and 70% in case of tamarind seed.

ATUL Direct bordeaux dye - The removal efficiency is about 80-85% by the nirmali and alum for the concentration of 150 mg/lit. About 60-70% as in the case of tamarind and chitosan and 50% in the case of moringa oleifera seed. In combination with metal coagulant nirmali and tamarind seed remove about 95% colour and the colour removal efficiency is about 65% in case of tamarind and chitosan. Overall colour removal efficiency is less in the case direct bordeaux dye compared

to direct brown dye because of the fact direct bordeaux dye is more dispersive than direct brown dye.

Summery and Conclusions

Coagulation studies were conducted with dyeing effluents, synthetically prepared using acid dyes, direct dyes, and reactive dyes. Results of this investigation are summarized as follows.

The following physical observations were made during the time of experiments.

1. The size of the formed with natural coagulant was superior to that produced with alum alone.
2. The flocs were not found to be disntegrable when subjected to rapid mixing.
3. The floc densities were found sufficient for final settlement even without addition of polyeletrolyte.

The following conclusions are drawn from the investigations.

1. The following Eco friendly natural coagulants. Nirmali seed, moringa oleifera seed, could be attempted as a coagulant for the removal of colour from the dyeing effluents. For selective dye wastes chitosan could be used as a coagulant whereas tamarind seed has not been found effective in colour removal.
2. Natural coagulant in combination with alum in varying dosages reduces the does of alum, and it is advantageous as alum imparts total dissolved solids (TDS) content in the final effluent.
3. Compared to alum, the natural coagulants are effective in pH ranges of 8.5 to 9.0 hence do not need pH adjustment.
4. Natural seeds are non toxic as they are Eco friendly and easily biodegradable compared to conventional metal coagulant
5. Use of natural coagulant has a definite advantage generating least quantity of sludge and easy to handle.
6. Use of polyelectrolyte as a coagulant aid in a meager quantity reduces the sludge volume resulting in minimization of sludge handling.
7. There is a lot of potential in our country for the use of natural seeds as coagulant. Research work were going on for the removal of arsenic, Fluoride etc. from the water/ wasts water. Hence it is recommended that further intensive work be carried out by collecting technical know-how from the agricultural universities in the direction of removal of colour from the industrial waste using natural coagulants.

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