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Experimental Investigation on Treatment of Industrial Waste Using Natural Coagulant

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Abstract: ***A brief study on the experimental investigation for the treatment of industrial waste water (washing water) had been carried out for the analysis of better treatment of water by using natural coagulants. While treatment, natural coagulant such as Strychnospotatorum (nirmali seeds), Eirchorrniacrassipes (water hyacinth) are used for waste water treatment. This includes the various parameters such as pH, sulphates, chlorides, total solids, total suspended solids (TSS), total dissolved solids (TDS), acidity, alkalinity, optimum coagulant dosage (jar apparatus), biological oxygen demand (BOD) and chemical oxygen demand(COD).These natural coagulants, when used for treatment of waters with low to medium turbidity range (50–500 NTU), are comparable to their chemical counterparts in terms of treatment efficiency. The test results indicated that the natural coagulants give better results which can be used as either separately or in combination with chemical coagulant alum. The natural coagulant produces lesser floc, hence the cost of sludge treatment is reduced. From the natural coagulants used, water hyacinth gives better result than nirmali seed. The natural coagulants can be used for treatment of textile waste wherever it is available in plenty.***

Keywords: ***Industrial waste , treatment , alum , Natural Coagulant , Strychnos potatorum , Eichorrnia crassipes***

I. INTRODUCTION

The enormous use of water in industries has caused a serious problem of drainage of industrial wastewater. Effluents from industries are deteriorating the surface and underground water quality through seepage, due to chemical constituents of undesirable concentration and thus creating water pollution. Heavy metals are groups of pollutants which are non biodegradable and tend to accumulate in living organisms. Heavy metals are toxic because they cannot be degraded biologically into harmless products; hence they cause serious health hazards. The pollutants of tannery wastes are of inorganic, organic and toxic nature and require elaborate treatment before disposal to prevent physical, chemical and biological pollution of the receiving body of water. The tannery wastewater with high concentration of dissolved solids, suspended solids, chloride, color, ammonia etc. is being discharged every day in the receiving water.

Safe disposal of industrial wastewater is a major problem all over the world. In developing countries like India, about 10% of the industrial wastewater is treated before disposal. But, the remaining 90% of the industrial wastewater is generally discharge without any treatment. When the untreated industrial wastewater is discharged into the natural water bodies, the quality of water in the natural water bodies gets affected which in turn results in: (i) ground water contamination, (ii) typhoid, cholera, hepatitis, dysentery, diarrhea and polio on human beings, and (iii) death of aquatic animals due to depletion of dissolved oxygen. Besides, presence of heavy materials in industrial waste water creates bioaccumulation in animals and human tissues.

A. Coagulant For Water Teatment

Due to the lack of proper water treatment systems in these rural or underdeveloped communities, the best immediate option is to use simple and relatively cost effective point-of-use (POU) technologies such as coagulation. Coagulation is an essential process in the treatment of both surface water and industrial wastewater. Its application includes removal of dissolved chemical species and turbidity from water via addition of conventional chemical-based coagulants, namely, alum (AlCl3), ferric chloride (FeCl3) and polyaluminium chloride (PAC).

While the effectiveness of these chemicals as coagulants is well-recognized, there are, nonetheless, disadvantages associated with usage of these coagulants such as ineffectiveness in low-temperature water, relatively high procurement costs, detrimental effects on human health, production of large sludge volumes and the fact that they significantly affect pH of treated water.

There is also strong evidence linking aluminium based coagulants to the development of Alzheimer's disease in human beings. It is therefore desirable to replace these chemical coagulants with plant-based coagulants to counteract the fore mentioned drawbacks.

B. Chemical Coagulants

Chemical coagulants come in two main types – primary coagulant and coagulant aids.

C. Primary coagulant

Primary coagulants neutralize the electrical charges of particles in the water which causes the particles to clump together.

II. MATERIAL AND TESTING

A. Chemical Coagulant

1) *Alum:* There are a variety of primary coagulants which can be used in a water treatment plant. One of the earliest, and still the most extensively used, in aluminium sulphate, also known as alum. Alum can be brought in liquid form with a concentration of 8.3% or in dry form with a concentration of 17%. When alum is added to water, it reacts with the water and results in positively charged ions. The ions can have charges as high as +4, but are typically bivalent.

B. Natural Coagulant

1) *Strychnos Potatorum (Nirmali Seeds):* Strychnos potatorum (nirmali) is a moderate-sized tree found in Southern and central parts of India, Sri Lanka and Burma, used predominantly as a traditional medicinal extract. Sanskrit writings from India reported that the seeds were used to clarify turbid surface water over 4000 years ago which indicated that they were the first reported plant-based coagulant used for water treatment.

Most studies concerning its use as coagulant seem to be limited within the Indian subcontinent. Nirmali seed extracts are anionic polyelectrolytes that destabilize particles in water by means of interparticle bridging. The nuts of this species of Strychnos are very largely used in some parts of India for cleaning muddy water, and are stated to have found their way into American commerce. The fruit is also employed by the native practitioners of Hindhustan, under the name of nirmali, as an emetic and dysentery. They do not contain strychnine. In clearing water, one of the dried nuts is rubbed hard for a short time around the inside of the earthern water pot; on settling, the water is left pure and tasteless. The seeds contain a large quantity of an albuminous principle, upon which their virtues probably depend. The tree, which grows to a very large size, produces a shining, black, one-seeded berry (that of the nux vomica being many seeded).

FIGURE 2.1 Nirmali plant – flowers and seeds

2) *Eichorrnia crassipes (Water hyacinth):* Water hyacinth is a free-floating perennial aquatic plant (or hydrophyte) native to tropical and sub-tropical South America. With broad, thick, glossy, ovate leaves, water hyacinth may rise above the surface of the water as much as 1 meter in height. The leaves are 10–20 cm across, and float above the water surface. They have long, spongy and bulbous stalks. The feathery, freely hanging roots are purple-black. Water hyacinth is also observed to enhance nitrification in waste water treatment cells of living technology. Their root zones are superb micro-sites for bacterial communities. Lekki lagoon was chosen for this study because more than two-thirds of lagoon area was covered by water hyacinth mats, and the lagoon was a major reference point of water hyacinth infestation during the 1988 International workshop/seminar on water hyacinth held in Lagos, Nigeria (Kusemiju 1988).

The plant is extremely tolerant of, and has a high capacity for, the uptake of heavy metals, including Cd, Cr, Co, Ni, Pb and Hg, which could make it suitable for the biocleaning of industrial wastewater. In addition to heavy metals, Eichhornia crassipes can also remove other toxins, such as cyanide, which is environmentally beneficial in areas that have endured gold mining operations. Water hyacinth removes arsenic from arsenic contaminated drinking water. It may be a useful tool in removing arsenic from tube well water in Bangladesh.

FIGURE 2.2 Water hyacinth in pond and the root of the plant

III. PREPARATION OF NATURAL COAGULANT

A. Strychnos Potatorum (Nirmali seeds)

1) The seeds of the tree is collected and dried in sunlight.

2) Then the seeds are powdered and used as a coagulant.

Fig 3.1 Powdered form of Nirmali seeds

B. Eichorrnia Crassipes (Water hyacinth)

Fig 3.2 Powdered form of Water hyacinth

1) The collected water hyacinth root was extensively washed with tap water to remove soil and dust.

2) The dried water hyacinth roots were sliced into pieces.

3) The sliced material was dried by exposure to the sunlight for 3days and subsequently at 80c for 3 hour in a hot air convection oven.

4) The dried material was milled into a powder using ‘domestic mixie’

5) The powder is used as coagulant and ready for use.

IV. RESULT ANAND DISCUSSIONS

The treatment of waste water (washing water) by using natural coagulants as Strychnos potatorum and Eichorrnia crassipes in comparison with chemical coagulant are compared. This test results shows that the natural coagulants give more results when compared to alum. According to the compared results, Eichorrnia crassipes (water hyacinth) gives better results than Strychnos potatorum (nirmali seeds). It reduces the pH as well as turbidity in the waste water.

S.No	Coagulant dosage(gms)	Floc formation(ml)
1	0.5	15
2	1	25
3	1.5	30
4	2	38

. Table 4.1 Determination of optimum coagulant dosage using chemical coagulant (alum) for waste water

S.No	Coagulant dosage(gms)	Floc formation(ml)
1	3	18
2	3.5	10
3	4	15
4	4.5	20

Table 4.2 Determination of optimum coagulant dosage using natural coagulant (Strychnos potatorum) for waste water

S.No	Coagulant dosage(gms)	Floc formation(ml)
1	4	8
2	5	18
3	6	20
4	7	25

Table 4.3 Determination of optimum coagulant dosage using natural coagulant (water hyacinth) for waste water

S.No	Description	Efficiency%	Natural coagulant (nirmali seeds)	Unit
1	pH value	1.95	7.03	-
2	Turbidity	23.08	10	NTU
3	Chlorides	1.93	762.26	mg/lit
4	Acidity	20	100	mg/lit
5	Total alkalinity	21.42	110	mg/lit
6	Total solids	9.6	2260	mg/lit
7	Suspended solids	26.87	1445	mg/lit
8	Dissolved solids	50.71	520	mg/lit
9	Bio chemical oxygen demand	19.51	528	mg/lit
10	Chemical oxygen demand	12	1760	mg/lit

Table 4.4 Treatment of waste water (Industrial water) using nirmali seeds and efficiency results

S.No	Description	Efficiency%	Natural coagulant (water hyacinth)	Unit
1	pH value	2.37	7.00	-
2	Turbidity	53.85	6	NTU
3	Chlorides	16.08	652.23	mg/lit
4	Acidity	32	85	mg/lit
5	Total alkalinity	64	50	mg/lit
6	Total solids	68	800	mg/lit
7	Suspended solids	63.45	670	mg/lit
8	Dissolved solids	87.68	130	mg/lit
9	Bio chemical oxygen demand	65.24	228	mg/lit
10	Chemical oxygen demand	50.80	984	mg/lit

Table 4.5 Treatment of waste water (Industrial water) using water hyacinth and efficiency results

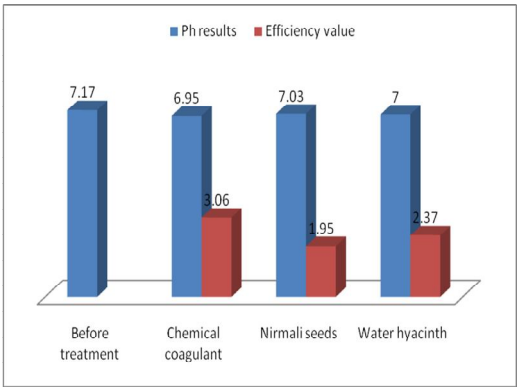

FIG. 4.1. efficiency value of pH

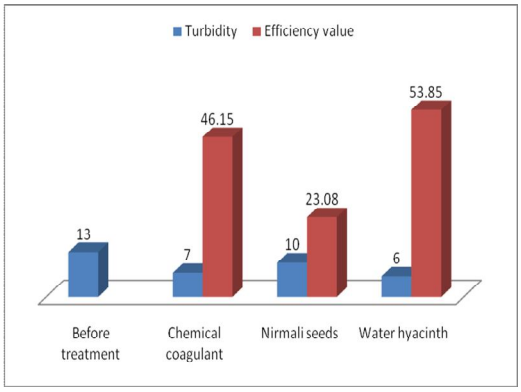

FIG.4.2. efficiency value of Turbidity

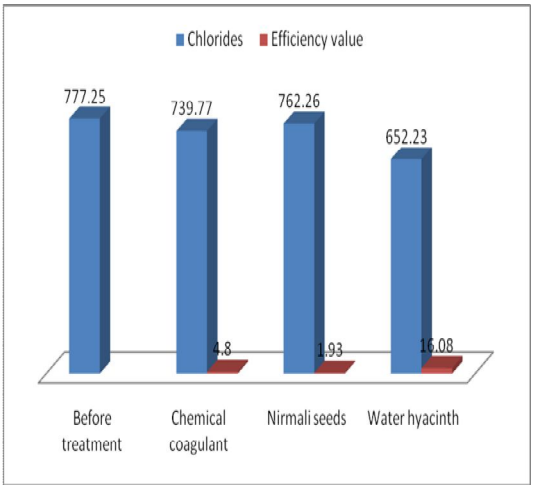

FIG.4.3. efficiency value of Chlorides

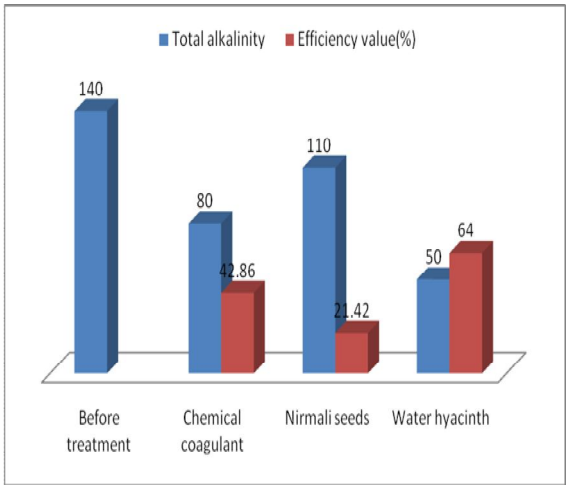

FIG.4.4. efficiency value of Total alkalinity

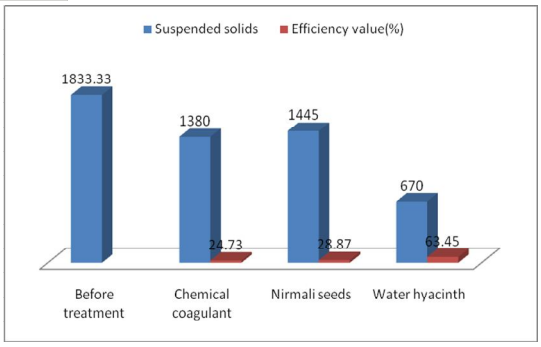

FIG.4.5. efficiency value of Suspended solids

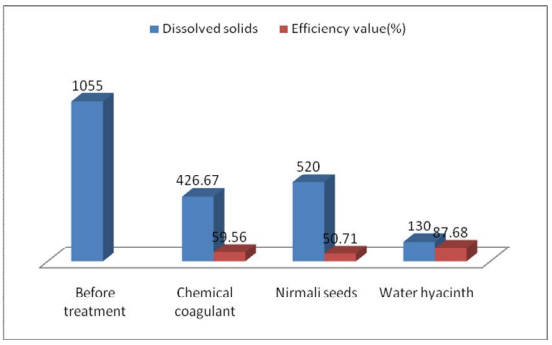

FIG.4.6. efficiency value of Dissolved Solids

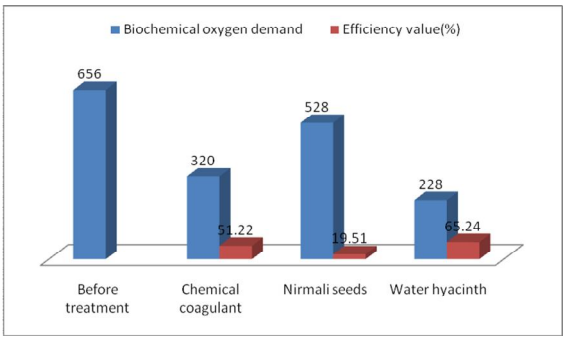

FIG.4.5. efficiency value of BOD

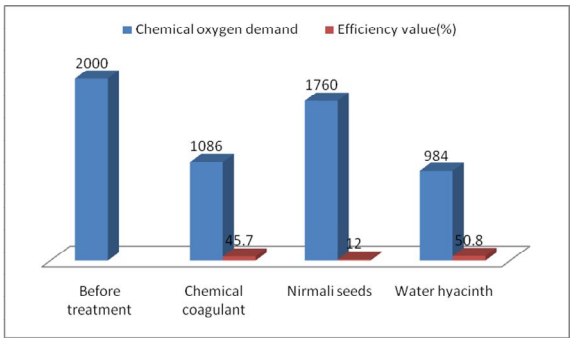

FIG.4.6. efficiency value of COD

V. CONCLUSIONS

The characteristics of the waste water (washing water) from the industrial effluent is collected and analyzed for the various parameters. The usage of natural coagulants derived from plant based sources represents a vital development in 'grassroots' sustainable environmental technology since it focuses on the improvement of quality of life for underdeveloped communities. However, the practice of the natural coagulants is limited due to the loss of mass plantation of the agro-based plants.

The treated waste water gives better results by using Eichornia crassipes as natural coagulant. The best results are obtained by using the natural coagulant in proportions by finding the optimum coagulant dosage.

The use of Eichornia crassipes reduces the volume of sludge produced in the treatment of waste water than it is produced in chemical coagulant and it is eco –friendly and biodegradable.

In technical terms, these natural coagulants are highly effectual for treatment of waters with low turbidity but may not be feasible in the case of wastewaters with extreme pH. As such, it is always prudent for water treatment practitioners to circumspectly select the most suitable natural coagulants and tailor them for specific purposes.

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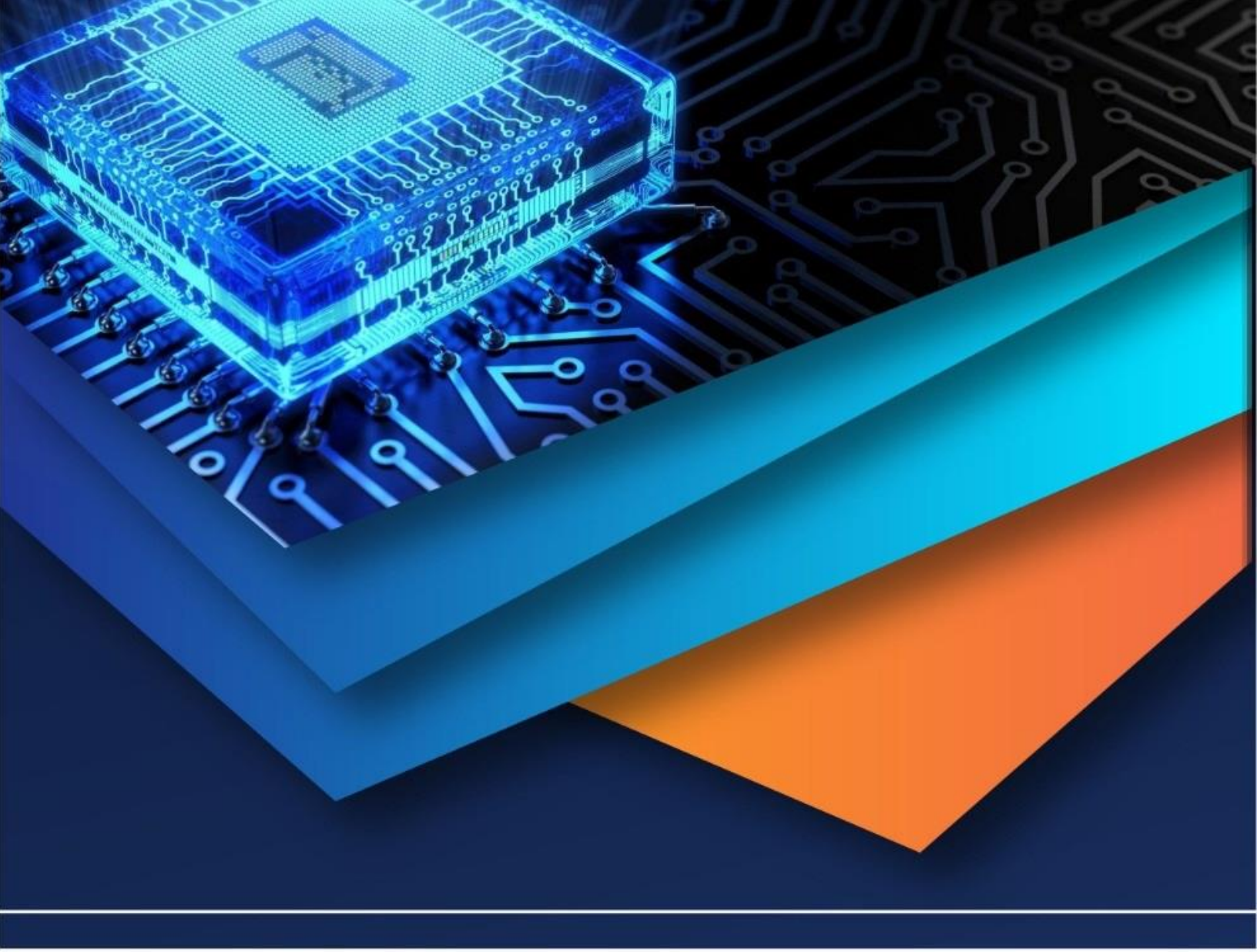

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