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Effluent Treatment of Sago Waste Water by Using Natural Coagulants

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Abstract: *One of the most important treatment processes in raw water treatment plant is coagulation. Waste water contains suspended solids and turbidity. With the help of coagulants, and by flocculation process, followed by sedimentation and filtration, these impurities can be removed from raw water, besides conventional chemicals such as Alum, Ferric chloride and Poly Aluminum Chloride. These chemicals are used for the purpose of pretreatment of water. There are some disadvantages related to the use of such chemicals as their residues present in the waste water may cause the health hazards.*

In this research, the preliminary investigation was carried out for the possible use of oil cakes as natural coagulants for the treatment of sago effluent. The quality of the treated raw water were analyzed and compared with each other. The experiments were conducted for various dosages of the crude extracts of the cotton seed and castor oil cakes using flocculate. The optimum dosage of these natural coagulants was identified. Various parameters of quality of the waste water were measured before and after the treatment to evaluate the removal efficiency on the major pollutants of concern in waste water treatment such as pH, Total Solids (TS), Total Dissolved Solids (TDS), sulphates, chlorides, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) etc., Results showed that the use of cotton seed oil cake was more efficient for the treatment of the sago effluent when compared to the castor oil cake. The alkalinity, sulphates and Total Suspended Solids of sago effluent after treated with the cotton seed oil cake were highly reduced. Hence, the use of cotton seed oil cake can be adopted as a natural coagulant for purification of the sago effluent.

KEYWORDS*: Coagulant, Ferric Chloride, Poly Aluminum Chloride, Alkalinity*

1 Introduction

Growing population, increased economic activity and industrialization has not only created an increased demand for fresh water but also resulted in severe misuse of this natural resource. Water resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. Indiscriminate dumping of untreated wastewater and chemical wastes directly into rivers, lakes and drains have made these water bodies unable to cope up with the pollutant load. The steady increase in the amount of water used and waste water produced by urban communities and industries throughout the world also poses potential health and environmental problems. The contaminated water disrupts the aquatic life and reduces their reproductive capability.

Color in water results from the presence of natural metallic ions, humus and peat materials, plankton, weeds and industrial wastes. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms are responsible for turbid waters. Coagulation is accomplished by the addition of ions having the opposite charge to that of the colloidal particles. In coagulation, a coagulant (generally positively charged) is added which causes compression of the double layer and thus the neutralization of the electrostatic surface potential of the particles. The resulting destabilized particles stick sufficiently.

Aluminum and iron salts are commonly used as chemical coagulants. They form insoluble material i.e. aluminum and ferric hydroxides when they react with calcium and manganese hydrogen carbonates, which are almost always present in water together when contact is made. Utilization of alum has raised a public health concern because of the large amount of sludge produced during the treatment and the high level of aluminum that remains in the treated water. The intake of large quantity of alum salt may cause Alzheimer disease. For these reasons, and also due to others advantages of natural coagulants/flocculants over chemicals, developing countries adopted the use of natural polymers in the treatment of waste water. Natural polyelectrolyte's have been used as auxiliary of flocculation and coagulation in wastewater treatment and water cleaning process.

NATURAL COAGULANTS:

COTTON SEED OIL CAKE:

Cottonseed Oil Cake is made from cotton seeds after extracting oil from the cotton seeds. Cottonseed Oil Cake, used for animal feed, is a good source of nutrition. Being a great source of protein, fiber and energy, Cottonseed Oil Cake has long been used as a highly economic protein concentrated food for animal feeding. Sometime Cottonseed Oil Cake is used as an organic fertilizer to enhance soil health, yield of the crops. Since they are rich in protein content, they are used as a natural coagulant for the treatment of waste water.

Fig.1. Cotton Seed

Fig.2 .Castor Seed

NEED FOR THE PRESENT STUDY:

- Aluminum creates chronic effects.
- Long term exposure of aluminum may cause effect on brain and bones.
- Aluminum has been shown to be a neurotoxic compound, if it is allowed to enter into the bloodstream.
- Sludge produced is voluminous and non-biodegradable after treatment and therefore poses disposal problems leading to increase cost of treatment. The cost of these chemicals has been increasing at an alarming rate in developing countries.
- Foreign exchange problem for imported chemicals.

ADVANTAGES OF NATURAL COAGULANTS:

- Eco friendly.
- Cheap and easy method for developing countries.
- The efficiency is independent of raw water pH.
- Safe to human health.
- Antibiotic effect on various bacteria and fungi.
- The low volume of sludge precipitated is biodegradable.
- The sludge can be used as good manure for crops.
- Alkalinity of the waste water can be highly reduced.
- When compared to the chemical coagulants, natural coagulants are economical in cost.

I.LITERATURE REVIEW

Aweng E.R, et al., **"Cassia alata as a Potential Coagulant in Water Treatment"** have concluded that the widely available legume plant *Cassia alata*, as natural coagulant can treat low turbidity surface water. The result of this study showed that the extract of *Cassia alata* leaves is able to remove turbidity of river water by up to 93.33% a level almost similar to that obtained by *Opuntia* spp.[16], which gave a reduction percentage of 95%. The ability to remove suspended solids by 56.4% is another remarkable feature. It had some effect in lowering the pH level by 1% and raised the iron and manganese concentrations by 15.7% and 78.6% respectively.

Sachin M.Kanawade and R.W.Gaikwad, **"Removal of Dyes from Dye Effluent by Using Sugarcane Bagasse Ash as an Adsorbent"** has concluded that the Sugar cane be gases ash, an agricultural by-product, acts as an effective adsorbent for the removal of dyes from aqueous solution. Batch adsorption study was investigated for the removal of Acid Orange-II from aqueous solution. Adsorbents are very efficient in decolorized diluted solution. The effects of bed depth on breakthrough curve, effects of flow rate on breakthrough curve were investigated. The removal of dyes at different flow rate (contact time), bed height, initial dye concentration, column diameter, pH & temperature by Sugarcane Biogases Ash as an adsorbent has been studied. It is found that percent adsorption of dyes increases by decreasing flow rate from 2 lit/hr to 1 lit/hr, by increasing bed height from 15cm to 45cm, by decreasing initial conc.150mg/lit to 100mg/lit, by increasing column diameter from 2.54cm to 3.5cm, by maintaining neutral pH & at temperature 450ºC than 25ºC & 35ºC.The result shows that, bagasse ash is a good adsorbent for dye effluent treatment.

Marina B. Šćiban, et al., **"The Investigation of Coagulation Activity of Natural Coagulants Extracted from Different Strains of Common Bean"** have concluded that all

investigated strains of bean showed potential to be used for preparing coagulants for water clarification. Turbidity of model water was decreased by 5 – 50 % by using natural coagulants obtained from different strains of bean. Samples 1, 2 and 4 showed maximum of coagulation activity (about 45%) in the range of applied doses of coagulants from 3.5 mg/l to 4.5 mg/l. Sample 3 showed a lower coagulation activity (maximum about 33%) in comparison with other samples, but at a significantly lower dose of coagulant – 1.5 mg/l. Content of organic matter in the water after coagulation tests performed with all samples was high, twice higher than it was in the blank.

Kalyani Ladole, **"Rajma Powder as a Natural Coagulant in Turbidity Removal from Raw Water"** have concluded that the dosage of Rajma powder in this research was Moderate than other traditional chemicals application in turbidity removal with dosage of up to 10 mg/L in a water treatment plant, the efficiency in turbidity removal was also lower. With many advantages of Rajma Powder that is a natural coagulant for water treatment.

Yin Chun Yang, et al., **"A Study on Cactus Opuntia as Natural Coagulant in Turbid Water Treatment"** have concluded that the powdered and dried cactus opuntia was very effective in removing turbidity from both estuarine and river waters as evident by the high removal efficiencies. It was also proven that the cactus powder did not have a significant effect on final pH of the waters as compared to chemical-based coagulants. Increased cactus dosages correlated with decreased pH of surface water. It can be concluded that cactus opuntia has the potential to be utilized for surface water treatment applications.

OBJECTIVES:

- To remove the turbidity in the waste water.
- To determine the effective dosage of the chemical coagulants.
- To avoid the usage of the chemical coagulants like aluminum, ferric chloride and iron salts etc.,
- To maintain the pH level before and after the treatment process.
- To avoid the health risk problems.
- To reduce the various parameters in the raw water such as TS, BOD, COD, sulphides, nitrates, etc.,
- To make the treatment process an eco friendly one.
- To reuse the waste water for the further treatment process once the parameters has been reduced.

II.MATERIALS

The waste water was taken from sago industry and two types of oil cakes such as cotton seed oilcake and castor oil cake were taken for this study.

Fig.3 .Powdered Form of Cotton Seed Oil Cake

Fig.4 . Powdered Form of Castor Seed Oil Cake

I. **RESULTS AND DISCUSSIONS**

GENERAL:

Colloidal particles found in waste water typically have a net negative surface charge. The size of colloids is such that the attractive body forces between particles are considerably less than the repelling forces of the electrical charge. Under these stable conditions, Brownian motion (i.e. random motion) is brought about by the constant thermal bombardment of the colloidal particles by the relatively small water molecules surrounded by them.

Coagulation is the process of destabilizing the colloidal particles so that particle growth can occur as a result of particle collisions. Coagulation is a safe and effective method of treating water, which improves its quality by reducing levels of organic compounds, dissolved phosphorus, colour, iron and suspended particles. The experiments were carried out for the different effluents like tannery effluent, textile effluent, sugarcane industry effluent etc. normally in the industries, colloidal particles were removed from the waste water with the help of chemical coagulants but the present study discuss about the treatment of waste water with the help of natural coagulants.

CHARACTERISTICS OF THE SAGO EFFLUENT:

The two types of the natural coagulants such as cotton seed oil cake and the castor oil cake was used for the treatment of the sago effluent.

OPTIMUM COAGULANT DOSAGE (ml)	VARIOUS PARAMETERS	RAW SAGO EFFLUENT	TREATED SAGO EFFLUENT	PERCENTAGE REDUCTION (%)
30	pH	8.52	8.50	0.24
	TDS (mg/L)	3500	3000	14.29
	TS (mg/L)	5000	3500	30.00
	TSS (mg/L)	**1500**	**500**	**66.67**
	TFS (mg/L)	4000	3000	25.00
	Total hardness (mg/L)	1380	1280	7.25
	Permanent hardness (mg/L)	1085	1055	2.76
	Temporary hardness (mg/L)	295	225	23.73
	Turbidity (NTU)	25	15	40.00
	Chlorides (mg/L)	1005.30	806.72	19.75
	Sulphates (mg/L)	**576.24**	**164.64**	**71.43**
	Sulphides (mg/L)	**389.25**	**76.52**	**80.34**
	Alkalinty (mg/L)	**250**	**-**	**100.00**
	Acidity (mg/L)	350	260	25.71
	BOD (mg/L)	90	73.20	18.67
	COD (mg/L)	288	202	29.86

Table 1. Percentage reduction of various parameters of sago effluent using cotton seed oil cake

OPTIMUM COAGULANT DOSAGE (ml)	VARIOUS PARAMETERS	RAW SAGO EFFLUENT	TREATED SAGO EFFLUENT	PERCENTAGE REDUCTION (%)
40	pH	8.52	7.58	11.03
	TDS (mg/L)	3500	3500	0.00
	TS (mg/L)	5000	4000	20.00
	TSS (mg/L)	**1500**	**500**	**66.67**
	TFS (mg/L)	4000	3500	12.50
	Total hardness (mg/L)	1380	1295	6.16
	Permanent hardness (mg/L)	1085	1060	2.30
	Temporary hardness (mg/L)	295	235	20.34
	Turbidity (NTU)	25	18	28.00
	Chlorides (mg/L)	1005.30	960.67	4.41
	Sulphates (mg/L)	576.24	1152.48	-
	Sulphides (mg/L)	**389.25**	**98.26**	**74.80**
	Alkalinty (mg/L)	**250**	**-**	**100.00**
	Acidity (mg/L)	350	305	12.86

	BOD (mg/L)	90	86.29	4.12
	COD (mg/L)	288	254.67	11.57

Table 2. Percentage reduction of various parameters of sago effluent using castor oil cake

Table 3. Determination of Effective Dosage of Cotton Seed Oil Cake

COAGULANT DOSAGE (ml)	FLOC FORMATION(ml)
30	225
40	180
50	310
60	350

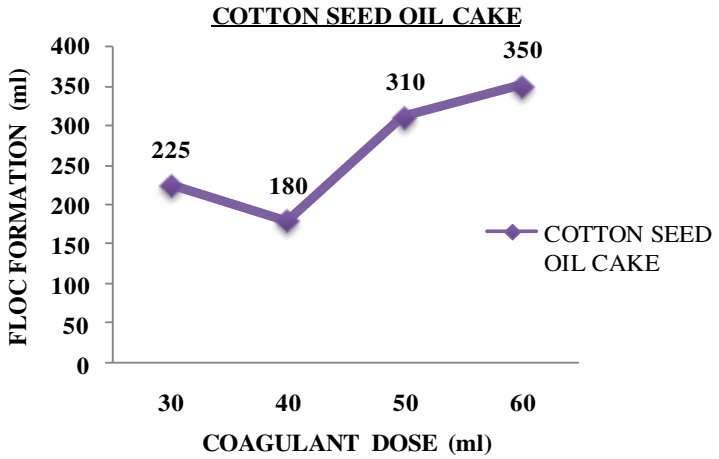
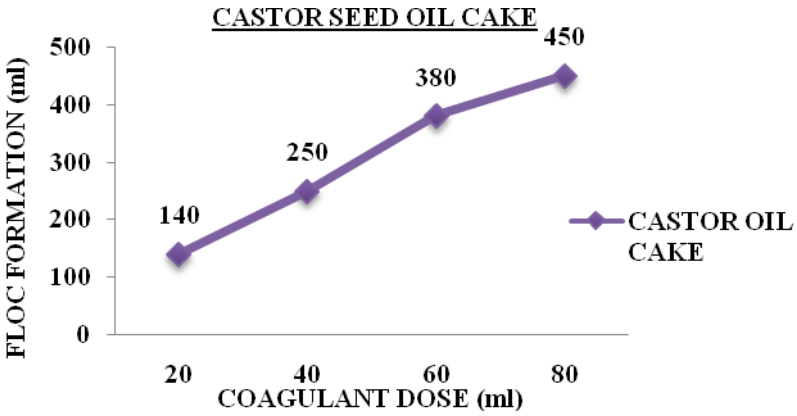


Table 5. Optimum Dosage of Cotton Oil Cake



5. Optimum Dosage of Castor Oil Cake

Table 3. Determination of Effective Dosage of Castor Seed Oil Cake

COAGULANT DOSAGE (ml)	FLOC FORMATION(ml)
20	140
40	250

60	**380**
80	**450**

Fig.5. Raw Sago Effluent

Fig.6. Treated Sago Effluent using Cotton Seed Oil Cake

Fig.7.Jar Test Apparatus

Fig.6. Treated Sago Effluent using Castor Cake Oil

VII. DISCUSSIONS

By using cotton seed and castor oil cake, the maximum removal of Total Suspended Solids from the sago effluent was measured as 66.67%.

- The maximum removal of the alkalinity and sulphides in the sago effluent were 100% and 74.80% respectively.
- The removal of BOD is not so effective in castor oil cake when compared to the cotton seed oil cake.
- The effect of COD removal is not effective.
- The pH level was maintained by using the Cotton Seed Oil Cake.
- From the above results, because of having greater efficiency in removing the impurities and from the economic point of view, it is recommended that Cotton Seed Oil Cake is a best coagulant for treating the sago effluent.
- Also sludge volumes produced by natural coagulants are less when compared to the chemical coagulants.
- At various proportions, the chemical coagulants were replaced by natural coagulants and the efficiencies were analyzed.
- From the above results, it is recommended to replace the use of chemical coagulants by cotton seed oil cake for the removal of suspended particles.

VIII. CONCLUSIONS

- In this Research, the characteristics of the sago effluent were analyzed.
- The optimum coagulant dosages for the removal of various parameters using the oil cakes were studied.
- The pH level was maintained by using the cotton seed oil cake as it makes the further treatment process more effective.
- Maximum removal efficiency of the sulphide was 74.80%. Hence it will reduce the corrosion of the pipelines and foul odour.
- The sludge volume was reduced to a greater extent.
- Because of having greater efficiency in removing impurities and from the economic point of view, Cotton seed oil cake is recommended as a natural coagulant for the treatment of sago effluent.
- They are economical in costs when compared to the chemical coagulants like Alum, Ferric Chloride etc.,
- The sludge produced can be used as a fertilizer as they are biodegradable.
- The natural coagulants are economical in cost when compared to the chemical coagulants.
- From the above results, natural coagulants can be gainfully used as an alternative of common chemical coagulant for the treatment of sago effluent.

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