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CHEMICAL COAGULANTS- A SOLUTION FOR COAL WASHERY EFFLUENT

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A B S T R A C T

Waste water from coal washery plant has high suspended particulates, high turbidity, and color, besides it contains heavy metals. Removing turbidity from the effluent is more important because the presence of particulates in the effluent affects the water quality. Before reuse of these discharged waters, suspended particulates and various contaminants must be removed from this effluent. Coal washery consume huge amount of water and hence generates huge amount of waste water. In this project work, chemical and natural coagulants have been used and comparative study has been made about the effectiveness of chemical and natural coagulants. The present study deals with the evaluation of treatment efficiency of chemical coagulants like ferric chloride and ferrous sulphate with addition of lime. Primarily the basic parameters-pH, suspended solids, turbidity, and coagulant dosage are optimized. Coagulation of ferric chloride and ferrous sulphate was assessed by the use of jar test experiment in coal washery effluent with various coagulant doses. About 99% and 81% of turbidity removal was achieved by ferric chloride and ferrous sulphate when added with lime respectively. Lime was added to maintain pH.

Keywords: Chemical coagulants, Colliery effluent characteristics, ,. Jar test method, removal of high turbidity

I. INTRODUCTION

The process for having high quality coal requires wet cleaning process, the coal washery plants are used for washing the coals for improving its quality. In areas where there is demand for large volume of water for treating coal requires efficient recovery of water for the reuse and also for the area where is limited supply of water. When water supply is not the problem, disposal of slurry into the stream will create environmental pollution. Moreover, where there is high demand of drinking water due to ever increasing population, water recycling to plants is must. In a coal washing plant, discharge of the effluent is continuous and therefore, requires uninterrupted water supply in order to maintain the continuous production of washed coal. The continuous use of the same used water without clearing would lead to increasing impurities and will also decreases efficiency of coal washery operations. After the process of coal cleaning the left effluent consist of chemical treated water, very fine particles, rock and clay etc which is also called as coal slurry. The rock, coal, and clays contain a wide range of heavy metals including arsenic, lead, cadmium, chromium, iron, manganese, aluminum and nickel all of which dissolve in the water and some hydrocarbons and other organic chemicals [3]. Chemicals used in the coal wash process may make serious concern to the workers in the plant. Natural

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coagulants are biodegradable and also cost effective as they can be locally grown. Natural coagulants have several other advantages when compared to chemical coagulants, as they produces less sludge and are also safe for human. Therefore, to control the problems from the effluent of coal washery, it can be treated using natural coagulants, which is also a cost reduction technique and by the chemical precipitation. Seeds of okra, bitter gourd as coagulants are used for the treatment, and the chemicals like lime & ferric chloride, are used for maintaining pH, reduction of turbidity and suspended solids. Therefore, there is a need of developing cheap and easily available coagulant from seeds to be used in water treatment, so that this will be useful for the area where there is the lack of water [4, 5].

II. METHODOLOGY-

In this study, coal washery water sample was collected from the coal washery plant. In the experiment, chemical coagulants were used. Chemical coagulants used are ferric chloride with lime and ferrous sulphate with lime. The comparative study is done between the chemical coagulants itself.

Turbidity was measured with a 'Digital Nephelo-Turbidity meter'. The turbidity removal efficiency of the coagulants was calculated using the following equation:

$$\text{Turbidity Removal (\%)} = \frac{No - N}{No} \times 100$$

2.1 Experimental work-

Before treating the coal washery water sample, their physical parameters especially pH, turbidity, and suspended solids were measured with the aid of pH digital meter, turbidity meter. Suspended solids were also measured by using the standard method.

Jar test method was carried out to determine the coagulation properties of the derived coagulants. All the 4 beakers were used for various dosing of the coagulants with the same quantity of sample. Jar test were conducted on 1000ml of coal washery water sample, which was highly turbid. In the process, the amount of coagulants added were 100 ppm, 200 ppm, 300 ppm, 400 ppm, 500ppm, 600ppm, 700ppm, and 800ppm respectively. The samples were subjected to slow mixing step at 50 rpm for 15min and rapid mixing at 150 rpm for 3min. The samples were allowed to settle for 30min. After sedimentation, the supernatant liquid was collected and analyzed. All the experiments were performed at room temperature. No pH control was applied, since the pH did not change during flocculation. The turbidity, pH, suspended solids of each of the samples was measured.

III. RESULTS AND DISCUSSION

In this work, coagulants were used at different doses, and their performances in the turbidity removal of the coal washery sample are shown in the table 1. The initial turbidity of sample was **770 NTU**.

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TABLE 3.1: Values of pH, turbidity and suspended solids (without adding any coagulant)

Parameters	Coal washery effluent
pH	**6.5-7**
Turbidity(NTU)	**770**
Suspended solids(mg/l)	**750**

3.1 Effect of ferric chloride –

From the experimental results it is seen that when dosage of ferric chloride was increased from 100 - 800 ppm, the corresponding reduction in turbidity was observed to be 48.05 –63.63%. It was noticed from the fig that the highest turbidity removal for the sample was achieved when the dose was 400 ppm which is shown in table 4 and has been represented graphically in Fig 3.1.

TABLE 3.2: Effect of ferric chloride on pH, turbidity and suspended solids

Coagulant dose (ppm)	pH	Turbidity removal (%)	Suspended solids (mg/l)
100	3.11	48.05	0.940
200	4.14	76.62	0.820
300	2.99	79.22	0.720
400	2.72	81.81	0.810
500	5.08	79.02	0.860
600	5.45	68.83	0.890
700	3.45	56.63	0.760
800	4.56	50.74	0.980

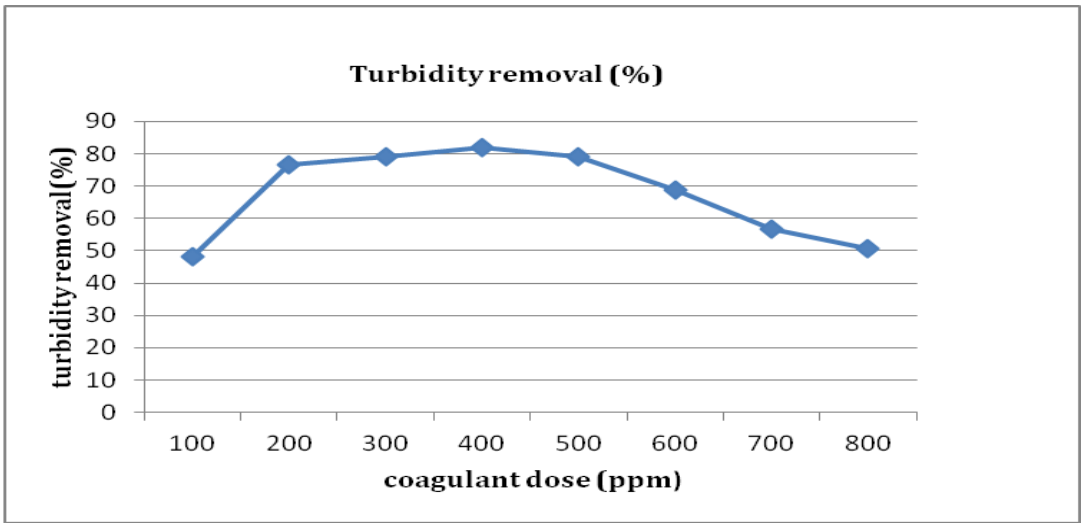

Fig.3.1 Effect of ferric chloride on turbidity removal

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3.2 Effect of ferric chloride with lime-

From the experimental results it is seen that when dosage of ferric chloride was increased from 100 - 800 ppm, the corresponding reduction in turbidity was observed to be 96.49 – 50.47%. It was noticed from the fig that the highest turbidity removal for the sample was achieved when the dose was 400 ppm which is shown in table 5 and has been represented graphically in Fig 3.2**.**

TABLE.3.3 Effect of ferric chloride with lime on pH, turbidity and suspended solids

Coagulant dose (ppm)	**pH**	**Turbidity removal (%)**	**Suspended solids (mg/l)**
100	6.32	96.49	0.110
200	6.32	99.61	0.060
300	6.56	99.74	0.030
400	6.58	99.87	0.040
500	7.25	90.85	0.160
600	7.90	84.34	0.110
700	8.07	80.90	0.320
800	8.25	76.98	0.110

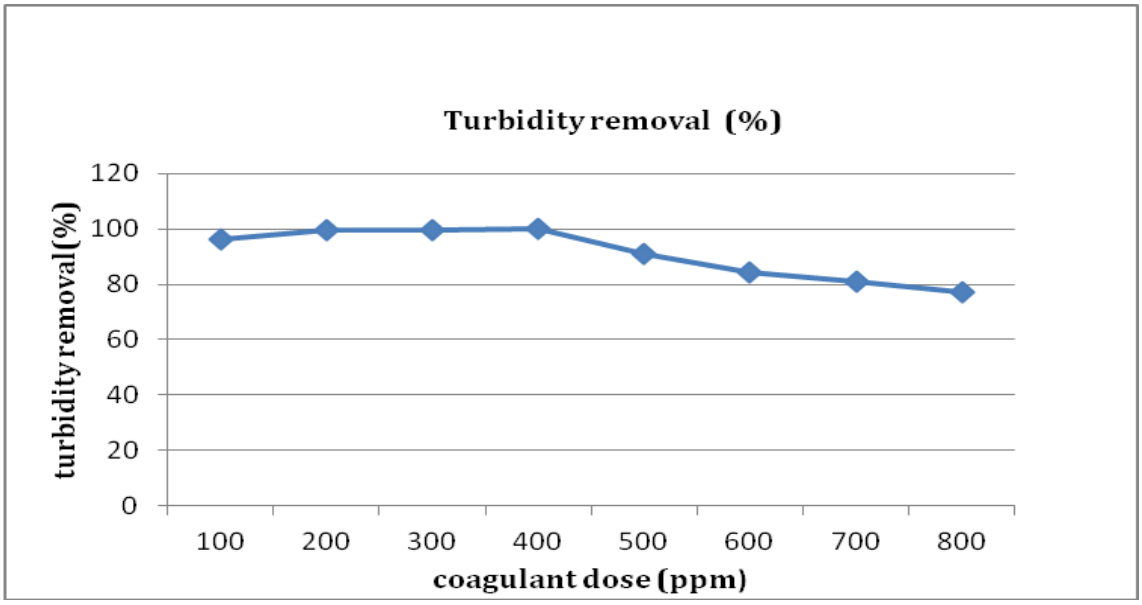

Fig.3.2 Effect of ferric chloride with lime on turbidity removal

The ferric chloride was very effective on removal of turbidity but it changes the pH value and therefore lime was used to maintain pH value. Ferric chloride and lime was added in the same proportion.

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3.3 Effect of ferrous sulphate-

From the experimental results it is seen that when dosage of ferrous sulphate was increased from 100 - 800 ppm, the corresponding reduction in turbidity was observed to be 35.06– 28.57%. It was noticed from the fig that the highest turbidity removal for the sample was achieved when the dose was 500 ppm which is shown in table 6 and has been represented graphically in Fig 3.3.

TABLE 3.4: Effect of ferrous sulphate on pH, turbidity and suspended solids

Coagulant dose (ppm)	pH	Turbidity removal (%)	Suspended solids (mg/l)
100	5.80	35.06	0.050
200	5.52	51.95	0.020
300	5.42	53.24	0.030
400	5.48	54.54	0.060
500	5.90	56.67	0.070
600	4.98	32.46	0.120
700	4.54	28.51	0.340
800	3.54	29.87	0.110

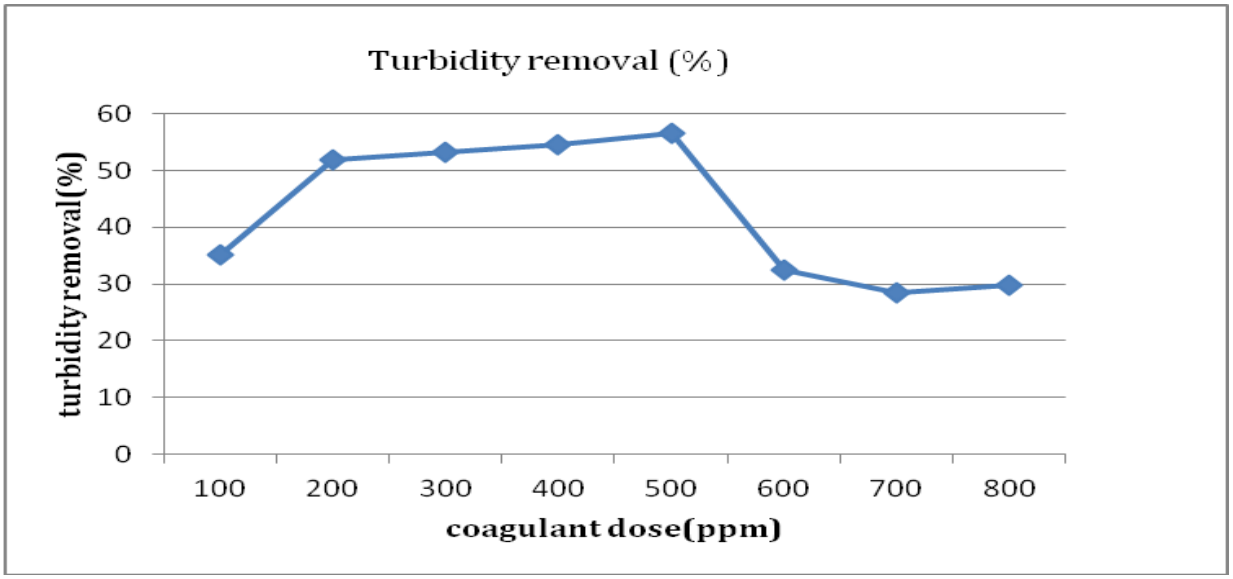

Fig.3.3 Effect of ferrous sulphate on turbidity removal

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3.4 Effect of ferrous sulphate with lime-

From the experimental results it is seen that when dosage of ferrous sulphate was increased from 100 - 800 ppm, the corresponding reduction in turbidity was observed to be 67.53- 64.93%. It was noticed from the fig that the highest turbidity removal for the sample was achieved when the dose was 400 ppm which is shown in table 7 and has been represented graphically in fig 3.5.

TABLE 3.5: Effect of ferrous sulphate with lime on pH, turbidity and suspended solids

Coagulant dose (ppm)	pH	Turbidity removal (%)	Suspended solids (mg/l)
100	8.05	67.53	0.100
200	8.05	74.02	0.090
300	8.30	80.52	0.080
400	8.50	81.81	0.070
500	9.00	72.72	0.200
600	9.50	70.76	0.120
700	9.75	67.11	0.150
800	10.20	64.93	0.080

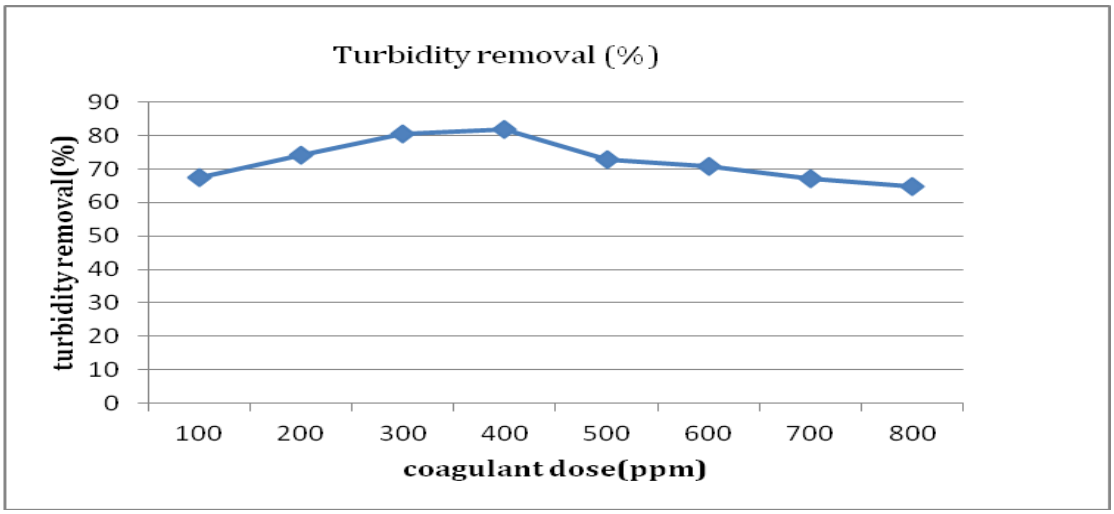

Fig.3.4 Effect of ferrous sulphate with lime on turbidity removal

IV. CONCLUSION

The study was conducted to obtain effective chemical coagulants for the treatment of coal washery effluent.The effect of seeds on pH, suspended solids, turbidity, is to be compared accordingly.

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- The chemical coagulants ferrous sulphate with lime, ferric chloride with lime was used for comparing the values. The results obtained from this research revealed that feeric chloride was more effective than ferrous sulphate, but the value of pH turned into acidic form because of acidic nature of the chemicals.
- Therefore, lime was added to control the Ph and get efficient results.The efficiency of ferrous sulphate with lime and ferric chloride with lime was 81.81% and 99.87% respectively for an optimum dosage of 400 ppm. The chemical coagulant was more effective in removing turbidity as well as suspended solids.

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