STUDY ON TURBIDITY REMOVAL BY ALUM COAGULATION AND SAND BALLASTED ALUM COAGULATION WITH *ALOE VERA*

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Abstract : Turbidity removal is primary objective of conventional water treatment. The laboratory study was conducted by jar test process for alum coagulation, flocculation and sand ballasted alum coagulation of surface water with *Aloe Vera*. The experiments were planned to assess the effectiveness of i) *Aloe Vera* as a coagulant aid with alum as a coagulant for turbidity removal, ii) micro sand as ballasting agent with Aloe Vera as polymer and alum as coagulant, ii) synthetic polymer used with coagulant and ballasting agent. This study concluded that the alum is effective for turbidity removal for water of varied turbidity levels. *Aloe Vera* improves turbidity removal by 7 to 15%.The use of micro sand further improves turbidity removal by 10 to 15 % by increasing the weight of precipitate which results in more complete settlement. *Aloe Vera* is more effective polymer as compared to synthetic polymer when used with alum for turbidity removal.

IndexTerms - *Aloe Vera*; Alum; Ballasting; coagulation*;* Polymer; Turbidity

I. INTRODUCTION

The flowing surface waters are normally characterized by presence of turbidity. The removal of turbidity is primary objective of any conventional water treatment. The unit processes involved in water treatment system for turbidity removal include coagulation, flocculation and settling. Alum is the most widely used chemical coagulant in water treatment. The use of alum is more appropriate in treat and supply centralized systems for treating larger quantity of water. Alum coagulation results in larger production of sludge. Sand ballasted coagulation/flocculation enhances the efficiency of turbidity removal. The alum dose can be reduced by using coagulant aid. There is a scope to use natural material as coagulant aid and polymer. Local availability and non-toxic nature of natural coagulants provide a potential alternative to any other chemical as coagulant aid/polymer. Gulmire and Munavalli (2017) used *Aloe Vera* as a coagulant/coagulant aid for turbidity removal and found 60-65 % removal efficiency to treat raw water having turbidity of 20 to 30 NTU. Olesen (1987) developed low cost water treatment by using Bentonite clay with *Moringa oleifera.* Dalen et al., (2011) studied Synergy between *Moringa oleifera* seed powder and alum in the purification of domestic waste water. Blumenschein et al., (2004), and Ghanem et al., (2007) studied the ballasted flocculation using sand. Present study is focused on comparison of effectiveness of i) Aloe Vera as coagulant aid in alum coagulation, ii) Aloe Vera as polymer and micro sand as ballasting agent for turbidity removal in sand ballasted coagulation/flocculation. Further, the potential of natural polymer

(Aloe Vera) and synthetic polymer is assessed and compared for turbidity removal by ballasted flocculation.

II. MATERIALS AND METHODS

2.1 Water sample

Raw water was collected from river Krishna near Sangli and used in the present study to prepare water sample of required turbidity/quality. The quality of collected river water is given in Table 1.The prepared water samples were categorized into low (0 -12 NTU), medium (13-24 NTU) and high (25-35 NTU) turbidity. In case of medium and high turbidity water an appropriate amount of alluvial clay was added and settled for 30 minutes to obtain required turbidity.

Table 1 Composition of Krishna river water

Parameter	Value
p^H	7 to 7.6
Turbidity, NTU	5 to 50
Hardness, mg/L as $CaCO_3$	120 to 140
Alkalinity, mg/L as $CaCO_3$	200 to 220
TDS, mg/L	300 to 400

2.2 Coagulant and Polymer

Alum was used as a coagulant. 1% strength of alum solution was prepared for dosing water. It was prepared by dissolving 1 g of alum in 100 mL of distilled water.

Aloe vera was used as a natural polymer. 1 g of Aloe Vera leaf pulp was mixed with 100 mL of distilled water to get 1% solution. The synthetic polymer Max floc-T supplied by Thermax, India, was also used in the present study.

2.3 Ballasting agent

Indian **s**tandard sand (IS650, grade-III) was subjected to sieve analysis and sand of size 90 to 150 micron was used as a ballasting agent. The specific gravity of sand was determined to be 2.65.Alluvial clay obtained from Krishna river bed was sieved and size of 75 microns.

2.4 Planning of experiments

The experiments were planned to assess the effectiveness of i) *Aloe Vera* as a coagulant aid with alum as a coagulant for turbidity removal, ii) sand ballasted coagulation/flocculation with alum and aloe vera (natural polymer), ii) sand ballasted coagulation/flocculation with alum and Max floc –T (synthetic polymer). Jar test procedure was used for the present study and conducted in 1 L of water sample. The dose of coagulant was added and rapidly mixed uniformly with a speed of 120 to 200 rpm for 60 seconds. The flocculation was done at a speed of 40 to 60 rpm. The flocculated sample was settled for 30 minutes and supernatant slightly below the water surface was used for measurement of residual turbidity. During ballasted

flocculation, ballasting agents were added during rapid mixing with coagulant and polymer, and mixing was continued for further 2 minutes.

2.5 Analytical Procedures

All the procedures for analyzed parameters viz. pH, turbidity, alkalinity, and TDS were referred to APHA[2012]. pH value of the samples was determined by pH meter. Turbidity was measured using a Hach 2100 series Nephelo-turbidity meter. The specific gravity of sand was determined by Pycnometer method.

III. RESULT AND DISCUSSION

3.1 Alum coagulation:

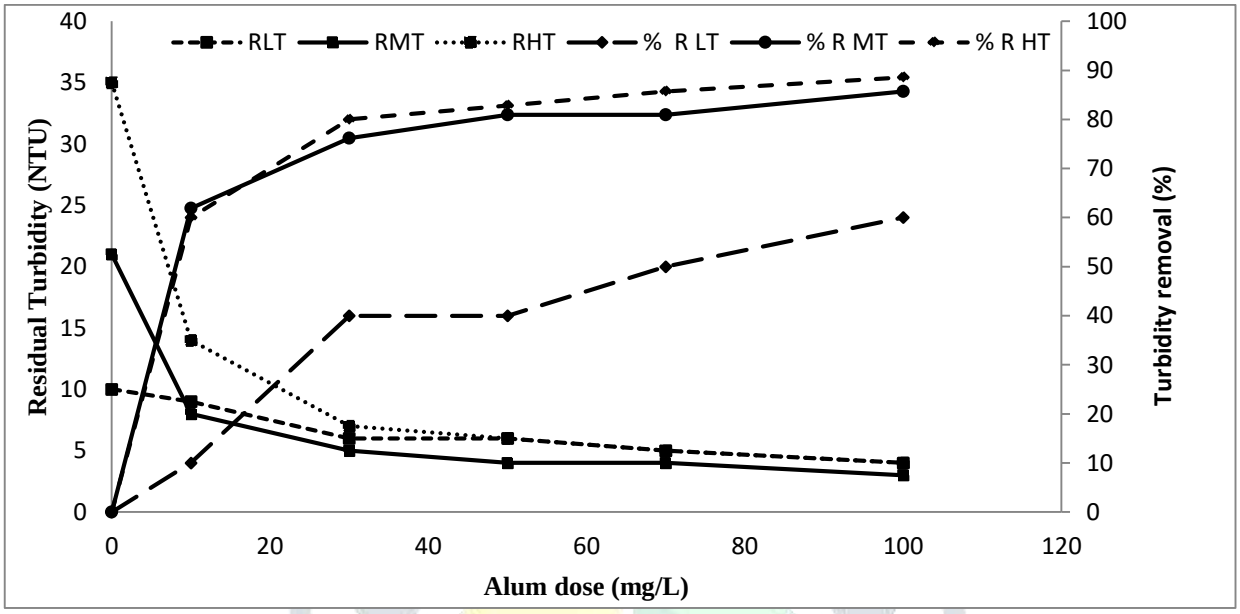

Fig.1 Turbidity removal by alum coagulation

(RLT,RMT,RHT- Residual Turbidity for low, medium and high turbidity water respectively. %RLT, %RMT, %RHT- %Turbidity removal for low, medium and high turbidity water respectively.)

Fig.1 shows the turbidity removal by alum coagulation for low, medium and high turbidity water. The alum dose was varied as 10,30,50,70 and 100 mg/L. The turbidity removal by alum is by formation of aluminum hydroxide precipitate, enmeshment of colloidal and suspended particles in precipitate and settling. The turbidity removal of 60, 85.71 and 88.57 % was obtained at alum dose of 100 mg/L for low, medium and high turbidity water respectively. The study shows that alum is more effective for medium and high turbidity water. For low turbidity water 40% removal is achieved for alum dose of 30mg/L and additional 20% removal is obtained up to a dose of 100mg/L. The turbidity removal increases with increase in initial turbidity level of water. For medium and high turbidity water almost 80% removal is achieved at a dose of 30mg/L and additional 20% removal is obtained up to a dose of 100mg/L.

3.2 Alum coagulation with Aloe Vera as a coagulant aid:

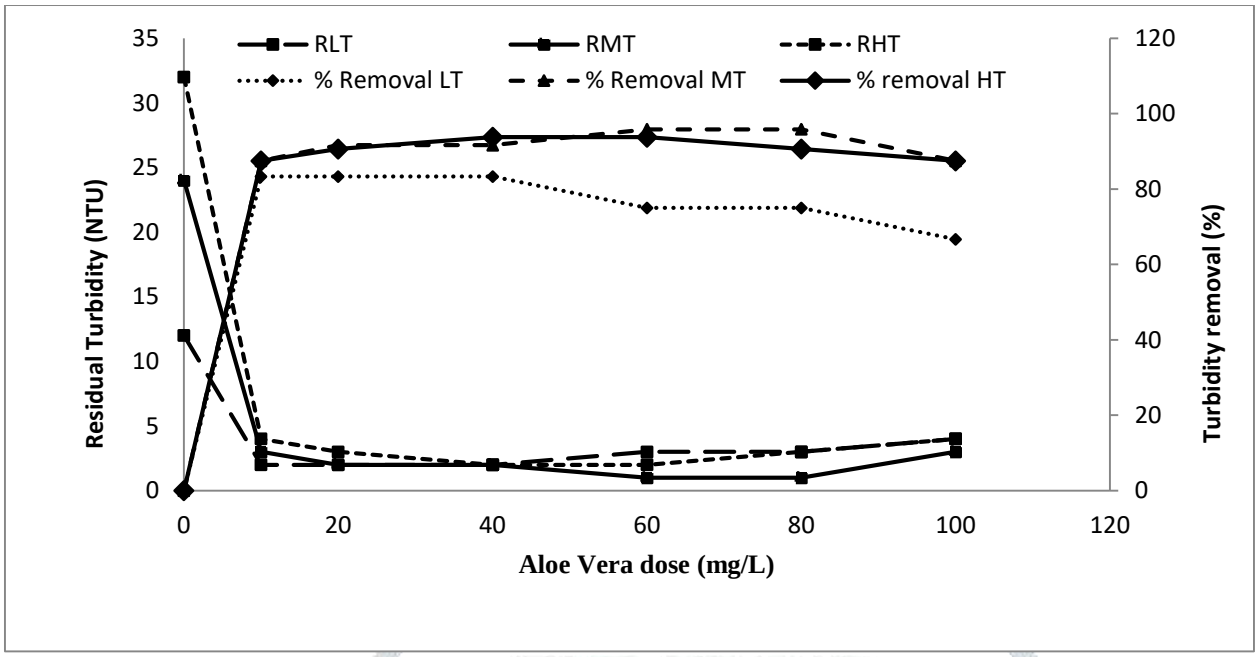

Fig.2 Turbidity removal by alum coagulation with Aloe Vera as coagulant aid

Fig 2 shows the effectiveness of Aloe Vera as a coagulant aid with alum for low, medium and high turbidity water. The Aloe Vera dose was varied as 10,20,40,60 and 100 mg/L and alum dose used was 100 mg/L. Turbidity removal of 80, 92 and 94 % was obtained at Aloe Vera dosages of 10, 20 and 40 mg/L, respectively for low, medium and high turbidity water. Aloe Vera acts as coagulant aid for formation of micro flocs which become entrapped in hydroxide precipitate formed with alum and sweep coagulation takes place. The Aloe Vera is found effective as a coagulant aid in turbidity removal.

3.3 Alum Coagulation and Sand ballasted flocculation with Aloe Vera as polymer:

Table 2 Turbidity removal by alum and sand ballasted coagulation with aloe vera

Initial Turbidity	Alum dose, mg/L	Residual Turbidity,NTU	Alum dose, mg/L	Aloe Vera dose, mg/L	Residual Turbidity,NTU	Alum dose, mg/L	Aloe Vera dose, mg/L	Micro sand dose, mg/L	Residual Turbidity,NTU
Low Turbidity, (0-12 NTU)	100	4	100	10	2	100	10	0.5	1
Medium Turbidity, (13-24NTU)	100	3	100	20	2	100	20	1	0
High Turbidity, (25-35NTU)	100	4	100	40	2	100	40	2	1

Table 2 gives the summary of study conducted on assessing effectiveness of Aloe Vera as a coagulant aid. The alum dose used was 100 mg/L. But varied dose of aloe vera and sand was used. The results were compared for Aloe Vera dose of 10mg/L (low turbidity), 20mg/L (medium turbidity) and 40mg/L (high turbidity) with 100 mg/L of alum dose. It can be seen from the results that Aloe Vera improves turbidity removal by 7 to 15% by acting as coagulant aid in the formation of micro flocs which become entrapped in hydroxide precipitate formed with aluminum sulphate and sweep coagulation takes place. The use of micro

sand further improves turbidity removal by 10 to 15 % by increasing the weight of precipitate which results in more complete settlement. The micro sand is inert, free of foreign matter and can be reused, is suitable ballasting agent for water treatment.

3.4 Comparison between natural and synthetic polymer:

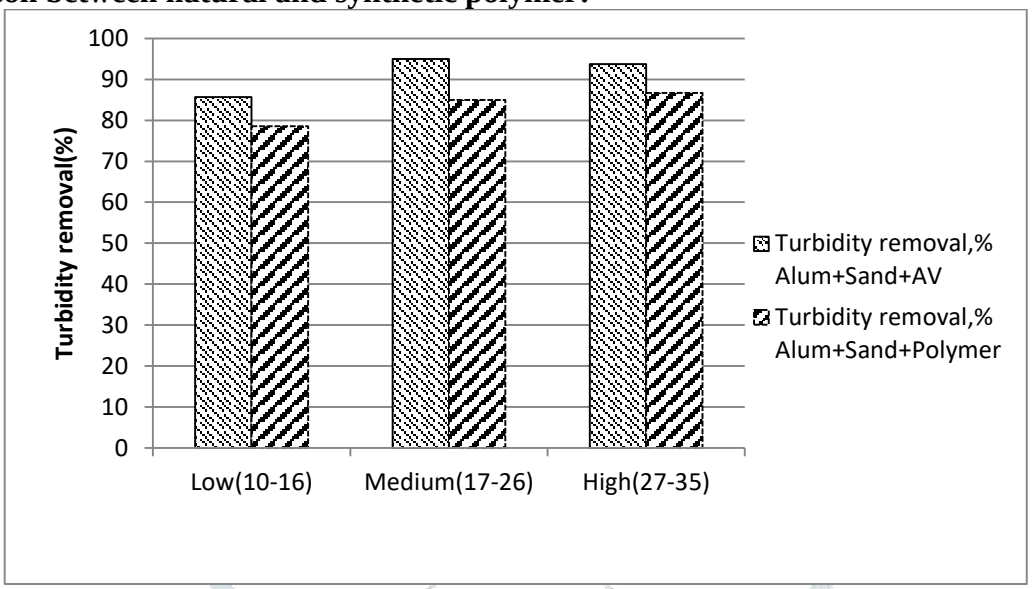

Fig.3 Turbidity removal with sand ballasted coagulation with natural and synthetic polymer

Figure 3 shows the turbidity removal for low, medium and high turbidity water for alum dose 70 mg/L, micro sand 1 gm/L, and polymer dose 20 mg/L. From this graph it can be seen that Aloe Vera is more effective polymer as compared to synthetic polymer when used with alum, for water of low, medium, as well as high turbidity level. This indicates that Aloe Vera polymer may have more branched structure with more charged sites available for adsorption and inter particulate bridging with colloidal particles, as compared to synthetic polymer. It seems that the formation of micro flocs and their enmeshment in hydroxide precipitate is more complete with Aloe Vera as compared to synthetic polymer. The Aloe Vera, which is locally available, non-toxic and economical natural polymer, is a better alternative to natural polymers, for turbidity removal.

IV.CONCLUSIONS

The following conclusions are drawn based on the study conducted with conventional alum coagulation, sand ballasted coagulation with natural and artificial polymer.

1. The turbidity removal of 60, 85.71 and 88.57 % was obtained at alum dose of 100 mg/L for low, medium and high turbidity water respectively, which indicates alum is more effective for medium and high turbidity water.
2. Turbidity removal of 80, 92 and 94 % was obtained at Aloe Vera dosages of 10, 20 and 40 mg/L, respectively for low, medium and high turbidity water, with constant alum dose 100 mg/L. Aloe Vera as a coagulant aid improves turbidity removal by 7 to 15%.
3. The use of micro sand as ballasting agent along with alum and Aloe Vera further improves turbidity removal by 10 to 15 % by increasing the weight of precipitate which results in more complete settlement. The micro sand is inert, free of foreign matter and can be reused is

considered as suitable ballasting agent for water treatment.

4. Aloe Vera is more effective polymer as compared to synthetic polymer when used with alum for turbidity removal.

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REFERENCES

[1] APHA (2012), Standard Methods for the Examination of Water and Wastewater, American Water Works Association, Water Environment Federation

[2] Blumenschein Charles D., Latker Erica and Banerjee Kashi (2004) Sand ballasted high rate clarification process for treatment of process water, International water center, 06-20.

[3]Ghanem Ana V., Young James C., and Edwards Findly G. (2007), Mechanisms of Ballasted Flocculation, *Journal of Environmental Engineering, American society for Civil engineers*, 133(3), 271-277.

[4] Gulmire Amruta and Munavalli G.R., 2017. Use of Aloe Vera as coagulant aid in turbidity removal, *International journal of Engineering research and technology*, 10(1), 314-317.

[5] Muyibi A. Suleyman, and Evison Lilian M. (1994), *Moringa oleifera* seeds for softening hard water, *Water research*, 29(4), 1099-1105.

[6] Olesen Annette (1987), Low technology water purification by bentonite clay and *Moringa oleifera* seed flocculation as performed in Sudanese village: Effects on *Schistosoma mansoni cercariae*, *Water research*, 21(5), 517-522.