IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 4, Ser. III (Jul - Aug 2019), PP 69-76
www.iosrjournals.org

Blend of Natural and Chemical Coagulant for Removal of Turbidity in Water

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Abstract:
The chemical coagulant is widely used for turbidity removal in water treatment but they have health problems associated with them and are additionally uneconomical for use in developing countries. The present work aimed to comparative study of turbidity removal efficiency in the settling columns with traditional coagulant Alum, natural coagulant Moringa Oleifera, and blended Coagulant Alum and Moringa Oleifera. The Moringa Oleifera is recently used as coagulant for water treatment in laboratory work. But even though the Moringa Oleifera possesses coagulation property it is not used in water treatment plant because of quantity of dose required for turbidity removal is more as compared to alum coagulant. In the present work study is carried out to reduce drawbacks of alum and Moringa Oleifera coagulant and develop a new coagulant by blending these two coagulants. Experiments is carried out in a specially designed two settling columns to investigate the settling characteristics of different initial turbidity samples such as 150 NTU (Low), 450 NTU (Medium), 1000 NTU (High). The optimum dosage of coagulants like Alum, Moringa Oleifera, and blended Coagulant Alum and Moringa Oleifera is found out. The optimum coagulant dosage showed that the coagulation with blended coagulant Alum & Moringa Oleifera is better than Alum. A conventional jar test apparatus is employed for the tests. In the blending process of coagulants we can reduce the Alum dose up to 62-75%.
***Keywords** –Alum, Moringa Oleifera, Coagulation, Flocculation, Settling column, Turbidity removal.*

I. Introduction

Surface drinking water sources in many countries have problems with high turbidity, which is normally solved by adding the chemical coagulant such as aluminum sulphate, which is generally at a high cost. About one billion people do not have healthy drinking water. More than six million people (about two million children) die because of diarrhea which is caused by polluted water. Developing countries pay a high cost to import chemicals including alum [1, 2]. Using chemical coagulant is a very common treatment method used mainly in water treatment practices. Recently there has been more interest, especially in developing countries, in possible application of natural coagulants. Use of Moringa Oleifera as natural coagulant is reported to have many advantages over chemical coagulant. Use of chemical coagulant has constrains of pH and alkalinity. However, Moringa Oleifera has been reported to be free of these constraints. Sludge produced with Moringa Oleifera is reported to be four to five times compact than that produced with alum. Turbidity removal can be achieved with Moringa Oleifera. This is the reason why these countries need low cost methods requiring low maintenance and skill. Nowadays, Alum and polyaluminum Chloride is widely used in water treatment plants all over the world. Polyaluminium chloride and alum add impurities such as epichlodine are carcinogenic [3, 4]. Aluminum is regarded as an important poisoning factor in dialysis encephalopathy. Aluminum is one of the factors which might contribute to Alzimer disease [5, 6]. Alum reaction with water alkalinity reduces water pH and its efficiency in cold water [7, 8]. However some synthetic organic polymers such as acrylamide have neourotoxicity and strong carcinogenic effect [3, 5]. Natural macromolecular coagulants are promising and have attracted the attention of many researchers because of their abundant source, low price, multi-purposeness and biodegradation [7, 9, 10]. Okra, rice and chitosan are natural compounds which have been used in turbidity removal [11-13]. Moringa oleifera is a tree of Moringaceae family with 14 species. The seeds of moringa oleifera tree are used to reduce water turbidity in the countries all-round the Nile River, especially Sudan [14,15].

Moringa oleifera tree is known as clarifier tree around the Nile river. This is the species belonging to the north of India which is the most famous one among all species. This tree is resistant to dryness and grows in arid and semiarid areas, so it is called miracle tree [1, 2, 16]. one type of this tree, i.e. Moringa Pergenia, belongs to Iran and grows in the deserts of Sistan- and-Balochestan [17]. The advantages of moringa oleifera usage in water treatment will be mentioned later in the paper. Antimicrobial factor (rhamnosyloxy benzyl-Iso thiocyanate) has been found in this tree seed which can remove 4 log coliforms from water [1, 18, 19]. The extracted part of moringa seeds prevents the growth of coliforms, sodomonas aeroginosen which reduces the requirement for disinfection [20, 21]. The extract of oleifera seed removes 60% to 70% of hardness as well as 99% of turbidity [19]. Coagulating active element in extracts is a cationic dimeric protein with molecular weight of 13 kilo Dalton and isoelectric point 10-11 [14, 22]. Extract efficiency of moringa oleifera seed for turbidity removal equals that of alum [4]. Proteinouse active element extracted from moringa oleifera seeds by dialysis and Ion exchange is 34 times more effective than that extracted by distilled water. This active proteinouse material has a molecular weight of 3000 Daltons and removes 99.9% of 10 NTU turbidity with a dosage of0.6mg/l.Theuseofthisproteindoesn'tincreasedissolvedorganiccarboninwater[15,23,

24]. The volume of sludge produced by extract of moringa oleifera seed is 5 times less than that produced by alum [1, 7, 15]. Moringa oleifera extract has no effect on pH, electrical conductivity and alkalinity after treatment [1, 4, 15, 23]. Studies show that the sodium chloride increases the solubility of coagulating active elements in moringa oleifera seed [15, 24] and that the most effective salt for the extraction of coagulating active element in sodium chloride for turbidity remove is 7.4 times more than that extracted by distilled water [23].

So due to this advantages of natural coagulant Moringa Oleifera, the present study is carried out for traditional coagulant – Alum, Moringa Oleifera, and Blended coagulant Alum & Moringa Oleifera. We are reducing the quantity of Alum dose and increasing the quantity of Moringa Oleifera dose and observing the results.

II. Materials And Methods

Tree dried Moringa Oleifera seeds were procured from local trees. Good quality seeds were then picked up and crushed to fine powder. From this seed extract is prepared.

Preparation of Seed Extracts: 5 gm of seed powder was mixed with 500 ml distilled water for 2 minutes. Then mixture was kept in the Rapid mixer apparatus for 20 minutes with 120 rpm. Then, mixture was filtered through Muslin Cloth. Resulting stock solution was having approximate concentration of 10000mg/l (1%). Fresh stock solutions were prepared everyday for the one-day's experimentalrun.

Preparation of 1% Alum Solution: 1 gm of the Alum was mixed with 100 ml of distilled water. This mixture was stirred for 5 minutes so that all the Alum powder is soluble into the distilled water.

Preparation of 1% Lime Solution: 1 gm of the Lime was mixed with 100 ml of distilled water. This mixture was stirred for 5 minutes so that all the Lime powder is soluble into the distilled water.

Preparation of Moringa Oleifera and Alum Solution: M Oleifera and Alum Solution were prepared separately and entered separately with Al first and M Oleifera a couple of seconds later. **Preparation of turbid water sample:** 5gm of kaolin clay was mixed to 500 ml distilled water. Mixed clay sample was allowed for soaking for 24 hrs. Suspension was then stirred in the rapid stirrer so as to achieve uniform and homogeneous sample. Resulting suspension was found to be colloidal and used as stock solution for preparation of turbid water samples. Everyday stock sample of kaolin clay was diluted to tap water to desired turbidity.

Jar Test Apparatus : Jar test Apparatus generally used for determining optimum dosage of coagulant for coagulation-flocculation treatment.

Digital Turbidity Meter: Capable of measuring, turbidity up to 2000 NTU. Manufactured by Lovibond. It is a digital instrument with new advanced technology. (Fig. 1)Settling Columns: Two Settling columns of diameter 30 cm & 18.5 cm with six sampling port of 12 mm in diameter are Provided. Total depth of column is 1.2 m, the sampling port is provided at depth 0.1m, 0.3m, 0.5m, 0.7m 0.9m, 1.1m. (Fig.3)

III. Experimentation Methods

Jar Test : Turbid water sample of required turbidity (150 NTU or 450 NTU or 1000 NTU) was prepared by using tap water and stock solution of kaolin clay prepared as per the procedure written above. Then all the required jars were filled by turbid water sample of 500 ml. Dose of coagulants as shown in the table 1 and 2 (Alum or M. O. with 1% concentration) was added to different jars filled by turbid water samples. For Alum dosage are selected 25, 50, 100, 150, 200, and 250 in mg/L. And for M.O. dosage are selected 50, 100, 125, 150, 200, 250, 300, 350, and 400 in mg/L. Dosed jars were put in the Jar Test apparatus for 2 minutes at 120 rpm for complete and effective dispersion of coagulant in the water sample. Then slow mixing was continued for 30 minutes and at the end of 30 minutes jars were taken out from the Jar Test apparatus and were kept 30 minutes for settling. At the end of settling period supernatant was taken from 2 cm below the water surface to measure the residual turbidity. Then Graphs 1 and 2 were plotted Residual turbidity versus dosage of coagulant to see the optimum dose of coagulant. Also the using the optimum dosage of alum and M.O. Dose of coagulant which was found to be optimum during the jar Test was used in the all the testing of settling columnTest.

Settling column Test:
Settling Column Tests is carried out using the optimum dosage of coagulants to see the turbidity removal efficiency at different settling time. Also the effect of different types of coagulants used for the effective Sedimentation and settlement characteristics of the turbid water of different type of initial turbidity samples, different diameters of settling columns are studied. The different types of initial turbidity samples are filled in the two settling column of diameters 18.5 cm and 30 cm. Then settling column test was carried out for no coagulant and for different types of coagulants Alum, Moringa Oleifera (drum stick), and blended coagulant Alum and Moringa Oleifera. The optimum dosage found in the Jar Test is used in these settling column tests, depending upon the volume of the settling columns. Dose calculation required for that particular volume of a settling column was carried out. The optimum dosages are added in the settling column and at a constant time interval the samples are drawn from the sampling ports of settling column and their turbidity is measured. The measured turbidities of each sample from each sampling port at constant time interval are tabulated. Then the percentage removal of these turbidities readings is calculated from their initial turbidity readings. Then the graphs of sampling depth versus Detention time of percentage removal of turbidity readings are plotted. (As shown in figure 2) From these graphs the overall turbidity removal efficiency is calculated for constant timeinterval.

IV. Results And Discussion

Jar Test: The optimum dosage of coagulants for initial Turbidity 150NTU, 450 NTU, 1000 NTU, shown in Table 1, 2, 3. From the Graph 1 for Alum coagulant, it is observed that the optimum dosage of the coagulant required for the initial turbidity 150 NTU are 50 mg/lit. The residual turbidity observed for this dose is lowest. Further addition of dosage beyond 50 mg/lit is showing increase in the residual turbidity. The large dosage, which eventually leads to overdosing resulting in the saturation of the polymer bridge sites. This in turn gives rise to the restabilization of destabilized particles resulting in the higher residual turbidity. Then for 450 NTU initial turbidity the optimum Alum dose was 100 mg/lit and for 1000 NTU initial turbidity the optimum Alum dose was 200mg/lit.

From the Graph.2 for Moringa Oleifera coagulant, the optimum dose of the Moringa Oleifera for initial turbidity 150 NTU, 450 NTU and 1000 NTU are 125 mg/lit, 200 mg/lit and 350 mg/lit. From the Table 3, it is observed that for 150 NTU initial turbidity if we reduce the optimum dose of the Alum obtained in the Graph 1 up to 75 % and if we reduce the optimum dose of the M. O. obtained in the Graph 2 up to 40 % then this blended coagulant gives the minimum residual turbidity. Similarly for 450 NTU initial turbidity if we reduce the optimum dose of the Alum obtained in the Graph 1 up to 62.5 % and if we reduce the optimum dose of the

M. O. obtained in the Graph 2 up to 25 % then this blended coagulant gives the minimum residual turbidity. For 1000 NTU initial turbidity if we reduce the optimum dose of the Alum obtained in the Graph 1 up to 62.5 % and if we reduce the optimum dose of the M. O. obtained in the Graph 2 up to 43 % then this blended coagulant gives the minimum residual turbidity. The optimum dose of the blended coagulant for initial turbidity 150 NTU are found as Alum - 12.5 mg/lit, M.O. – 75 mg/lit. For initial turbidity 450 NTU the optimum dose of the blended coagulant are found as Alum – 37.5 mg/lit, M.O. - 150 mg/lit. For initial turbidity 1000 NTU the optimum dose of the blended coagulant are found as Alum - 75 mg/lit, M.O. - 200 mg/lit. **Settling column Test:**

Settling column analysis is carried out using optimum dosage of coagulants. The graphs Depth vs. detention time of percent removal of turbidity is constructed as shown in figure 2 such 24 figures are plotted for different initial turbidity samples, different diameter of settling column and different coagulants, and from these graphs overall removal efficiency is calculated at constant time interval. The comparism of overall removal efficiency of all coagulants at constant time interval is shown in the Graphs of Time Vs % Overall Removal Efficiency for Turbidity 150 NTU, 450NTU,

Table 1 Optimum dose of Alum

Sr.no.	Turbidity in NTU	150	450	1000
	Dosemg/L	Average Residual Turbidity		
1	25	13	17	20
2	**50**	**6.1**	12.5	17
3	75	6.9	10.7	14
4	**100**	8	**8.8**	12
5	150	8.2	9.3	11.5
6	**200**	8.8	9.5	**11**
7	250	9.2	9.8	11.3

Figure 1 Turbidity meter & Settling columns

Table 2 Optimum Dose of Moringa Oleifera

Sr.no.	Turbidity in NTU	150	450	1000
	Dose mg/L	Average ResidualTurbidity		
1	50	22	28	35
2	100	16.5	26.5	33
3	**125**	**12.9**	23.8	32
4	150	13.3	21.5	30
5	**200**	13.5	**16.8**	28
6	250	14	17	26
7	300	14.5	17.5	24
8	**350**	14.8	18	**22**
9	400	15	18.6	24

Table 3 Optimum Dose of Alum & M.O.

Sr	Turbidity in NTU	Proportions	Dose mg/L	Residual turbidity		Average
1		1 : 0.5	25, 62.5	12.8	12.1	12.45
2		0.5 : 0.6	**12.5, 75**	**8.1**	**7.9**	**8**
3	**150**	0.4 : 0.8	10, 100	10	10.1	10.05
4		0.5 : 0.625	50,125	9.6	9.5	9.55
	450	0.375 :	**37.5,**			
6		0.2 : 0.875	20, 175	9.8	10	9.9
7		0.5 : 0.5	100, 175	18	17.8	17.9
8		0.375:0.572	**75, 200**	**12**	**12.2**	**12.1**
9	**1000**	0.25 : 0.715	50, 250	14	14.3	14.2

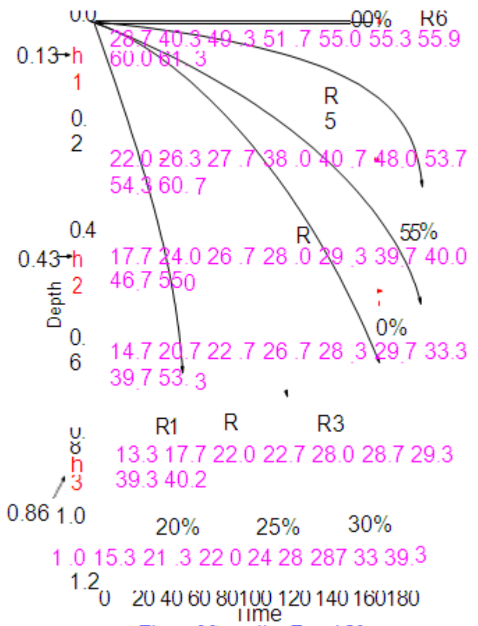


Figure2SamplingDepthVs. DetentionTimeforDia.18.5cm Turbidity150NTU, Coagulant -No

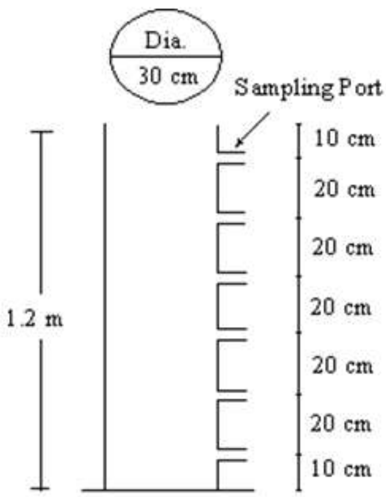
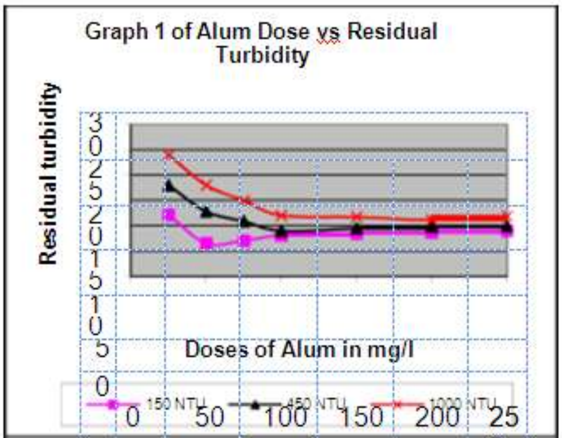
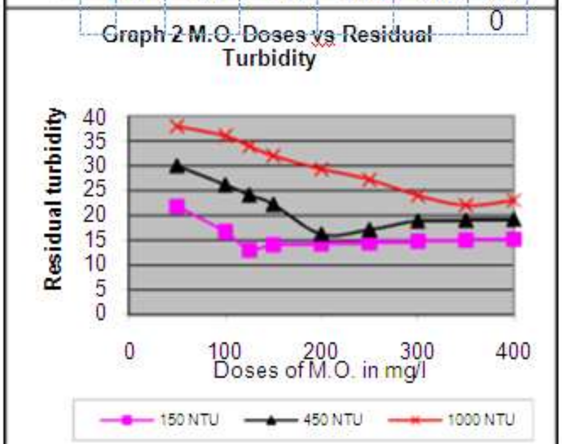
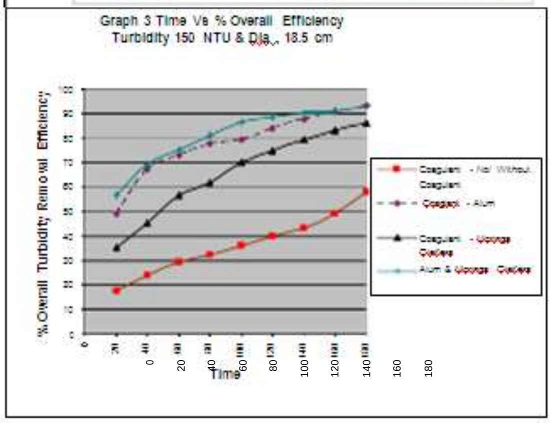
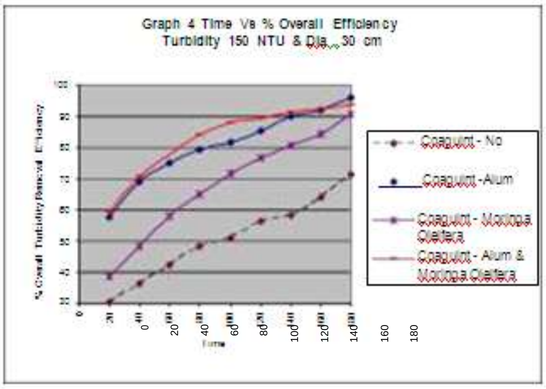


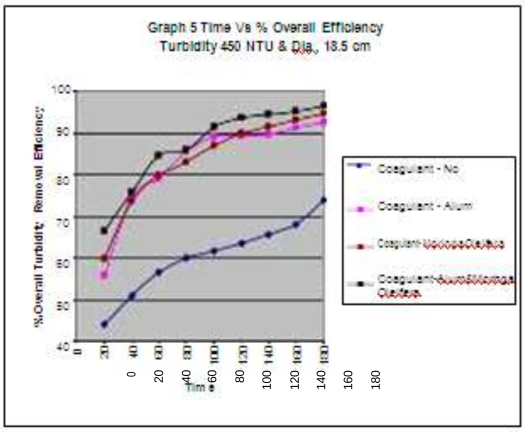
Figure 3 Sketch of Settling Column

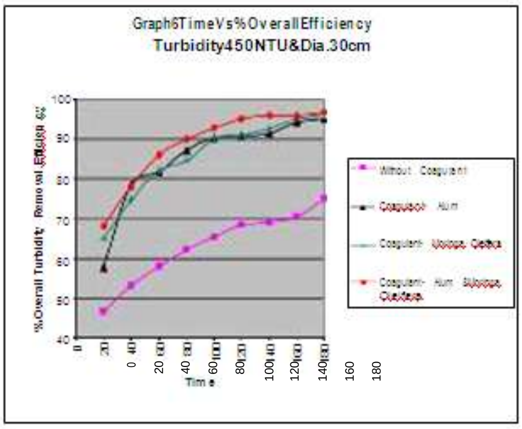


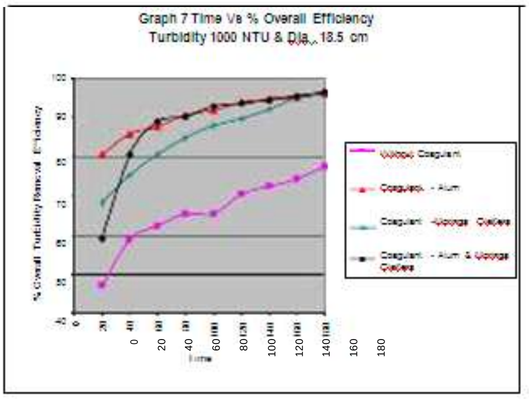


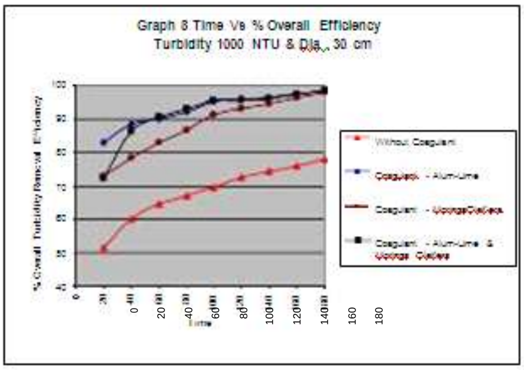












1000 NTU, & Dia. 18.5, Dia. 30 cm. The settling column test is carried out for without coagulant and for different types of coagulants like Alum, Moringa Oleifera and Alum- Moringa Oleifera, using the optimum dosage. The overall removal efficiency obtained for different time intervals, different diameter of the settling columns and different initial turbidity as shown in the graphs 3, 4, 5, 6, 7,8.

From the graphs 3, 4, 5, 6, 7, 8 it is observed that for no coagulant and with all the coagulants as the initial turbidity increases the percentage removal efficiency also increases. The reason behind this is as the concentration of the sample increases rate of the settlement of the particle also increases. It is also observed that for the larger diameter the removal efficiency is more as compared to the smaller diameter of the settling column. This is because of the wall effects are more pronounced in smaller diameter columns. But not to the extent that might have been anticipated. The maximum turbidity removal efficiency obtained for no coagulant at 180 minutes detention time in the settling column, for 150 NTU, 450 NTU and 1000 NTU initial turbidity the removal efficiency of larger settling column diameter (30 cm) are as 71.44 %, 75.10% and 78.06 % respectively. The maximum turbidity removal efficiency obtained for Alum coagulant at 180 minutes detention time in the settling column, for 150 NTU, 450 NTU and 1000 NTU initial turbidity the removal efficiency of larger settling column diameter (30 cm) are as 95.93 %, 95.10% and 98.10 % respectively. The maximum turbidity removal efficiency obtained for M. O. coagulant at 180 minutes detention time in the settling column, for 150 NTU, 450 NTU and 1000 NTU initial turbidity the removal efficiency of larger settling column diameter (30 cm) are as 90.51 %, 96.20% and 97.83 % respectively. The maximum removal efficiency obtained for Alum and M. O. coagulant at 180 minutes detention time in the settling column, for 150 NTU, 450 NTU and 1000 NTU initial turbiditytheremovalefficiencyoflargersettlingcolumndiameter(30cm)areas93.77%, 96.82 % and 98.40 % respectively.

From the comparison of overall removal efficiency at constant time interval of all these coagulants it is observed that the maximum turbidity removal efficiency is obtained by blended coagulant Alum and M. O. then the overall removal efficiency decreases in order of Alum, and then M.O. and finally it is least for no coagulant. This comparison is shown in the graphs 3- 8. From all these graphs it is observed that Alum and M. O. blend Coagulant gives the best result as compared to the traditional Alum coagulants. Here in this blending process we reduce the Alum dosage up to 75 % for 150 NTU initial Turbidity samples and for 450 NTU, 1000 NTU the Alum dosage is reduced up to 62.5 %. So we can reduce the drawbacks of the AlumCoagulant.

V. Summary And Conclusion

The overall turbidity removal efficiency at constant time interval of all these coagulants shows that the maximum removal efficiency is obtained by blended coagulant Alum and M. O. then it decreases for Alum, and then for M.O. and finally it is least for without coagulant. It is observed that blended coagulant Alum and M. O. gives maximum removal efficiency as compared to the traditional Alum coagulants at minimum settling time. Here in this blending process we reduces the Alum dose up to 75 % for 150 NTU initial turbidity sample and up to 62.5 % for medium and high turbidity i.e. 450 NTU and 1000 NTU initial turbidity sample thus we reduce the drawbacks of the Alum. Also we can reduce the cost of the treatment by using the natural coagulant (M.O.) instead of traditional coagulant (Alum). Thus it can be concluded that the blended coagulant i.e. Alum and Moringa Oleifera is the best coagulant which gives the maximum removal efficiency in minimumtime.

References

[1]. Ghebremichael, K.A., 2004. Moringa seed and pumice as natural alternative materials for drinking water treatment, PhD Thesis, University of Stockholm Sweden1-70

[2]. Lilliehook, H., 2005. Use of sand filtration on river water flocculate with moringa oleifera, Master Degree Thesis, Lulea University of Technology.1-33

[3]. Ghebremichael, K.A., K.R. Gunaratna, H. Henriksson, H. Brumer and G. Dalhammar, 2005. A simple purification and activity assay of the coagulant protein from Moringa oleifera seed, Water Research, 39(11):2338-2344.

[4]. Muyibi, S. and M.S. Alfugara, 2003. Treatment of surface water with moringa oleifera seed extract and alum- a comparative study using a pilot scale water treatment plant, Intern. J. Environ. Studies, 60(6):617-626.

[5]. Okuda, T., A.U. Baes, W. Nishijima and M. Okada, 1999. Improvement of extraction method of coagulation active components from Moringa oleifera seed, Water Research, 33(15): 3373-3378.

[6]. Sharma, P., P. Kumari, M.M. Srivastava and S. Srivastava, 2006. Removal of cadmium from aqueous system by shelled moringa oleifera lam. seed powder. Bioresource Technology, 97(2):299-305.

[7]. Katayon, S., M.N. Megat, M. Asma, L.A.A. Ghani, A.M. Thamer, I. Azni, J. Ahmad, B.C. Khor and A.M. Suleyman, 2006. Effects of storge conditions of moringa oleifera seeds on its performance in coagulation. Bioresource Technology, 97(13):1455–1460

[8]. Santos, A.F.S., A.C.C. Argolo, L.C.B.B. Coelho and P.M.G. Paiva, 2005. Detection of water soluble lectin and antioxidant component from Moringa oleifera seeds. Water Research, 39: 975-980.

[9]. Muyibi, S., M. Megat and L. Loon, 2002. Effects of Oil Extraction from Moringa Oleifera Seeds on Coagulation of Turbid Water. Environ. Studies, 59(2):243-254.

[10]. Zhang, J., F. Zhang, Y. Luo and H. Yang, 2006. A preliminary study on cactus as coagulant in water treatment. Process Biochem., 41(3):730-733.

[11]. Diaz, A., N. Rincon, A. Escorihuela, N. Fernandez, E. Chacin and C.F. Forster, 1999. A preliminary evaluation of turbidity removal by natural coagulants indogenous to venezuela. Process Biochem., 35:391-395.

[12]. Ozacar, M. and A. Sengil, 2002. The use of tannins from turkish acorns (valonia) in water treatment as a coagulant and coagulant aid. Turkish J. Eng. Env. Sci., 26: 255- 263.

[13]. Roussy, J., M. Vooren, B.A. Dempsey and E. Guibal, 2005. Influnce of chitosan characteristic on the coagulation and the flocculation of bentonite suspensions. Water Research, 39: 3247-3258.

[14]. Narasiah, K.S., A. Vogel and N.N. Kramadhati, 2002, Water Sci. Technol., 2(5-6):53-58.

[15]. Ndabigengesere, A. and K.S. Narasiah, 1998. Quality of water treated by coagulation using moringa oleifera seeds. Water Research, 32(3):781-791.
[16]. Ali, E.N., A.M. Suleyman and H.M. Salleh, 2004. Moringa oleifera seeds for use in water treatment, in 1st International conference on managing rivers in the 21century
[17]. : issues and challenges, pp: 401-407.
[18]. Mozafarian, V., 1996. A Dictionary of Iranian Plant Names. Tehran, Iran: Farhang Moaser Press271-272.
[19]. Bina, B., 1991. Investigation into the use of natural plant coagulants in the removal of bacteria and bacteriophage from turbid waters, PhD Thesis, University Newcastel Upontyne.
[20]. Muyibi, S.A. and L.M. Evison, 1995. Moringa Oleifera seeds for softening hardwater. Water Research, 29(4):1099-1104.
[21]. Caceres, A., 1991. Pharmacological properties of moringa oleifera preliminary screening for antimicrobial activity. J. Ethnopharmacol.,33:213-220.
[22]. Lipipun, V., 2003. Efficacy of thai medicinal plant extracts against herps simplex virus type1 infection in vitro and *in vivo*. Antiviral research, 60(3):175-180.
[23]. Broin, M., C. Santaella, S. Cuine, K. Kokou, G. Peltier, and T. Joet, 2002. Flocculent activity of a recombinant protein from moringa oleifera lam. seed. Appl. Micobiol. Biotechnol., 60:114-119.
[24]. Okuda, T., A.U. Baes, W. Nishijima and M. Okada, 2001a. Coagulation Mechanism of Salt SolutionExtracted Active Component in Moringa oleifera Seeds. Water Research, 35(3): 830-834.
[25]. Okuda, T., A.U. Baes, W. Nishijima and M. Okada, 2001b. Isolation and characterization of coagulant extracted from moringa oleifera seed by salt solution. Water Research, 35(2):405-410.