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Investigation the performance of LT_{25} anionic poly-electrolytes as a coagulant aid in the turbidity removal case study

N. Osouleddini[1,*], M. Abdollahzadeh[2]

[1]*Department of applied Chemistry, Faculty of Pharmaceutical Chemistry, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran- Iran*

[2]*Water & Wastewater Engineering, Maintenance and Operation of Tehran Water Treatment Plants Directory, Tehran- Iran*

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All water sources contain a broad spectrum of inorganic and organic constituents. $FeCl_3$ is coagulate in water treatment process. Therefore, function of $FeCl_3$ and LT_{25} coagulant aid are studied. To determine coagulant amount and proper pH, jar test be used. Results show that LT_{25} poly electrolyte has good function which cause decrease in coagulant consumption, ma ke large floc, decrease in flow sedimentation time, pH decrease less than before due to $FeCl_3$ consumption and it need lime less. Chemical usage decrease and economical use due to LT_{25} is about 40 to 50 present in 3 to 8 NTU turbidity. $FeCl_3$ decreases pH remarkably while in LT_{25} usage time pH decrease tawny. LT_{25} Increase floc size and in turn speed of sedimentation. In turbidity up 8 NTU, the jar test is not used because coagulation occurs better.

Keywords: Anionic polyelectrolyte; Ferric chloride; Jar test; Coagulation; Flocculation; turbidity removal; sedimentation

INTRODUCTION

Water treatment describes those processes used to make water more acceptable for a desired end-use. These can include use as drinking water, industrial processes, medical and many other uses. The goal of all water treatment process is to remove existing contaminants in the water, or reduce the concentration of such contaminants so the water becomes fit for its desired end-use [1]. One such use is returning water that has been used back into the natural environment without adverse ecological impact [2].

The processes involved in treating water for drinking purpose may be solids separation using physical processes such as settling and filtration, and chemical processes such as disinfection and coagulation [3].

Biological processes are employed in the treatment of wastewater and these processes may include, for example, aerated lagoons, activated sludge or slow sand filters [4].

So, coagulation and flocculation method is used to remove them. Adding a coagulant to water, neutralize colloids electrical charge so that near each other and cause larger flocs. To make large and heavy floc, coagulant aid can be used. These flocs which consist of suspended particles and colloids are large enough and deposited easily [5]. For removing colloids from sewage and water, metal complexes such as, aluminum, Iron or some electrolytes should be used.

Poly-electrolytes are polymers whose repeating units bear an electrolyte group. These groups will dissociate in aqueous solutions (water), making the polymers charged. Poly-electrolyte properties are thus similar to both electrolytes (salts) and polymers (high molecular weight compounds), and are sometimes called polysalts. Like salts, their solutions are electrically conductive. Like polymers, their solutions are often viscous [6, 7]. Charged molecular chains, commonly present in soft matter systems, play a fundamental role in determining structure, stability and the interactions of various molecular assemblies. Theoretical approaches to describing their statistical properties differ profoundly from those of their electrically neutral counterparts, while their unique properties are being exploited in a wide range of technological and industrial fields. One of their major roles, however, seems to be the one played in biology and biochemistry. Many biological molecules are poly-electrolytes. For instance, polypeptides, glycosaminoglycan, and DNA are poly-electrolytes. Both natural and synthetic poly-electrolytes are used in a variety of industries [9,10].

Metal salts as a coagulant enter to water and change to ions, hydroxide or polar hydroxides. This

* To whom all correspondence should be sent:
E-mail: osouleddini.n@gmail.com

large polar molecule by neutralizing colloids particles and decreasing zeta potential (is a scientific term for electro kinetic potential in colloidal systems) which is main factor of repelling force between colloids particles; provide necessary Van der Waals force to create adhesion between particles. Ferric chloride sold commercially as liquid or powder which is the important coagulant for sewage and water treatment. One of effective factors in coagulation of colloids and suspended materials are type and size of particles, so particles with 0.2 to 5 micron diameter which is larger than Colloids particles precipitates more easily [11].

Therefore, the more turbid water, it is easier coagulation. To improve coagulants functions, some coagulants aid can be used. Coagulants aid to accelerate precipitation by forming a bridge between small floc making large and heavy floc, and increasing the lost pH range and decreasing coagulants consumption. In present research, function of LT_{25} coagulant aid and ferric chloride in removing turbidity and determining pH in different conditions of coagulation and possibility to use it in turbidity of water less than 5NTU in number 1 Tehran water treatment plant have been studied.

Poly-electrolytes with electrolytic and polymeric properties can increase floc size. Polyelectrolyte should be studies in three groups: cationic, anionic and nonionic. The most important advantage of electrolyte usage is decreasing coagulants usage. A polyelectrolyte which be used in this research is LT_{25} poly acryl amide ($CH_2CHCONH_2$), and anionic polymeric coagulant aid is best floc a product of colon company of south- Korea. These can be used for treatment of drinking water, industrial water, industrial sewage and limpidity of water.

In this work, function of $FeCl_3$ and LT_{25} coagulant aid are studied. To determine coagulant amount and proper pH, jar test be used.

MATERIAL AND METHODS

To determine the best dosage of coagulant and optimum pH for coagulation, Jar test be used. Jar system, consist of 6 plates and sample be poured in them equally. In each plate a needed amount of coagulant and coagulant aid be poured , then it place in mixing system with speed mixing 140 (rpm) round per minute about 2 min and 20 ^{O}C , and slow mixing of 40 rpm about 20 min. So, some LT_{25} electrolyte is added to it after 10 minutes and finally 30 minutes for precipitation and sedimentation time. After these processes, Jar samples analysis, done, the best result is the most precipitation and more limpidity of above solution, in other word, larger floc size and less turbidity.

Sampling

Sampling was done in April 2012, and a sample of raw inlet water to Jalaliyeh water treatment plant be selected according to “standard methods 21 edition in 2005”. So this sample be analyzed in physical chemistry lab with attention to the rule which say "sample should be a part of a whole". In these samples mean of year for TOC is 1 mg/L, turbidity is 6 NTU, temperature is 12 ^{O}C, pH is 7.95, alkalinity is 130 mg/L as $CaCo_3$, and EC is 600 μs/cm.

Measurement methods

Turbidity was measured by nephelometric method with 2100N system of HACH which made in USA, pH was measured with Metrohm system which made in Switzerland and it determined by calibration standard buffer solution daily. A quality index of floc size is studied by standard index. Floc with size 0.3 to 0.75 mm is among flocs hardly be seen, floc with size from 0.75 to 1.5 mm is considered fine flocs, floc with size from 1.5 to 2.25 mm is considered moderate flocs, Flocs with size from 2.25 to 3 mm among flocs are good (good for sedimentation), and flocs with size of 3 to 5 mm are considered as very good flocs. At first, different concentrations of floc coagulant and LT_{25} coagulant aid is determined in turbid of 2 to 10 NTU. So, quantity parameters changes process which include, residual turbidity, pH after and before of jar test and quality parameters such as particle diameter and sedimentation velocity which have been compared.

Chemical materials used in research

Ferric chloride 38%, lime powder 90% and poly acryl amide powder LT_{25} as a coagulant aid is used. All jar testes done in temperature of 20 ^{OC}. 0.1 g/l slake solution be prepared from LT_{25} polyelectrolyte and be used in jar testes. This solution be prepared daily because of instability.

Coagulants used in research

Chemical and physical properties of coagulants chemical and poly electrolytes which be used in this research, are presented in table 1. Sampling bases (dishes, sample volume and durability according to Table 1, derived by the U.S. Environmental Protection Agency [8].

Table 1. Physicochemical characteristics of coagulant and poly-electrolyte

Characteristic	Poly-electrolyte (LT_{25})	Coagulant (Chloride ferric)
Appearance	Yellow to brown, liquid	Red, liquid
Concentration %	-	35-47
Relative density	-	1.3-1.5
pH Solution	7-8	
Type of electric charge	Anionic	Cationic

RESULT AND DISCUSSION

Variety of turbidity (3, 6, and 8 NTU) are analyzed by jar test. LT_{25} and ferric chloride e is injected at different amounts In order to study effects of different concentration. In LT_{25} polyelectrolyte and ferric chloride on pH a series of testes be done. Based on the results of these experiments at 17.1 °C with adding amount 2 mg/L of ferric chloride, pH was 7.97 and at 18.1 with the addition of 8 mg/L of ferric chloride and 2 mg/L lime, pH was 7.69 that the results show by adding ferric chloride pH is reduced considerably. But in about LT_{25}, at 16 °C with the addition of 0.04 mg/L LT_{25}, pH is equal to 8.08 and at 17 °C with the addition of 1 mg /L LT_{25}; pH was 8.11 that these results show that if injected LT_{25} changed, pH will not change. In this study, the turbidity removal of water by ferric chloride, lime and LT_{25} for samples with a turbidity of 3, 6 and 8 NTU was investigated. Removal the water turbidity by different amounts ferric chloride, lime and LT_{25} is shown in Figures 1, 2 and 3.

The best dosage of ferric chloride and polyelectrolyte could be gain according to above mention graphs and remove percent of turbidity. Noteworthy, that in NTU above 10, flocculation be done properly and in full scale process it isn't necessary to use LT_{25} polyelectrolyte. Totally, results of research are: LT_{25} Powder as an anionic coagulant aid is very effective in removing turbidity and decreasing ferric chloride usage in coagulation process. LT_{25} polyelectrolyte don't change pH of water so in comparison with ferric chloride with is very acidity solution, LT_{25} is proper aid material for flocculation in treatment process of Tehran water. In all turbidity, polyelectrolyte has good function in removing turbidity. Using ferric chloride decreases pH remarkably. While LT_{25} don't change pH, so by using less ferric chloride, consumption of lime-water solution's coagulant aid decrease more. Therefore, costs of lime decrease very much.

CONCLUSION

By using ferric chloride and LT_{25}, Coagulant consumption decrease about 40 to 50 present in 3-8 NTU turbidity. So, using polyelectrolyte is economical among chemical materials consumption. LT_{25} Increases floc size and accelerate sedimentation speed. This is very important in low turbidity. So, input biological load on filters decrease and treatment process is more proper point of view and decrease numbers of filter washing. Because ferric chloride solution contains heavy metals like lead, mercury, cadmium, arsenic etc., if this material be used less, its destructive effects are less.

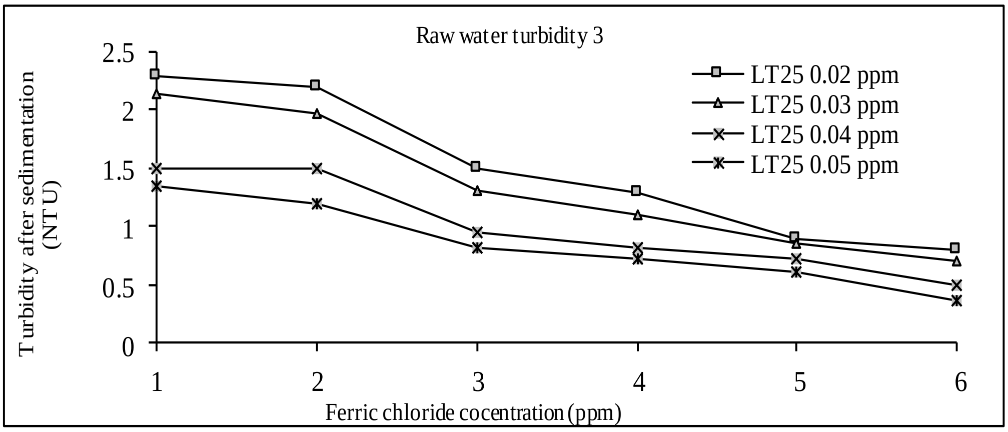

Fig. 1. Turbidity after sedimentation, using different values ferric chloride and LT_{25} in the turbidity 8 NTU.

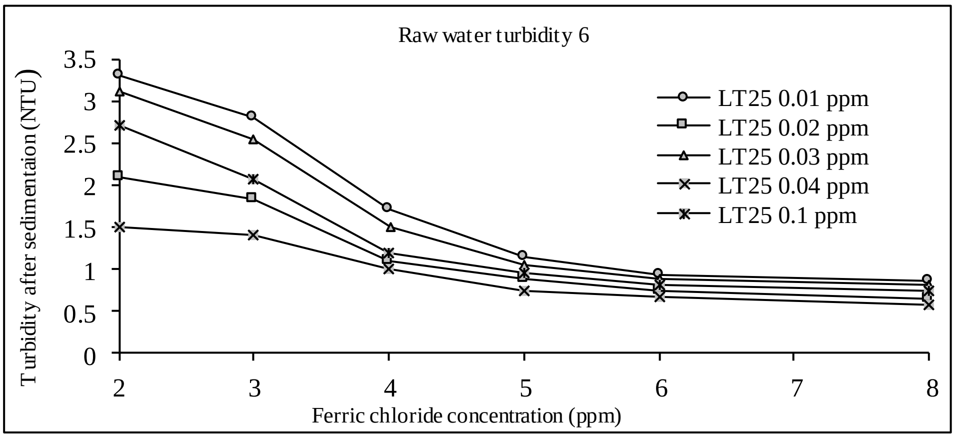

Fig. 2. Turbidity after sedimentation, using different values ferric chloride and LT_{25} in the turbidity 6 NTU.

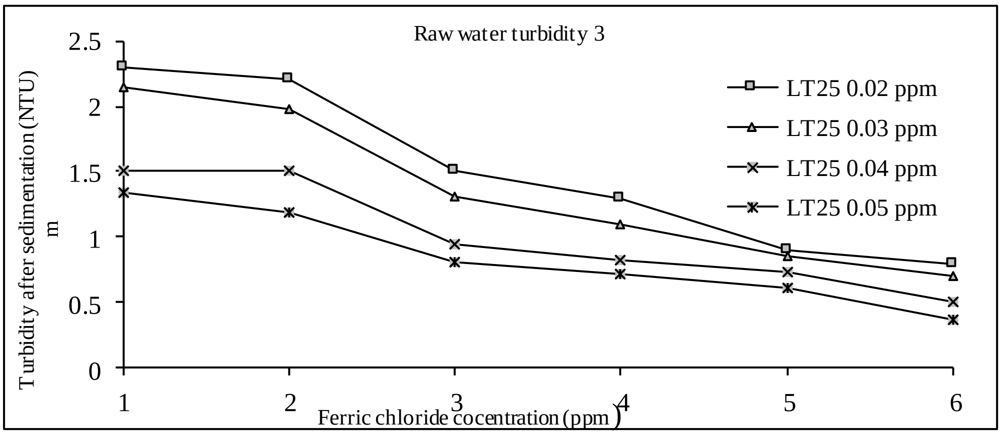

Fig. 3. Turbidity after sedimentation, using different values ferric chloride and LT_{25} in the turbidity 3 NTU.

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