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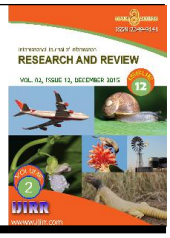

Review Article

APPLICATIONS OF POLYELECTROLYTES- A REVIEW STUDY

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ABSTRACT

Water is life. Water is the very important element which plays the important role in the development of our ecology. But due to the discarded of waste from the industry or any other human activity into the water resources water get polluted. Among the treatments available for the water, coagulation found to be the best one. Coagulation is done with the various chemicals like Alum; sodium Aluminate etc. Other than these chemicals polymers can prove the best. This article gives the details about the applications of polyelectrolyte which are basically the types of polymers.

INTRODUCTION

Water is non separated part of living things and we need water at every step of our day to day life. Water plays the vital role in the ecology of our world. It is the substance with great importance in all natural and anthropogenic activities. It develops the various natural resources like rivers, wells, oceans, springs and lakes which are the identity of our environment and increase the beauty of the environment. But currently an increase in the lifestyle and growing demand has made the fresh water decrease (Coagulants and Natural Polymers, 2013).Safe drinking water is important as a health and development issue at national, regional, and local levels. About one billion people do not have clean and treated drinking water.

More than six million people (about two million children) die because of diarrhea which is caused by polluted water. Clean and safe drinking water is difficult to available in rural areas of India. Water is generally available during the rainy season, but it is muddy and full of sediments. It is noticeable that the water has high turbidity and color. The characteristics of the superficial water observed are apparent color, odour turbidity, solids and pathogens (Screening and evaluation of innate coagulants for water treatment, 2012).

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The common impurities present in the water are in the form of dissolved and colloidal organic matter, suspended material such as clay, silica, microorganisms or algae, most commonly found organic compound such as zooplankton, phytoplankton, bacteria, viruses, clay-humic acid complexes, humic acids, proteins, polysaccharides, and small species like amino acids, fatty acids, and hydrocarbons etc (Brian Bolto and John Gregory, 2007). Among all of these water treatment methods according to M. Zainal-Abideen (Coimbra and Ferreira, 2014) Coagulation is one of the most important processes in water treatment. Coagulation is a Chemical treatment typically applied prior to sedimentation and filtration to enhance the ability of a treatment process to remove particles.

Two steps typically are employed: coagulation and flocculation. Coagulation is a process to neutralize charges and then to form a gelatinous mass to trap (or bridge) particles thus forming a mass large enough to settle or be trapped in the filter. Flocculation is gentle stirring or agitation to encourage the particles thus formed to agglomerate into masses large enough to settle or be filtered from solution. Particles in water smaller than about 10 microns are difficult to remove by simple settling or by filtration. This is especially true for particles smaller than 1 micron – colloids (Application Development Manager, ?). Coagulation is, "the effect produced by the addition of a chemical to a colloidal dispersion resulting in particle destabilization by the reduction of the forces tending to keep the particles apart (The cooperative research centre for water quality and treatment, 2008)."

The chemicals used for the process of coagulation are called coagulants. Generally coagulants used for the treatment are Alum, Sodium Aluminate, Ferrous sulfate, Lime, Ferric Chloride, Chlorinated Copper etc. these coagulants shows the different behavior after getting into the water and treat the water according to their efficiency. The coagulation treatment of water involves the phisico-chemical modification of the colloidal matters which have the characteristics like colour and turbidity by adding the coagulant chemical dose and reduce the forces which are responsible for their suspension and form the flakes (Coagulants and Natural Polymers, 2013). Subsequently flocculation is the physical process of settling of the particles which are denser than water and flakes form in the action of coagulation by the action of gravity (Coagulants and Natural Polymers, 2013).

Introduction to Polyelectrolyte

Coagulation is one of the most important aspects of potable water treatment, being essential in the separation of the solids and providing a primary barrier against waterborne diseases (Freese, 2004). Polyelectrolyte is a polymer; that is, it is composed of many (Poly) monomers (mer) joined together (Zeta-Meter, 1993). Polyelectrolytes are mainly used in the process of coagulation and flocculation in the production of treated water (Brian Bolto and John Gregory, 2007).

The general characteristics of the polyelectrolytes are the Molecular Weight (MW) and charge density. All polyelectrolytes are water soluble. Molecular weights are varies from low, medium or high MW (Brian Bolto and John Gregory, 2007). Polyelectrolytes (PELs) are the type of polymers that bear numerous ionizable groups (Brian Bolto and John Gregory, 2007). There are three types of the polyelectrolyte 1.Cationic polyelectrolyte 2. Anionic polyelectrolyte 3. Non-ionic polyelectrolyte (Brian Bolto and John Gregory, 2007). Cationic polyelectrolyte: - There are varieties of cationic polyelectrolytes are present. Usually they possess quaternary ammonium groups that have a formal positive charge irrespective of PH and they are called as a strong electrolyte polymer. Some weak polyelectrolytes are also found with the cationic charge in acidic media (Brian Bolto and John Gregory, 2007).

Anionic polyelectrolyte: - These are the polyelectrolytes with negative charge and can be produce by various charge densities from non-ionic to very strong anionic polyelectrolytes. Non ionic polyelectrolyte: - These are the polyelectrolytes with very low charge densities. These are typical polyacrylamide.

Advantages of Polyelectrolyte

As compares to Alum Polyelectrolytes have the following advantages

- Lower quantity of dose is required
- Volume of sludge is small
- Increase the ionic load in the treated water in the small amount.
- It reduced the level of Aluminium in water
- Polyelectrolytes save 25-30 % of cost (Brian Bolto and John Gregory, 2007)

The study on the coagulants like Iron and Aluminium salts is done in the numerous times in the past which coagulants can get affected by Ph of the water. But the polyelectrolyte unlike the inorganic salts cannot get affected by the ph of water and as they have much higher charged density they can be applied to much lower concentration than the inorganic salts use of proper polyelectrolyte eliminate the need of PH correction.[5] Polyelectrolyte solutions are very viscous and also only very small doses are required. It is therefore essential that there is sufficient turbulence at the dosing point to ensure rapid and thorough mixing of the small amount of reagent with the main water flow (Water treatment Manual; Environmental Protection Agency, Ireland?).

Applications of Polyelectrolytes

In drinking water treatment process, cationic polyelectrolyte can be used as the primary coagulant instead of Salts due to their high charge density and low molecular weight for example PDADMAC (Poly Diallydimethyl ammonium chloride) (Brian Bolto and John Gregory, 2007). Polymer primarily ort used in the combination with Alum can be effectively treat the water with high turbidity in the range of 21-28 NTU (Brian Bolto and John Gregory, 2007). Polyelectrolytes like ECM / DMA with low molecular weight can be used as primary coagulant which form long chain polymer and treat the water very effectively with very high turbidity. It can also help to remove organics from the water (Brian Bolto and John Gregory, 2007).

Filter plant capacity which is operated by in organic coagulant can be increased by using polyelectrolytes. Thus 25% of flow increased by adding 0.3mg/lit of cationic polyelectrolyte ferric chloride dose (Brian Bolto and John Gregory, 2007). Removal of humic substance cab be done very effectively by adding cationic polymer or we can say polyelectrolyte with inorganic coagulants. Coagulation and flocculation with wide range and decreased of reagent dosage can be achieved (Brian Bolto and John Gregory, 2007). Polyelectrolyte can also remove colour of the water very effectively. Kaolin when add with PDAMAC was used then it has been noticed that about 16% of the better colour was removed, measured be Ultraviolet absorbance. The addition of Alum with Polyelectrolyte is the convenient mix to treat the water. It has been noticed by the experiment that, 67% reduction of Alum can be possible when it added with 1mg/lit of PDADMAC. This mix give the better performance than the Alum alone PDADMAC with higher Molecular Weight polyelectrolyte can also be used solely., give better performance and found to be most effective (Brian Bolto and John Gregory, 2007).

Polyelectrolytes are used to ensure the water produced is of acceptable quality, while pushing production to the limit. [9] .With the help of polymers we can increase the size of floc in water and also strong and dense floc can be made. These big sizes of folc can settle more rapidly in water. Inorganic salt generally produce the particles with slightly negative or slightly positive charge. These charges of particles are depending on the dose of coagulant i.e. metal salt and condition of coagulation. APAM of low or medium CD (Charge Density) and high MW (Molecular Weight) can be the best removal of these slightly positive charge particles. In this way polymers can reduce the dose of Alum up to 40-6-% (Brian Bolto and John Gregory, 2007).

Polyelectrolyte form layered structure which is very useful for some industry. In the paper industry this layered structure of polyelectrolyte are responsible to enhance the quality of paper by modifications in fibers. It increases the wet and dry strength of the paper. Polyelectrolytes can also be useful in medicine and biotechnology as a protein immobilizers, and carriers for gene therapy or drug delivery.

Conclusion

From the above study we can conclude that the use of polyelectrolytes in water treatment is proved to be an effective way to treat the raw water. Polyelectrolytes can help to decrease the sludge volume produce by the treatment process which ultimately leads to decrease the operation and maintenance cost of the treatment plant and also reduces the disposal cost of the sludge.

Overall studied literature gives the importance of the use of polyelectrolytes in various ways like controlling waterborne diseases, reduction in the dose of coagulants, effectively removal of very minute particles, removal of toxic compounds and humic substances etc. Study also clears that, there are some limitations on the use of polyelectrolytes. The residues remain in the treated water are dangerous to the health. These residues are toxic in nature. The optimum dose of polyelectrolyte for the coagulation plays very important role as it does not leads to the residues in the water. At the last we can conclude we can use polyelectrolytes can be used in the partial replacement of conventional coagulants like Alum so that we can get the benefit of it.

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