Coagulating Agents, Alum, Poly Aluminum Chloride, Erai River

ABSTRACT

Two coagulating agents, alum, & polyaluminum chloride (PAC) were used to clarify samples; raw water collected from Erai river, synthetically prepared the sample of different turbidity. The results after raw water treatment showed that the dosage of PAC required for treatment was less than that of alum when it was applied to water at a low turbidity and very less in the case of much higher turbidity. The application of PAC produced rapidly forming flocks and more compact sludge compared to that of alum. However, there were no significant changes in the pH of the solution after treatment with PAC. From the results obtained, the PAC agent performed better compared to alum and might be considered a good alternative to alum for raw water treatment.

KEYWORDS: Coagulating Agents, Alum, Poly Aluminum Chloride, Erai River

1. INTRODUCTION

Water generally contains suspended and colloidal solids from land erosion, decaying, vegetation, microorganisms, and color-producing compounds. Coarser materials such as sand and silt can be eliminated to a considerable extent by plain sedimentation, but finer particles, such as those between 1-100 nm, must be chemically coagulated to produce larger flocks which are removable in subsequent settling and filtration. In considering the aggregation of particles in a colloidal dispersion, it is useful to distinguish between two distinct steps:

1. Particle transport to affect particle contacts, and
2. Particle destabilization to permit attachment when contact occurs.

Particle transport in aqueous systems is essentially a physical process, which is accomplished by Brownian diffusion, fluid motion, and sedimentation. It can be controlled by physical parameters such as temperature, velocity gradient, and particle size. Particle destabilization is clearly a colloidal – chemical process which can be controlled by both chemical and physical parameters. There are many substances which react suitably with water to produce such an effect, known collectively as coagulants. The precipitate so formed in the water is called the flock. The larger and heavier the flock is, the quicker the rate of settlement. Commonly used coagulants are:

1. Coagulants based on aluminum, such as aluminum sulfate (Al2(SO4)3.18H2O), sodium aluminate (Na3AlO3), poly aluminum chloride [Al2(OH)xCl6-x]n, potash aluminum (AlK(SO4)2 .12H2O), and ammonia aluminum (AlNH4(SO4)2 .12H2O),
2. Coagulants based on iron, such as ferric sulfate (FeSO4.7H2O), chlorinated copperas, and ferric chloride (FeCl3), &
3. Poly-electrolytes, which are long-chain synthetic polymers with a high molecular weight.

These organic chemicals are commercially available under a wide variety of trade names. Generally, the type of coagulants and aids available are defined by the plant process scheme and of course, dosages of these substances can be regulated to meet changes in raw water quality. Also, mechanical mixing can be adjusted by varying the speed of the flocculator paddles. Jar tests are widely used to determine optimum chemical dosages for treatment. This laboratory test attempts to simulate the full-scale coagulation-flocculation process and can be conducted for a wide range of conditions. The interpretation of test results involves visual and chemical testing of the clarified water. PAC has been found by others to be an acceptable alternative flocculating and coagulating agent for drinking water, waste water, and industrial water treatment.

2. EXPERIMENTAL WORK

2.1 Material Preparation

2.1.1 Alum stock solution Preparation

As stated above, alums, (consisting of 17 to 19% Al2O3) were used. For such, a 1% alum solution was prepared by dissolving 1.0 grams of crystal alum in 1 liter of distilled water (1000 ppm),100 ml of 1000 ppm sample makeup to 1.0 L by using distill water (100 ppm stock solution)

2.1.2 Poly aluminum Chloride (PAC) stock solution Preparation

1% PAC solution was prepared by dissolving 1.0 grams PAC powder in 1 liter of distilled water (1000 ppm),100 ml of 1000 ppm sample makeup to 1.0 L by using distill water (100 ppm stock solution)

2.2 Turbidity Test

Turbidity level was considered the criterion index for water clarity. Thus, turbidity meter used for this purpose. Before testing, samples of untreated raw water collected from Erai River and prepared sample of different turbidity (synthetic water) such as 145, 540,805 and 2190 NTU.

2.3 pH Test

Testing of the river water’s pH was undertaken before and after water treatment with both types of coagulants, but there were no significant changes in the resultant pH. Thus, the effect of the coagulating agents, especially the PAC, on the pH of the treated water was tabulated. However, pH of the raw water was 8.2

3. RESULTS AND DISCUSSION

From the Table No. I to V and Figure I, It was observed the performance of different types of coagulants on the clarity of river water samples at different levels of turbidity. The effects of increasing doses of coagulants on water samples were determined. These figures show the increased removal of water impurities with an increase in the dose of all types of agents. However, the PAC
produced the lowest water impurities. Coupled with a low range of dosing, the PAC produced better results than either of the alum coagulants.

Table I. Comparative performance of Alum and PAC.

<table>
<thead>
<tr>
<th>Source</th>
<th>Turbidity</th>
<th>pH</th>
<th>Alkalinity mg/L as CaCO₃</th>
<th>Hardness, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erai River Chandrapur</td>
<td>145 NTU</td>
<td>8.2</td>
<td>168</td>
<td>54</td>
</tr>
<tr>
<td>pH 8.2 &amp; Hardness 55 mg/L</td>
<td>156</td>
<td>8.2</td>
<td>168</td>
<td>54</td>
</tr>
</tbody>
</table>

Table II. Comparative performance of Alum and PAC.

<table>
<thead>
<tr>
<th>Source</th>
<th>Turbidity</th>
<th>pH</th>
<th>Alkalinity mg/L as CaCO₃</th>
<th>Hardness, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erai River Chandrapur</td>
<td>540 NTU</td>
<td>7.7</td>
<td>88</td>
<td>54</td>
</tr>
<tr>
<td>Turbidity: 145 NTU, pH 8.2 &amp; Hardness 55 mg/L</td>
<td>80</td>
<td>88</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Table III. Comparative performance of Alum and PAC.

<table>
<thead>
<tr>
<th>Source</th>
<th>Turbidity</th>
<th>pH</th>
<th>Alkalinity mg/L as CaCO₃</th>
<th>Hardness, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erai River Chandrapur</td>
<td>2190 NTU</td>
<td>7.9</td>
<td>120</td>
<td>42</td>
</tr>
<tr>
<td>Turbidity: 7.9 &amp; Hardness-42 ppm</td>
<td>42</td>
<td>7.9</td>
<td>42</td>
<td>42</td>
</tr>
</tbody>
</table>

These data show that the dosage of PAC required for raw water treatment was less than alum at low water impurities, and required very less agent at higher levels of impurities. However, other researchers have stated that the PAC required for water treatment is 60% less as compared to alum. During the experiment, it was noted that during the PAC treatment flocks formed rapidly and the sludge produced was more compact than that of the alum. This could be due to the great ease of PAC hydrolysis as compared to that of alum. PAC emits polyhydroxides with long molecular chains and great electrical charges in the solution, thus maximizing the physical action of flocculation. The coagulation can then be carried out by neutralizing the negative charges on colloids by the ionic sites and then causing a decrease in zeta potential without changing the pH or alkalinity of water. Also, it was noted that the alum concentration needed for water treatment at turbidity is much higher than that required for treatment at a lower turbidity. This can be explained by the additional charge from colloidal suspended solids, and therefore, the high ionic heaviness of the alum coagulant was required to overcome these forces, enhance Vander Walls force and decrease zeta potential. However, lower dosages of PAC were required for all turbidity levels. This could be due to the fact that PAC has a higher hydrolysis
characteristic than other alums, which may lead to the enhancement of adsorption of the present coordinated hydroxide group. Simple hydroxide ions may bind strongly to many solid surfaces. Alternatively, the replacement of an aqua group by a hydroxyl group in the coordination sheath of a metal atom (as is present in alum) may render the complex more hydrophobic by reducing the interaction between the central metal atom and the remaining aqua groups, as can be observed in the following equations: This reduction in solvent-coagulant interaction might then, in turn, enhance the formation of covalent bonds between the metal atom and specific sites on the surface of the colloidal particle by reducing the energy necessary to displace water molecules from the coordination sheath. Finally, adsorption becomes especially pronounced in the PAC species because more than one hydroxide group per “molecule” can become attached at the interface.

4. CONCLUSIONS
The following conclusions were drawn of PAC performed well in river water treatment as compared to alum. An application of PAC yielded lower residual turbidity of treated water. Experimental results showed that the dosage of PAC required for river water treatment was less as compared to alum at low turbidity, and required very less at higher levels of turbidity. Operation treatment using PAC gave excellent results as measured by rapid formation of flocks and compact sludge, and a shorter time for sedimentation. PAC also, has a wide range of dosage, and it may be well-suited to a wide range of turbidity. Thus, as compared to alum, it has better coagulation effects.

REFERENCE
- Waste water Engineering Treatment & Reuse By. Metcalf-eddy
- Status of water treatment plant in India by Central Pollution Control Board
- Coagulation jar test in a water treatment plant; http://www.ce.gatech.edu/image_desc.php
- www.safewater.org