

Comparison of Coagulants Performance with Enhanced Coagulation in Turbidity and Organic Matter Removal in Karaj River

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Introduction

In Enhanced Coagulation, total organic carbon removal depends on the total amount of organic Carbon in raw water and Alkalinity. But usually the removal of organic matter by coagulation depends on the concentration of dissolved organic carbon, chemical nature of natural organic matter, type of coagulants, pH and concentration of coagulants.

Coagulants concentration has a Stockio metric relationship with dissolved organic carbon (DOC), raw water or Ultraviolet absorbance at a wavelength of 254 nm (UV_{254}).

This Stockio metric relationship depends on a kind of coagulator that positively charges aluminum species to neutralize the negatively charged natural organic matter.

Optimum coagulant is defined by a certain pH and concentration to create maximum removal of turbidity, particles and total organic carbon precursor DBP_S and to create the minimum coagulant residual.

Materials and methods

Jar tests has been done by using raw water containers in Jar test beaker with 1 Lit capacity and the sampling depth was 2 cm from water level. Jar test instrument has been planed as follows:

60 seconds rapid mixing with 140 rpm, 20 min slow mixing with 40 rpm (Poly-electrolyte added 10 minutes after Flocculation), 30 minutes sedimentation and after that the samples were analyzed immediately.

Sampling Procedure

Sampling has been done from December 2006 for one year from the raw water entering Kan water treatment plant in accordance with standard methods of water analysis (21st edition, 2005) and sampling principles (containers, sample volume, storage and holding time) has been done according to Table I: 1060 of the standard method and the United states Environmental Protection Agency (EPA).

Analytical Methods

Turbidity has been determined by using Nephelometric method with HACH 2100 N instrument similar to standard methods.

PH has been determined by Swedish Metrohm instrument model 830.

Alkalinity was determined by Titration procedure (Standard method 2001 version 21).

Total Dissolved organic carbon (DOC) was analyzed by spectrophotometer DR/4000 (10129 method) in range 0-20 mg/L after filtering the sample by filters without organic carbon with 0.45 μ Mesh (MN, Germany).

UV₂₅₄ has been analyzed by spectrophotometer model DR/4000 (HACH, USA).

SUVA has been calculated by division of UV₂₅₄ on DOC (mg/L).

Total residual aluminium and iron were analyzed by spectrophotometer Dr/4000 (HACH,USA). THMs has been sampled by method no.6231 of standard methods and has been analyzed by spectrophotometer DR/4000 (HACH, USA) with method no.10132 in the range of 0-200 ppb.

All devices were calibrated according to the instructions manual before using.

Chemicals Used in Research

In this study, 37% Ferric chloride and liquid Poly Aluminium chloride with 13% active Al₂O₃ ion as coagulant, Potassium Hydrogen phthalate Merck Pro analysis as standard organic material were used.

all concentrations used in this study based on the active ion were prepared and used in accordance with the third section of EPA May 1999 815-R-99-012 .

Results

By determining the annual average opacity as 95% (NTU6), jar test was done with organic matter with the concentrations of 0.5,1,3,5,10,15 mg/L, and high doses of both PACL & FeCl₃ coagulants with concentrations of 2,5,10,20,50,80 mg/L.

The effects of increasing doses of PACL and FeCl₃ (coagulant materials) on TOC shows in Figures 1 and 2.

Results show that increasing the dose of coagulant substance from 5 to 80 mg/L, reduces the amount of remained aluminum in water and the size of floc increases abnormally and sedimentation velocity increases dramatically with the sweep mechanism and by adding coagulant, pH reduces from 7.47 to 6.5.

By increasing organic matter and dose of PACL (as a coagulant), the rate of organic material removal increases. Also with increasing doses of coagulant matter, the amount of residual iron in the water after sedimentation was reduced. By the maximum dose of coagulant substance the pH of water reached to 6.2.

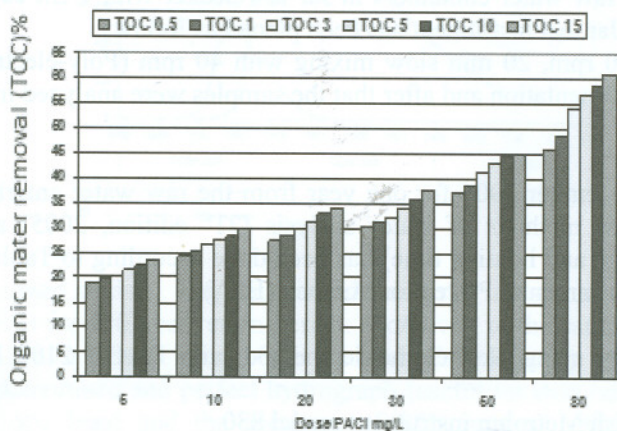


Fig.1: The effect of increasing PACL coagulant doses on TOC removal

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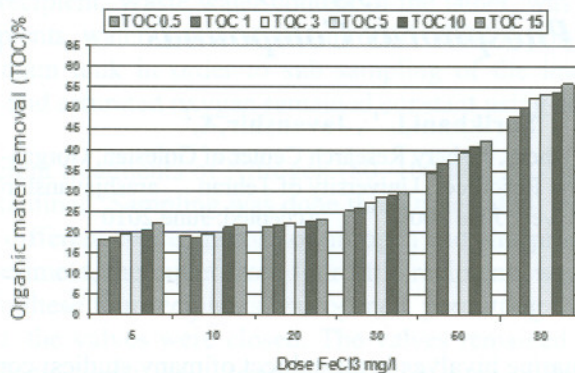


Fig.2: The effect of increasing FeCl₃ coagulant doses on TOC removal

Discussion and Result

Doing jar tests with annual average opacity as 95% (NTU₆) and 2 types of coagulants (PACL and FeCl₃) shows that by creating advanced Enhanced Coagulation condition with PACL, turbidity, TTHM, TOC, DOC, UV₂₅₄, pH and alkalinity decrease to less than ferric chloride.

Also in Enhanced coagulation conditions floc size was small and had nebulosity, so the sludge volume percentage increased.

The remaining amount of deposited aluminum due to using PACL in water was almost 5 times less than the total amount of remained iron in settling stage in Jar test.

The point that distinguishes this study from other researches is that this comparison of the doses of PACL and FeCl₃ coagulants on the active metal ions has been done in accordance with the third section of the Environmental Protection Agency May 1999 815-R-99-012 and building solutions have been compared.

Final conclusions are as follows:

- The percentage of removing Trihalomethanes when using PACL is 20% to 30% more than the state of using FeCl₃.
- TOC, DOC and UV₂₅₄ removal was 10% more when PACL has been used instead of FeCl₃.
- Removal Percentage of turbidity remaining after sedimentation of PACL was more than FeCl₃.
- The effective pH to remove total organic matter in enhanced coagulation for ferric chloride and poly aluminum chloride are 6.2 and 6.5.

Key Words

Enhanced Coagulation (EC), Poly aluminum Chloride (PACL), Ferric Chloride (FeCl₃), Karaj River, Turbidity, Organic Matter