Q&A

22Q3: I am an official who is in charge of water supply in rural area. I want to know the necessity of Jar-test, how to use it and your suggestion.

(Mr. T.H, Laos.)

A1：1) Introduction

In case of coagulation and sedimentation treatment process, the feeding ratio of coagulant in water purification plants should be decided depending on the quality of raw water (turbidity, pH, temperature and alkalinity). To decide the appropriate feeding ratio, the jar test should be regularly conducted to treat raw water. Jar-test is conducted when the quality of raw water changes rapidly as well. A feeding ratio which can generate flocs most and lower turbidity of treated water to the lowest is appropriate feeding ratio. In addition, as coagulant chemicals, there are pH control agents (acid and alkaline) and coagulant aid agents as well. They are used as needed and the feeding ratio is also determined by jar test. Operator in water purification plant should decide the proper feeding ratio of chemicals in reference to the result of jar test. Furthermore, they have to adjust the ratio by checking the result of coagulation and sedimentation in the plant.

2) Coagulant chemicals

(1) Coagulant

Aluminum sulfate：$Al_2(SO_4)_3$,

Polyaluminum chloride: (PAC):$[Al_2(OH)_nCl_{6-n}]_m$, Ferric Chloride : $FeCl_3$, Ferric sulfate : $Fe_2(SO_4)_3$ and so on. Aluminum sulfate and PAC are used mostly in Japan. PAC is an inorganic polymer coagulant developed in Japan. Compared with aluminum sulfate, PAC has advantages as follows; pH range for optimum coagulation is wide, allowable range of optimum feeding ratio is wide too, result of coagulation in high turbidity or in low temperature is good, alkali consumption is fewer and settling velocity is fast. When PAC is fed, pH and Alkalinity decrease as following figures. Excess feeding of PAC beyond the optimum feeding ratio may cause increase of turbidity, which makes effect

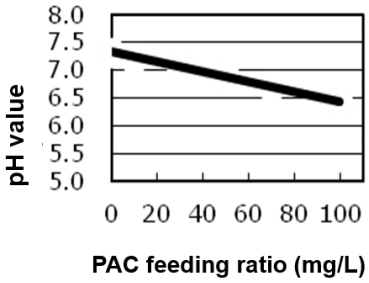

Fig. 1 Decrease in pH value

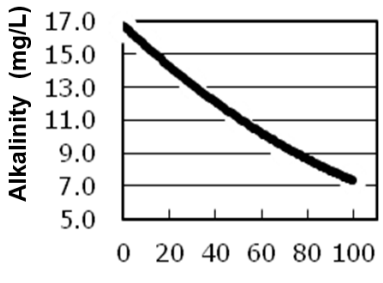

Fig.2 Decrease in alkalinity

of coagulation worse as following Figure.

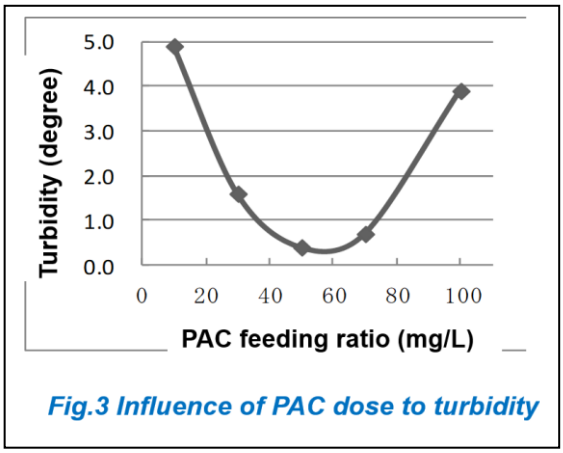

Fig.3 Influence of PAC dose to turbidity

(2) pH control agent

For keeping pH value in optimum range, pH is controlled. In case of high pH, acid agent is used. In case of low pH or low alkalinity, alkali agent is used. There are sulfuric acid, hydrochloric acid, carbon dioxide and etc. as acid agents. Calcium hydroxide, sodium carbonic acid, liquid sodium hydroxide and etc. are alkali agents.

(3) coagulant aid agent

When raw water has high turbidity or low temperature, good floc can not be generated even though coagulant agent and pH control agent are used. In this case, coagulant aid agent is used sometimes. There are activated silica, sodium alginate for water supply and polymer coagulant agent (polyacrylamide).

3) Preparation of jar test (case of PAC as coagulant

◆ Preparation of chemicals

(1) 1% Polyaluminum Chloride (PAC) Solution

Dissolve 5.0g poly-aluminum chloride with purified water and dilute to 500ml in a volumetric flask.

If 1ml of this 1% PAC solution is fed into 1L of the raw water, the concentration of PAC in this raw water will be 10mg/L.

(2) 1/50N（1/100mol） Sulfuric Acid

(3) MR-BCG indicator

◆ Apparatus and instrument

[For jar test]

Jar tester,

Volumetric flask (500ml),

Beaker (1000ml),

Graduated cylinder (1000ml),

Transfer pipette (10 or 20ml),

[For turbidity] Turbidimeter,

[For pH] pH meter,

[For alkalinity] Erlenmeyer flask (200ml), Burette,

Jar tester

[For temperature]　Thermometer,

4)　Procedures

(1) Examine raw water quality.

(2) Pour 1L of raw water into each beaker.

(3) Set the paddles of jar tester in each beaker.

(4) Add coagulant (PAC) to each beaker by the pipette.

(5) Flash mixing in 140 rpm for 1 minute.

(6) Slow mixing in 50 rpm for 10 minutes.

Observe the floc forming condition.

(7) Leave the water quiet for 10 minutes.

(8) After 10 minutes, observe the sedimentability of floc at settling and measure the temperature, turbidity, pH, alkalinity of clear water.

Be careful not to disperse the settled flocs.

(9) Optimum feeding ratio is determined by all results.

※ Revolving number and time in (5), (6), (7) are set optionally by water quality of raw water, chemicals used and characteristic of flocculation equipment.

（Example）

Results of examination are recorded in Jar Test Data Sheet.

Jar Test Data Sheet

Date : July 27 , 2010

Raw Water Quality			
Temperature (℃)	pH value	Alkalinity (mg/L)	Turbidity (degree)
23.4	7.3	16.6	36.4

Feeding Ratio	PAC (mg/L)	10	30	50	70	100
	Alkali (mg/L)	0	0	0	0	0
Floc Forming Condition	Floc Size	**poor**	**Good**	**Good**	**Good**	**poor**
	Sedimentability	poor	Good	Good	Good	poor
pH value		7.2	7.1	6.9	6.7	6.4
Alkalinity (mg/L)		15.6	13.2	11.2	9.2	7.4
Turbidity (degree)		4.9	1.6	0.4	0.7	3.9
Judgment				**Good**		

50mg/L will be optimum feeding ratio from above data sheet.

Furthermore, jar test should be carried out by changing the feeding ratio more finely around 50mg/L. And optimum feeding ratio is determined.

Second jar test data sheet

(Only show the feeding ratio as example)

Raw Water Quality			
Temperature (℃)	pH	Alkalinity (mg/L)	Turbidity (degree)

Feeding Ratio	PAC (mg/L)	40	45	50	55	60
	Alkali (mg/L)					
Floc Forming Condition	Floc Size					
	Sedimentability					
pH value						
Alkalinity (mg/L)						
Turbidity (degree)						
Judgment						

When optimum feeding ratio cannot be determined, jar-test is repeated by changing feeding ratio or/and adding pH control agent or/and adding coagulant aid agent.

(Above answer is extracted from the textbooks and PPTs for overseas training course of Sendai Waterworks Bureau and arranged by Ms. Yamamoto, WaQuAC-Net office, 2013)