

## Procedure

We collected samples of raw water at the intake of the Bangkok Water Works. The maximum turbidity of raw water was found to be about 190 ppm. This value was therefore kept constant in all experiments.

The experiment of coagulant aids are divided into two parts.

1. The coagulation by alum alone. From this part we study on the effect of pH on coagulation. The pH varies from 3-10 and alum dosage is 10, 15, 30, 60 ppm.

2. The coagulant aids together with alum. The study of the various kinds of clays was made. The results are item compared with (1)

### Variable pH series.

The test water was put into each of six-1000 c.c. jars in place under the machine. The amount of the alum  $\text{Al}_2 (\text{SO}_4)_3 \cdot 18 \text{H}_2\text{O}$ . were measured, and put in small individual beakers resting in front of each sample of test water. For adding the dosing chemicals quickly and accurately while the stirrer was operating, the alum dosages used were 10, 15, 30, 60 ppm. The mixing time was 2 min for rapid mix at 80 rpm. and 20 min for slow mix at 30 rpm. and 10 min. settling time. The residual turbidity were measured by siphoning off just under the surface of water of each jar at the period of 2, 5, and 10 min settling time and the turbidity was determined by comparing with standard turbid water. The pH and alkalinity

were both measured before and after tests.

The control of pH to give the desired final pH were very difficult. The relation between initial and final pH was shown in graph. After the finish of every set of jar test the curve of initial pH and final pH were plotted. This curve helps much in predicting the initial pH to give the desired final value.

Coagulant Aids

Aid A fuller earth

Aid B laterite

Aid C kaolinite

Floc Strength

1. no floc
2. very fine
2. fine
4. medium
4. good floc
6. very good floc
6. exceleant.



Flocculation time.

- 2 mins rapid mix at 80 rpm.
- 20 mins slow mix at 30 rpm.
- 10 mins settling time.

Turbidity 190 ppm.  
alum dosage 10 ppm.

No aid.

Data 1-1

pH.		Residual turbidity ppm.				Floc strength.	Alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before	
3.7	3.9	24	18	8	2	8	18	
4.4	4.7	20	14	12	4 <sup>-</sup>	5	20	
5.2	5.5	120	117	100	2 <sup>-</sup>	20	30	
5.8	6.5	20	10	5	0	40	60	
6.1	8.1	6	6	5	0	38	60	
6.4	6.9	60	35	20	2 <sup>-</sup>	30	35	
6.5	8.0	180	180	180	2 <sup>-</sup>	-	-	
6.6	8.2	180	180	180	2 <sup>-</sup>	-	-	
6.7	8.2	8	6	3	0	40	45	
6.1	6.2	2	1	1	0	30	40	
6.6	6.8	170	160	160	0	24	30	
6.8	7.1	45	35	30	2 <sup>-</sup>	24	30	
7.0	8.4	180	180	180	0	-	-	
7.1	8.5	180	180	180	0	40	50	
7.5	8.5	180	180	180	0	40	50	
7.7	8.7	180	180	180	0	-	-	
9.5	9.8	180	180	180	0	-	-	

Data 1-2

Turbidity 190 ppm.  
alum dosage 15 ppm.

No aid

pH.		Residual turbidity ppm			Floc. strength.	Alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	4.5	6	5	5	2 <sup>-</sup>	7	9
4.0	4.3	6	5	5	2 <sup>-</sup>	7	11
4.7	5.0	9	7	6	2 <sup>-</sup>	18	30
5.0	5.2	50	23	10	2 <sup>-</sup>	15	20
5.1	5.3	15	10	2	0	20	30
5.4	5.6	12	5	1	0	20	30
5.9	6.4	10	5	4	0	30	50
6.2	8.0	6	1	1	2 <sup>-</sup>	30	50
6.5	8.3	2	1	1	4 <sup>-</sup>	40	60
6.7	8.3	2	1	1	4 <sup>-</sup>	50	60
7.1	8.4	180	180	180	0	50	60
7.5	8.6	180	180	180	0	50	60
8.3	8.9	180	180	180	0	60	70

Turbidity 190 ppm.  
alum dosage 30 ppm.

No aidData 1-3

pH.		Residual turbidity ppm.			Floc strength	Alkalinity ppm	
after	before	2 min	5 min	10 min		after	before
3.8	4.8	5	1.5	1	0	6	10
4.2	5.5	2	1	1	4	20	30
4.9	5.7	2	1	1	4	24	30
5.2	6.0	2	1	1	4	20	36
5.5	6.6	2	1	1	4	24	40
5.8	7.4	5	2	1	4 <sup>-</sup>	20	40
6.1	8.7	1	1	1	4 <sup>-</sup>	28	60
6.6	8.8	1	1	1	4 <sup>-</sup>	40	60
7.2	9.0	180	180	180	-	50	70
7.5	9.0	170	170	170	-	56	75
7.9	9.2	180	180	180	-	65	80
8.1	9.2	180	180	180	-	70	94
8.7	9.5	180	180	180	-	94	110
9.5	9.8	180	180	180	-	120	140

Turbidity 190 ppm  
alum dosage 60 ppm.

No aid

Data 1-4

pH.		Residual turbidity ppm.			Floc strength	Alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	5.6	2	1	1	4	20	30
3.9	6.1	2	1	1	4	20	30
4.0	6.4	2	1	1	4	15	40
4.5	7.3	2	1	1	4	20	50
4.9	8.4	2	1	1	4	40	60
5.6	9.0	2	1	1	4	20	60
5.8	9.1	2	1	1	4	32	80
6.4	9.2	1	1	1	4	40	80
7.1	9.5	1	1	1	4	50	90
7.4	9.4	1	1	1	4	60	92
7.7	9.4	1	1	1	4	30	90
7.9	9.6	50	40	40	-	50	108
8.5	9.8	100	100	100	-	70	110
9.6	10.0	120	120	120	-	120	170

Aid A.O.1 ppm.

Data 2-1

Turbidity 190 ppm.  
alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	4.5	5	5	5	2	6	7
4.0	4.3	5	5	5	2	7	9
5.4	5.7	12	5	1	2	20	30
6.2	8.0	6	1	1	2	30	50
6.5	8.3	2	1	1	4	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.1	9.2	160	160	160	0	70	96



Aid A 0.5 ppm.

Data 2-2

Turbidity 190 ppm.

alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc. strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.7	4.5	5	5	5	2 <sup>-</sup>	6	8
4.0	4.3	5	5	5	2 <sup>-</sup>	12	20
5.4	5.7	12	5	1	0	20	30
6.2	8.0	5	1	1	2 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
7.5	8.7	160	160	160	0	52	60
8.3	8.9	160	160	160	6	60	70

Aid A. 1.0 ppm.

Data 2-3

Turbidity 190 ppm.  
alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc. alkalinity ppm.		
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	5	5	5	2 <sup>-</sup>	6	8
4.7	5.0	9	6	6	2 <sup>-</sup>	20	30
5.4	5.6	10	5	1	0	22	35
6.2	8.0	5	1	1	2 <sup>-</sup>	40	60
6.7	8.3	1	1	1	4 <sup>-</sup>	45	60
7.0	9.0	160	160	160	0	50	60
8.3	9.1	160	160	160	0	60	70

Aid A 3 ppm.

Data 2-4

Turbidity 190 ppm.  
alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc. alkalinity ppm.		
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	6	5	5	2 <sup>-</sup>	8	10
4.0	4.3	6	5	5	2 <sup>-</sup>	8	12
5.4	5.7	10	5	1	0	20	30
6.2	8.0	5	1	1	2 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	50	60
8.3	8.9	160	160	160	0	60	70

Aid A 0.1 ppm.		Data 2-5			Turbidity 190 ppm. alum dosage 15 ppm.		
pH.		Residual turbidity ppm.			Floc. strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	7	10
5.4	5.7	10	5	5	2 <sup>-</sup>	20	20
6.2	8.0	5	1	1	2 <sup>-</sup>	30	50
6.5	8.5	1	1	1	4 <sup>-</sup>	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	9.0	160	160	160	0	70	80





Turbidity 190 ppm.

Data 2-7

Aid B 1.0 ppm.

alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc. strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.5	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	7	10
5.4	5.7	10	5	5	2 <sup>-</sup>	20	30
6.2	8.0	5	1	1	2 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	9.6	160	160	160	0	70	80

Aid B 3 ppm.                                  Data 2-8                                  Turbidity 190 ppm.  
alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	8	10
5.4	5.7	10	5	1	2 <sup>-</sup>	20	30
6.2	8.0	5	1	1	2 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.1	9.2	160	160	160	0	70	98

Turbidity 190 ppm.

Data 2-9

Aid C 0.1 ppm.

alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	8	10
5.4	5.7	10	5	1	2 <sup>-</sup>	20	30
6.2	8.0	5	1	1	4 <sup>-</sup>	32	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	8.9	160	160	160	0	70	80



Turbidity 190 ppm.

Aid C. 0.5 ppm.

Data 2-10

alum dosage 15 ppm.

pH.		Residual turbidity ppm.			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	8	10
5.4	5.7	10	4	1	2 <sup>-</sup>	20	30
6.2	8.0	4	1	1	4 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	60
4.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	8.9	160	160	160	0	70	80

Aid C 1.0 ppm.

Data 2-11

Turbidity 190 ppm.

alum dosage 15 ppm.

pH.		Residual turbidity.			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	8	10
5.4	5.7	6	4	1	2 <sup>-</sup>	20	30
6.2	8.0	4	1	1	4 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	50
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	8.9	160	160	160	0	70	80

Turbidity 190 ppm.

Data 2-12

Aid C. 3.0 ppm.

alum dosage 15 ppm.

pH:		Residual turbidity ppm.			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	4.5	4	4	4	2 <sup>-</sup>	6	8
4.0	4.3	4	4	4	2 <sup>-</sup>	8	10
5.4	5.7	4	4	1	2 <sup>-</sup>	20	30
6.2	8.0	1	1	1	4 <sup>-</sup>	30	50
6.5	8.3	1	1	1	4 <sup>-</sup>	40	50
7.1	8.4	160	160	160	0	50	60
7.5	8.6	160	160	160	0	60	70
8.3	8.9	160	160	160	0	70	80

Aid C 0.1 ppm.

Data 2-13

Turbidity 190 ppm.

alum dosage 10 ppm.

pH.		Residual turbidity			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	3.9	24	18	8	2	8	18
4.4	4.7	20	14	8	2 <sup>-</sup>	15	20
5.8	6.5	20	10	5	2 <sup>-</sup>	30	50
6.1	6.2	2	1	1	2 <sup>-</sup>	30	40
6.4	6.9	20	10	5	2 <sup>-</sup>	35	40
6.7	8.2	8	5	2	2 <sup>-</sup>	40	45
7.0	8.0	170	170	170	0	40	50
7.7	8.7	170	170	170	0	40	50

Turbidity 190 ppm.

Data 2-14

Aid C 1 ppm.

alum dosage 10 ppm.

pH.		Residual turbidity			Floc strength	alkalinity ppm.	
after	before	2 min	5 min	10 min		after	before
3.8	3.9	20	15	6	2	10	18
4.4	4.7	20	12	6	2	15	20
5.8	6.5	20	10	5	2	30	50
6.1	6.2	2	1	1	2	30	40
6.4	6.9	5	2	2	2	35	40
6.7	8.2	5	2	2	2	40	50
7.0	8.0	170	170	170	0	40	50
7.7	8.7	170	170	170	0	40	50



Aid C 3 ppm.

Data 2-15

Turbidity 190 ppm.

alum dosage 10 ppm.

pH.		Residual turbidity			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	3.9	20	15	10	2 <sup>-</sup>	10	18
4.4	4.7	20	10	5	2 <sup>-</sup>	12	20
5.8	6.5	20	10	5	2 <sup>-</sup>	30	40
6.1	6.2	2	1	1	2 <sup>-</sup>	35	40
6.4	6.9	2	1	1	2 <sup>-</sup>	35	45
6.6	6.8	5	2	2	2 <sup>-</sup>	35	40
7.1	8.5	170	170	170	0	40	50
7.5	8.7	170	170	170	0	40	50

Turbidity 190 ppm.

Data 2-16

Aic C 5 ppm.

alum dosage 10 ppm.

PH.		Residual turbidity			Floc	alkalinity ppm.	
after	before	2 min	5 min	10 min	strength	after	before
3.8	3.9	20	5	4	2 <sup>-</sup>	10	18
4.4	4.7	20	5	4	2	12	20
5.8	6.5	15	6	4	2	30	50
6.1	6.2	2	1	1	4 <sup>-</sup>	30	40
6.4	6.9	2	1	1	4 <sup>-</sup>	35	45
6.6	6.8	5	1	1	4 <sup>-</sup>	30	40
7.1	8.5	170	170	170	0	40	50
7.5	8.7	170	170	170	0	40	50