Effect of phosphoric acid on the water quality in annular reactor

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Abstract

The objective of the study is to investigate the effect of phosphoric acid on the water quality in the annular reactor, which has 20 STS and DCIP coupons. The results suggested that phosphoric acid reduces turbidity and Fe concentration in the effluent of the annular reactor with DCIP coupons while it increased turbidity and chlorine decay rate with STS coupons.

Introduction

Phosphoric acid has been used in drinking water utilities to reduce lead, copper, and iron release from distribution system, and reduce visible Fe precipitation which is related to discolored water complaints.

Bench-scale experiments were conducted to evaluate the effect of phosphoric acid on the water quality in the annular reactor with DCIP and STS coupons.

Materials and Methods

Annular reactors (ARs) were used to model the hydraulic conditions typical in a drinking water distribution system. An inner cylinder which houses 20 removable coupons rotates with variable speed. The rotational speed of the inner drum determines the shear stress.

The residence time is controlled by the influent flow rate. The volume of water contained by the AR was measured by 1 L. Tap water was pumped into four ARs. #1 and #3 ARs had DCIP coupons and #2 and #4 ARs had STS coupons. The rotational speed of the ARs was maintained constant at 40 rpm.

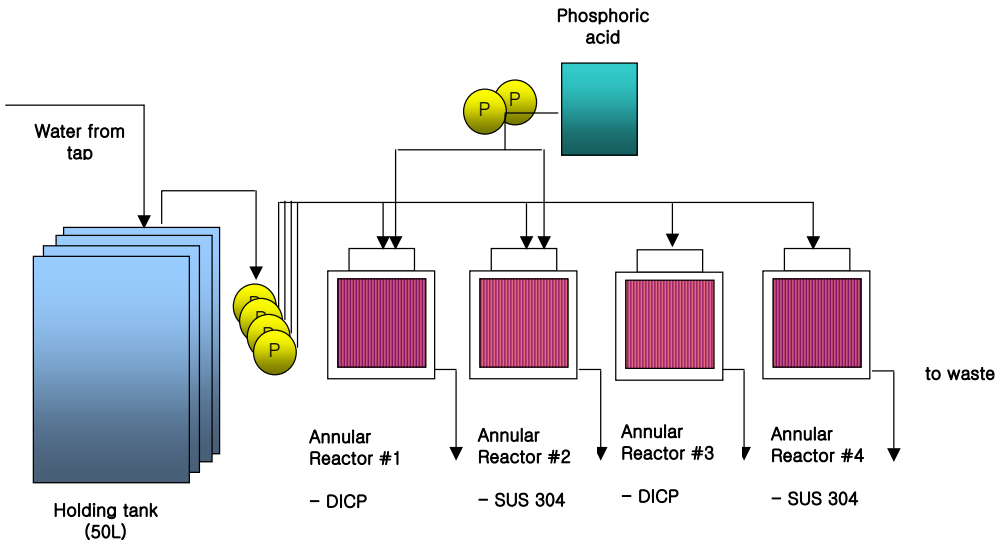

Fig.1 Experimental set up of Annular Reactor

Results and Discussion

1. The average phosphoric acid consumption rate with DCIP was 14% while 0.28% with STS. The pH decreased by 0.08 with DCIP while 0.17 with STS.
2. As phosphoric acid decreased by 0.67 mg/L with DCIP, Fe concentration in the effluent was 3.44 mg/L and turbidity was reduced by 78%.
3. The water quality was deteriorated with STS when phosphoric acid was added,

i.e., turbidity increased by 18% and chlorine decay rate increased by 64.8%.

4. When phosphoric acid is added in a water treatment plant, the difference in phosphoric acid consumption rate and water quality must be taken into account according to resistance to corrosion.

Table 1. Characteristics of the top water used in experiment

Parameters	Average	Range
Temparature (℃)	19.1	11.6 ~ 25.1
pH	7.32	7.0 ~ 7.78
Free Chloine (mg/L)	0.42	0.33 ~ 0.49
Hardness (mg/L as CaCO3)	68	64 ~ 75
Turbidity (NTU)	0.17	0.09 ~ 0.26

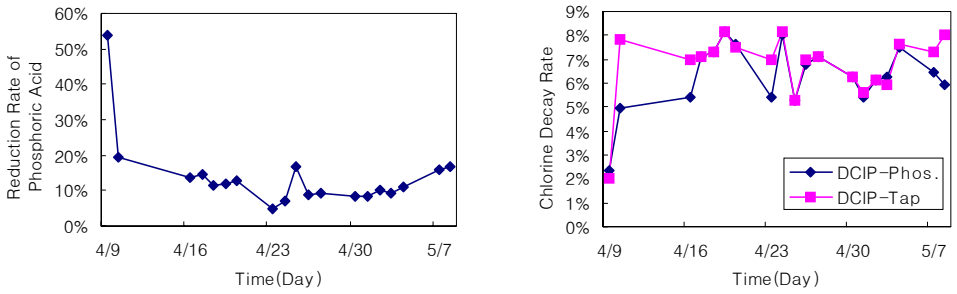

Fig.1 % Phosphorus Consumption and Chlorine Decay Rate

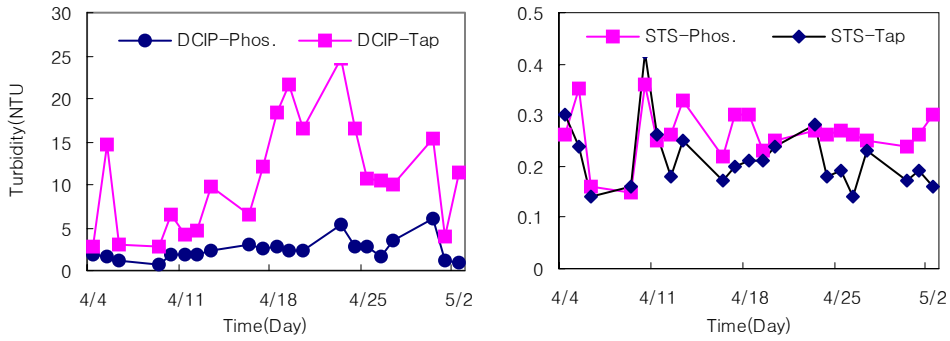

Fig. 2. Turbidity with DICP and STS when phosphoric acid was added

Table 2. Characteristics of the Effluent

Parameters	Influent	Effluent			
		AR 1	AR 2	AR 3	AR 4
Materials	-	DICP	STS	DICP	STS
Phosphoric Acid(mg/L)	4.6~4.7	4.04	4.64	-	-
Turbidity(NTU)	0.17	2.4	0.26	10.79	0.22
Chlorine(mg/L)	0.42	0.05	0.34	0.03	0.36
pH	7.32	7.24	7.15	7.37	7.34

Conclusion

Within the range of the variables tested, the results of the study suggested that, Phosphoric acid reduces turbidity and Fe concentration of the effluent in the annular reactor with DCIP coupons while increases turbidity and chlorine decay rate with STS coupons.

References

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