Evaluation of Rapid Filtration System with Particle Size Distribution and Turbidity in Different Effective Sizes

J.A. Park*, S.M. Eo*, J.S. Shin*, M.H. Kim*, M.J. Yu**, S.H. Chung**

*Seoul Metropolitan Government Research Institute of Public Health and Environment, Seoul, 137-734, Korea
**Department of Environmental Engineering, University of Seoul, Seoul, 130-743, Korea

Abstract

Characterization of particle behavior is becoming more important in performance evaluation of water treatment system as well as in operation of the system because conventional parameter, turbidity has lack of explaining ability on small sized microorganisms such like *Cryptosporidium* etc. Accordingly, particle counter has been introduced in evaluation and operation of the treatment system. However researches on the relationship between turbidity, particle count and/or different sand/anthracite sizes have not been concurrent. Therefore in this study, the relationship was investigated to improve performance evaluation of sand filter so as to help choosing sand/anthracite effective size as a design parameter of water treatment facility. According to the results, too small or too large effective size media filter reached to turbidity limit(0.1NTU) earlier. However, because shallow sand layer may cause early breakthrough, the depth of sand layer should be provided enough in order to compromise water quality and productivity.

Keywords: particle count; rapid filtration; effective size; size distribution; turbidity

Introduction

Characterization of particle behavior is becoming more important in performance evaluation of water treatment system as well as in operation of the system because conventional parameter, turbidity has been reported to be less sensitive particularly at low turbidity (Han *et al*, 1998; Shim *et al*, 2001). Also many studies relating to this topic by utilizing measurement of particle count in unit operation and process are on going worldwide(Emelko, 2003; Hsu *et al*, 2003). Accordingly, particle counter has been introduced and its adoption is now considered as one of the useful approaches in this field. In this study, dual media rapid filters with various sizes were investigated particle count and turbidity to help choosing sand/anthracite effective sizes as a design parameter of water treatment facility.

Methodology

Sand and sand/anthracite were used for dual media of the filter. Overflowing water from the sedimentation basin of Guwi water treatment plant was used as an influent of the filter. Schematic diagram of the plant is shown in Figure 1. Experiment was conducted in different effective sizes and depth at filtration rate 240m/day. The operating conditions are given in Table 1.

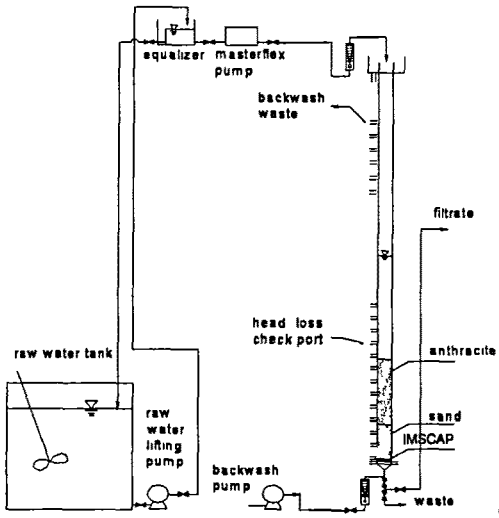

Table 1 Operating condition and raw water quality

mode	uniformity coefficient	de of sand (mm)	de of anthracite (mm)	depth of sand (mm)	depth of anthracite (mm)
A	1.40	0.40	0.79	200	353
B	1.40	0.45	0.88	225	393
C	1.40	0.50	0.98	250	442
D	1.40	0.55	1.08	270	486
E	1.40	0.60	1.18	300	530
F	1.40	0.65	1.28	325	574
G	1.40	0.70	1.37	350	619
H	1.40	0.75	1.47	375	663

Figure 1. Schematic diagram of the rapid filtration plant.

Result and Discussion

1. Comparison of filtrate quality between each size mode

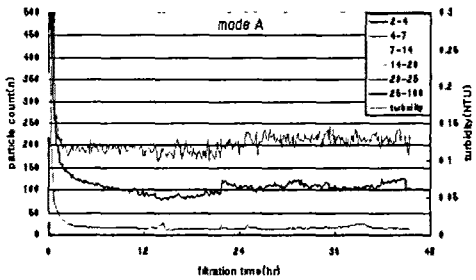

Figure 2. Size distribution and turbidity at mode A.

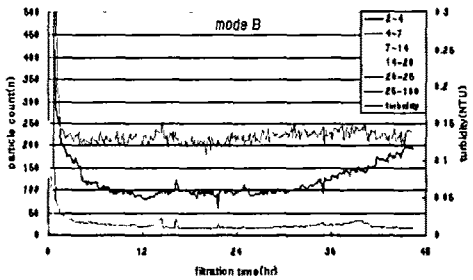

Figure 3. Size distribution and turbidity at mode B.

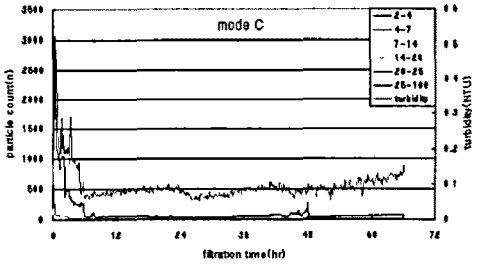

Figure 4. Size distribution and turbidity at mode C.

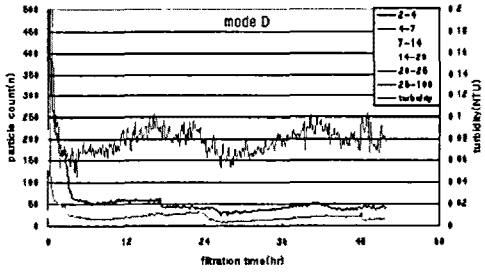

Figure 5. Size distribution and turbidity at mode D.

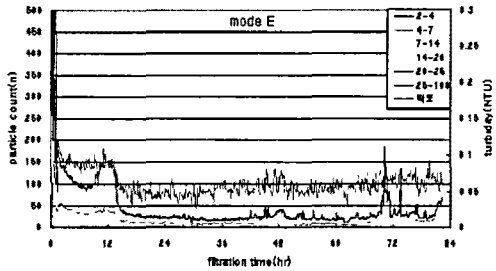

Figure 6. Size distribution and turbidity at mode E.

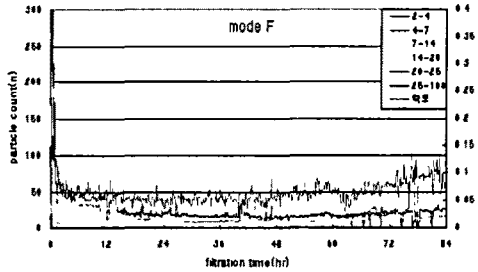

Figure 7. Size distribution and turbidity at mode F.

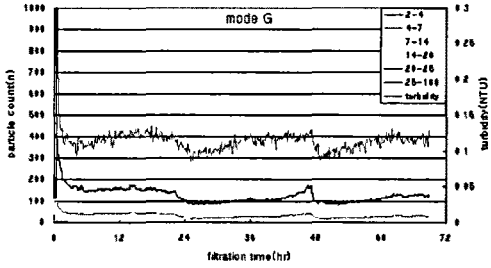

Figure 8. Size distribution and turbidity at mode G.

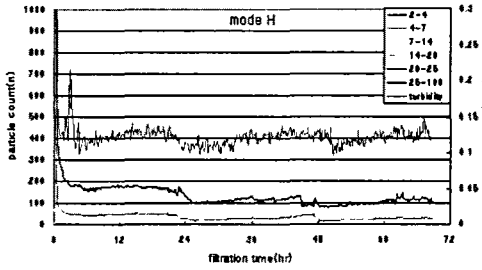

Figure 9. Size distribution and turbidity at mode H.

2. Comparison of size distribution and turbidity by size window

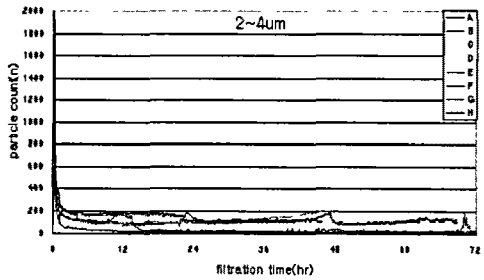

Figure 10. Size distribution at 2~4um.

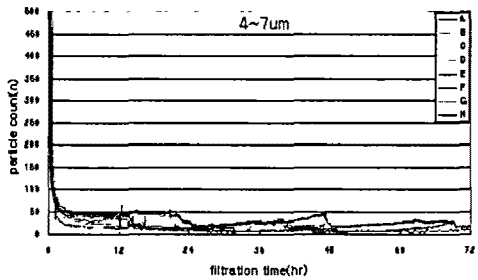

Figure 11. Size distribution at 4~7um.

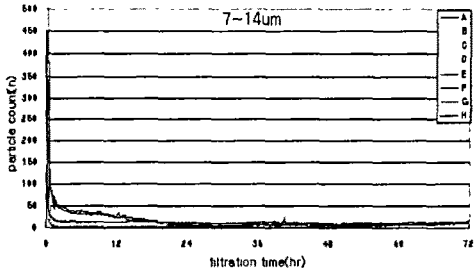

Figure 12. Size distribution at 7~14um.

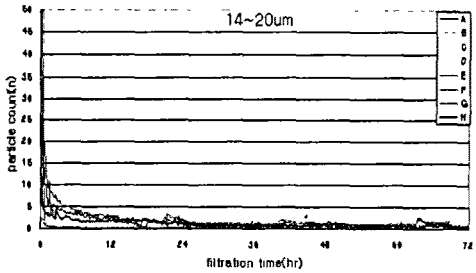

Figure 13. Size distribution at 14~20um.

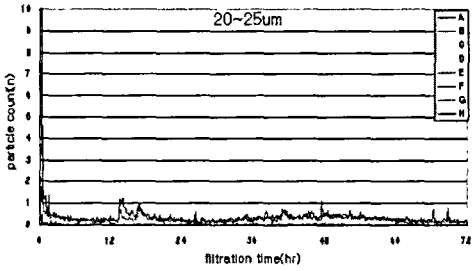

Figure 12. Size distribution at 20~25um.

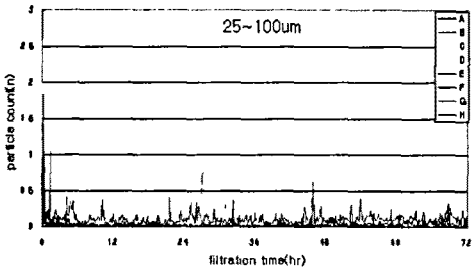

Figure 13. Size distribution at 25~100um.

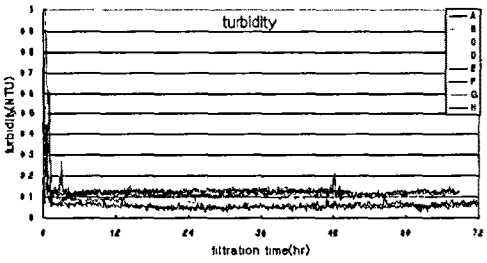

Figure 14. Turbidity at various modes.

3. Relationship between particle count and turbidity (r^2)

Table 2. Relationship between particle count and turbidity (r^2)

Mode / Size window	A	B	C	D	E	F	G	H
2~4um	0.31	0.26	0.18	0.30	0.35	0.57	0.37	0.19
4~7um	0.24	0.56	0.26	0.19	0.65	0.41	0.19	0.32
7~14um	0.15	0.75	0.16	0.18	0.56	0.35	0.22	0.31
14~20um	0.13	0.66	0.12	0.15	0.50	0.36	0.23	0.22
20~25um	0.13	0.71	0.67	0.14	0.57	0.33	0.18	0.31
25~100um	0.32	0.33	0.11	0.12	0.01	0.16	0.04	0.46

Conclusion

Turbidity of filtrate water from too small(mode A, B) or too large(mode G, H) effective size media was high and it didn't go down under 0.1NTU. For duration of filtration, mode C was shortest among other modes(C, D, E, F) and mode D, E & F didn't reach to turbidity limit during filtration.

Particles of size over 7um were removed well every mode while removal at 2~4 & 4~7um size window were different; particle count of mode A, B, G & H was more than 50 and that of C, D, E & F was below 50 during most filtration period at 2~4 um size window; particle count of mode A, B, G & H was more than 25 and that of C, D, E & F was below 25 during most filtration period at 4~7 um size window.

Relationships between particle count and turbidity were low at all modes. It shows that it needs the introducing of on-line particle count monitoring.

References

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