EFFECT OF DISSOLVED OXYGEN ON BIOLOGICAL DENITRIFICATION IN GRANULAR FILTER - A case study of the relationship between dissolved oxygen and methanol

Suraphong wattanachira and Kenji Fujita
Department of Urban Engineering
The University of Tokyo
7-3-1 Hongo, Bunkyo-Ku, Tokyo 113.

INTRODUCTION

Biological denitrification involves the conversion of nitrate nitrogen to gaseous nitrogen and is based on the capacity of denitrifying bacteria. Denitrifying bacteria accomplishes nitrate reduction by a process of nitrate dissimilation whereby nitrate replaces oxygen in the respiratory processes of organisms under anxoic condition. These organisms are able to use either nitrate nitrogen or dissolved oxygen as the terminal electron acceptor while oxidizing organic carbon. Theoretically, the use of dissolved oxygen is more energetically favourable than the use of nitrate nitrogen (Environmental Protection Agency,1975). Therefore, organic carbon consumption for deoxygenation, rather than for nitrate removal, is required. This study was to investigate the deoxygenation and the relationship of dissolved oxygen and methanol in granular filter without denitrification effects.

MATERIALS AND METHODS

The experiment was conducted in packed bed granular filters using anthracite media on which was attached denitrifying bacteria over the entire depth of 800±50 mm. The characteristics of raw water fed into the filters are depicted in Table 1. Nitrate nitrogen was not introduced so as to avoid effects of denitrification on the reaction between dissolved oxygen and methanol in the filters. Two different media sizes of 4.00-4.76 mm. and 2.00-2.83 mm. were tested. Filtration rate of 100 m/d was operated in upflow mode under a controlled temperature of 20±^{o}C. The filters were operated so that backwashing could be done everyday. Samples were taken from every sampling ports along filter depth at about 20 hours after each backwash.

<u>TABLE 1 The Characteristics of Raw Water Fed into the Filters</u>

	Filter A (with media size of 4.00-4.76 mm.)	Filter B (with media size of 2.00-2.83 mm.)
NO_3^--N (mg/l)	0	0
CH_3OH as TOC (mg/l)	approx.5,9,14,17	approx.5,9,13,19
DO (mg/l)	approx. 8.5	approx. 8.5

RESULTS AND DISCUSSION

The decreasing of dissolved oxygen and methanol concentration along filter depth were observed and the results are illustrated in Figure 1. This was done so as to determine the amount of

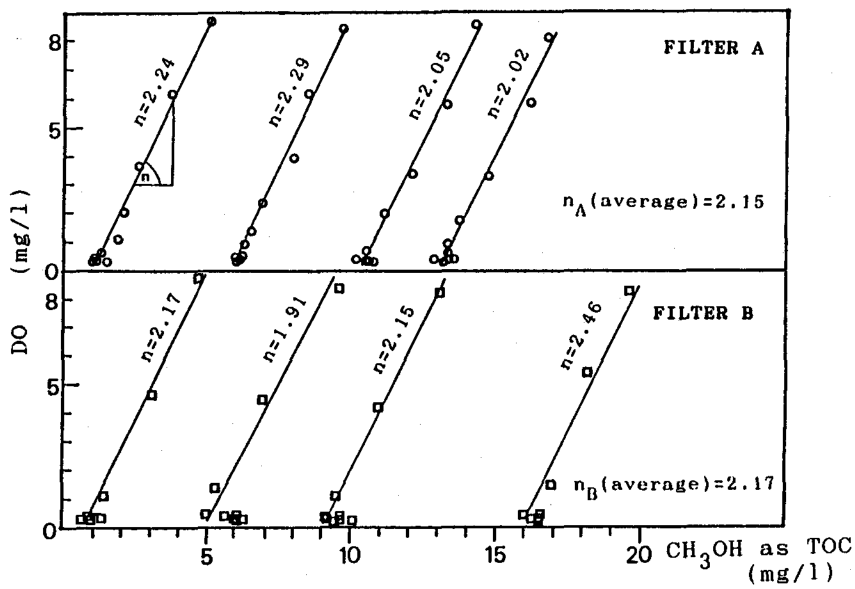

Figure 1. The relationship of dissolved oxygen and methanol as TOC in the filters.

dissolved oxygen removal per 1 mg of methanol (as TOC) consumption,"n value", and the effect of methanol concentration on such "n value". As can be seen in this graph, "n values" were not significantly different for introducing different concentrations of methanol into filters. In addition, "n values" of a smaller media size filter were comparable to those of a bigger media size filter. The average "n value" of 2.16 was obtained. From this, it can be concluded that the amount of dissolved oxygen removal per 1 mg of methanol consumption is considerably constant and does not depend upon methanol concentration and media size. It was also found that minimum dissolved oxygen concentration in filters ranged from 0.3-0.6 mg/l. This indicates that the reaction between dissolved oxygen and methanol was limited when dissolved oxygen was reduced to about 0.3 mg/l. However, it has been reported that the minimum dissolved oxygen concentration in columnar biological denitrification was 0.7 mg/l (Biswas and Warnock, 1985). Figure 2 shows the profiles of dissolved oxygen concentration along filter depth for different levels of methanol were fed into filters. The results indicated that a first-order equation could be used to express the relationship between dissolved oxygen and filter depth . No significant effect of methanol concentration on deoxygenation was observed. Similar observations that methanol concentration and denitrification reaction do not effect deoxygenation rate have been reported (Suraphong and Fujita, 1988). In addition, Figure 2 shows that dissolved oxygen in raw water can be removed from about 8.5 mg/l to a minimum level of 0.3-0.6 mg/l within the filter lengths of 550 mm and 250 mm of filter A and filter B, respectively. Considering the difference of filter lengths used for removing the same amount of dissolved oxygen, it can be concluded that a filter with smaller media size produced higher deoxygenation rate than a filter with bigger media size. The deoxygenation rate constant (K) were 5.57 m^{-1} for filter A and 12.88 m^{-1} for filter B.

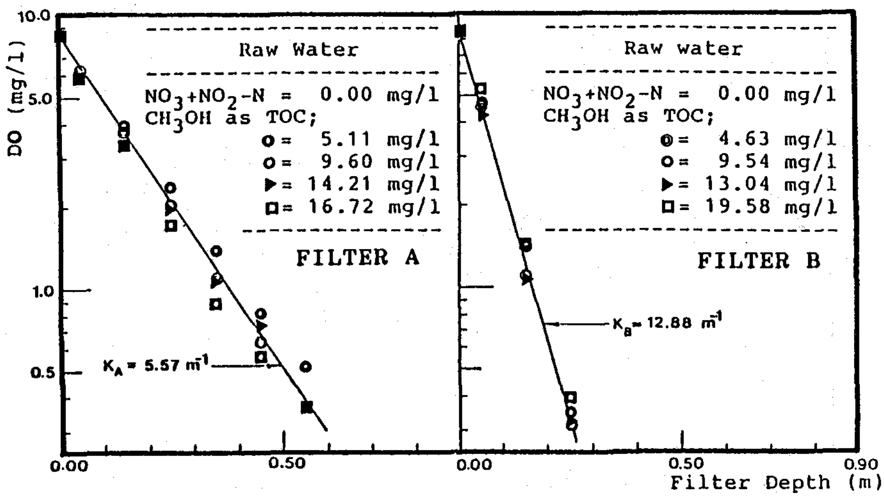

Figure 2. The profiles of dissolved oxygen concentration along the filter depth.

CONCLUSIONS

Based on the experimental results from this investigation, the following conclusions can be drawn :

-2.16 mg of dissolved oxygen was removed for every 1 mg of methanol as TOC that was consumed. In addition, methanol concentration and media size did not influence such value.

- The reaction between dissolved oxygen and methanol was limited as dissolved oxygen was reduced to approximately 0.3 mg/l.

- A first-order equation could be used to express the relationship between dissolved oxygen and filter depth.

- No significant effect of methanol concentration on deoxygenation was observed.

- A filter with smaller media size produced higher deoxygenation rate than a filter with bigger media size.

REFERENCES

Biswas, N. and Warnock, R.G. (1985). Nitrogen Transformation and Fate of Other Parameters in Columnar Denitrification. Water Res., 19 (8), 1065-1071.

Environmental Protection Agency (1975). Process Design Manual for Nitrogen Control, Washington D.C.

Suraphong, W. and Fujita, K. (1988). Biological Denitrification in Granular Filter. Proceedings of Second IAWPRC Asian Conference on Water Pollution Control held in Bangkok, Thailand, 563-569.