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STUDY ON TWO STORY RASCHIG RING － SAND FILTER

D.G.Viraj De Silva; Hitoshi Hozumi and Hideki Yoshida
Department of Civil Engineering
Muroran Institute of Technology, Muroran 050, Japan

1. INTRODUCTION

Direct filtration (DF) was introduced about 20 years ago. In its simplest form, the process of the DF includes only filters preceded by chemical coagulant application and mixing without settling process. Raw water must be of seasonally uniform quality with turbidities routinely less than 10 mg/L in order to be effectively filtered by an in-line direct filtration system.

During monsoon seasons and snow melting periods, raw water concentration rises to a higher level and cannot be effectively filtered by DF. Due to this reason DF technology is not widely used on water supplies. The proposed two story Raschig ring - sand filter ensures low turbid effluent before sand filters and can be used for DF throughout the year even with raw water of high concentration.

The upper bed of the proposed filter is packed with Raschig rings of few millimeters diameter and is placed in overlaid water above the backwash troughs of a conventional sand filter.

The aim of this investigation is to examine the removal efficiency of raschig ring bed and to determine the extensibility of the filter run.

2. Experimental Apparatus and Method

Experimental studies were carried out using the experimental apparatus shown in Fig. 1. As shown in Fig.2 the apparatus consists of two columns; column A - sand bed 1 and column B - Raschig ring bed followed by sand bed 2. Sand Beds in both columns are identical.

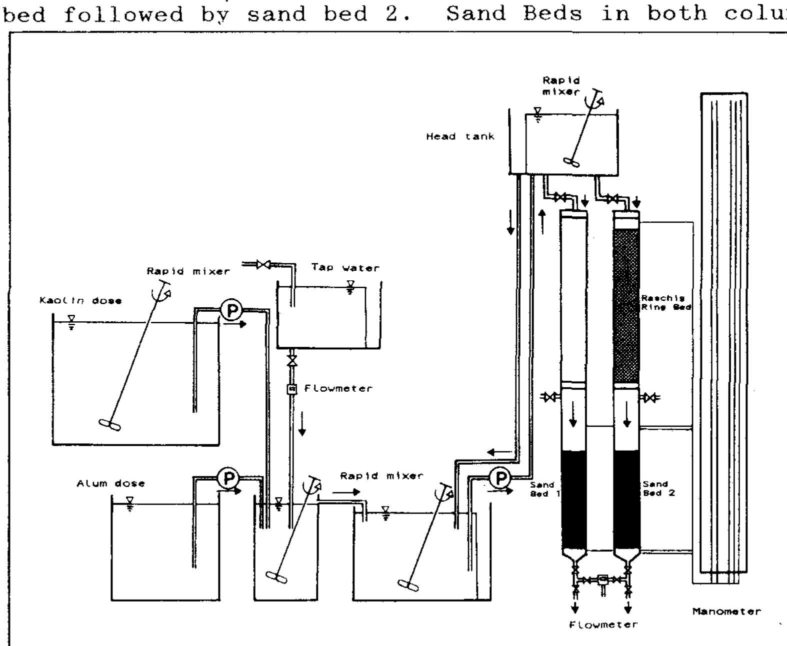

FIG. 1 SCHEMATIC DIAGRAM OF EXPERIMENTAL APPARATUS

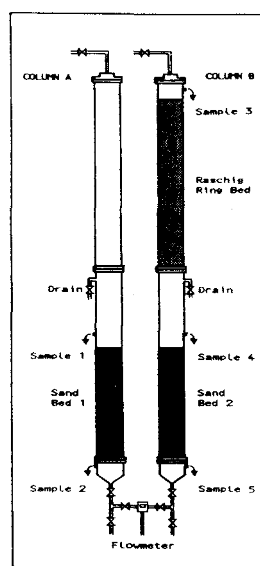

FIG. 2 CROSS SECTION OF FILTER COLUMNS

Kaolin suspensions are coagulated by aluminum before being fed to the columns.

Semi-cylindrical Raschig rings of 2mm inside diameter and 4mm outside diameter and 6mm length are packed in a 7cm diameter ethylene tube with a 90 cm bed height.Raschig rings(density = 1.12) are made from vinyl tube. Porosity of the packed bed is about 0.45 at the start of a filter run.

A sand bed of 60 cm depth with 0.59 - 0.71 mm diameter grains follows the Raschig ring bed. In between these two beds a wash water exit valve is fixed. Through the valve, water in the upper Raschig ring bed is discharged by gravity for bed washing and backwash water for the sand bed cleaning is allowed to overflow.

The rate of filtration which was monitored by a flowmeter was changed at five levels namely 120, 180, 240, 300 and 360 m/day. ALT ratio (Aluminum dosage / Turbidity) was increased from 0.005 to 0.05 during the experiments. Samples were taken from 5 different points as indicated in Fig 2. Head loss was measured by a manometer. Filter run is terminated either when the head loss exceeds 2.5m or when the quality of the filtered water no longer meets a standard value of 2 mg/L.

3. RESULTS & DISCUSSIONS

Fig. 3 shows the progress of the proposed filter, i.e. variation of turbidity and head loss at the Raschig ring bed inlet and outlet, sand bed 2 outlet and the sand bed 1 outlet with filtration time. The rate of filtration is 120 m/day and the ALT ratio is 0.05. The experimental data shown in Fig. 3 implies that major parts of suspended matter(more than 80%) in a coagulated water can be removed in the Raschig ring bed with very little (few centimeters) head loss. Therefore an ample head to drive DF in the lower sand bed ensures a longer filter run. In this case the length of filter run has increased more than thrice. This figure illustrates the effectiveness of the two story Raschig ring - sand filter,i.e. lower turbidity at the inlet of the sand bed and a longer filter run.

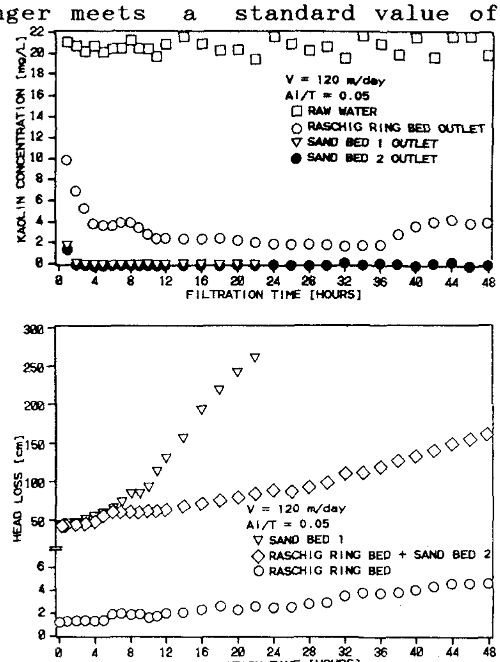

FIG. 3 PROGRESS OF THE TWO STORY RASCHIG RING - SAND FILTER

The performance of the Raschig ring bed was examined for its effectiveness of turbidity removal and head loss variation with time at a filtration rate of 180 m/day by changing the ALT ratio at four stages as shown in Fig. 4.

These data show that the incoming suspension concentration can be reduced up to 40%-80% by Raschig ring bed depending on the ALT ratio with a very small head loss. Higher ALT ratios can remove turbidity up to 80%, but the length of filter run is shorter. Lower ALT ratios can remove turbidity up to 40% with a longer filer run. According to the results, the minimum possible ALT ratio was 0.005 to receive an effluent of less than 2mg/L. This value is agreeable for filtration rates up to 300 m/day and it should be increased for 360 m/day to get effective results. This data (Fig.4) shows that 0.005 ALT ratio gives the best results.

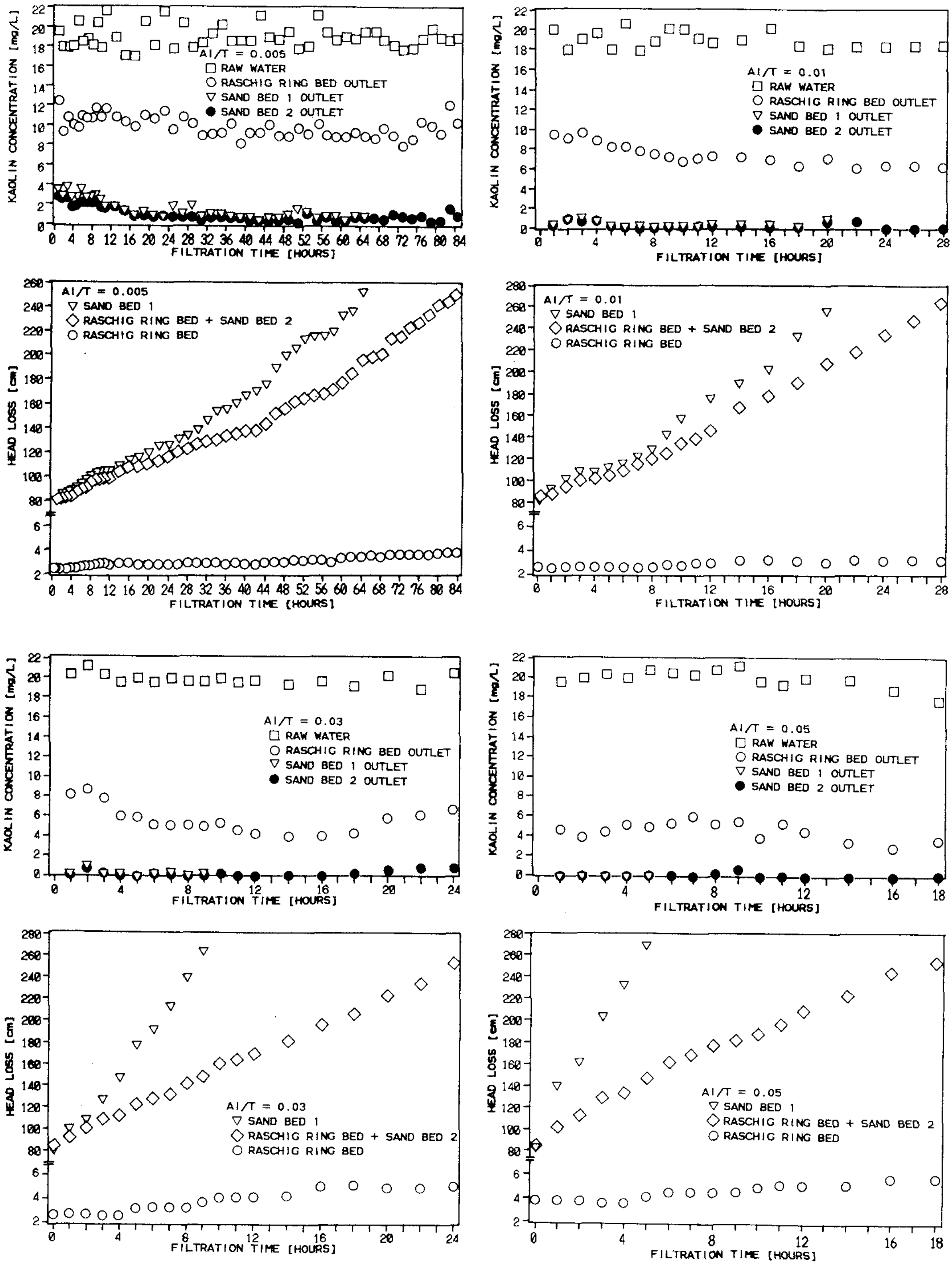

FIG. 4 VARIATION OF EFFLUENT CONCENTRATION AND HEAD LOSS WITH FILTRATION TIME (V = 180 m/day)

Fig. 5 was drawn to find out the most suitable rate of filtration at ALT ratio = 0.005 for 20 mg/L turbidity water. This figure illustrates that higher velocities have lower removal efficiencies.

From these data, filtration rate of 240 m/day or less seems to be more effective.

Fig. 6 shows the expansibility of the filtration time for different ALT ratios at V = 180 m/day. When ALT ratio is 0.05 expansibility of filter run is 3.6 times than that of a conventional filter and when ALT ratio is 0.005 it has become 1.3 times. Even though higher ALT ratios give better results on the filter run extensibility, lower values of ALT ratios have longer length of filter runs (Fig.6).

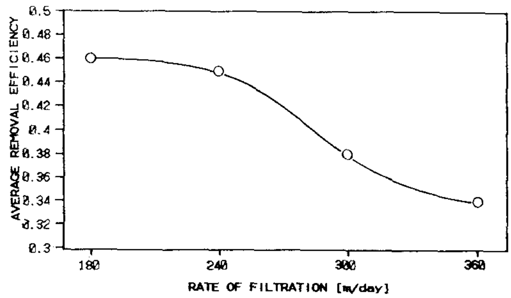

FIG. 5 AVERAGE REMOVAL EFFICIENCY OF THE RASCHIG RING BED WITH FILTRATION RATE (ALT RATIO = 0.005 ;T = 18 HRS)

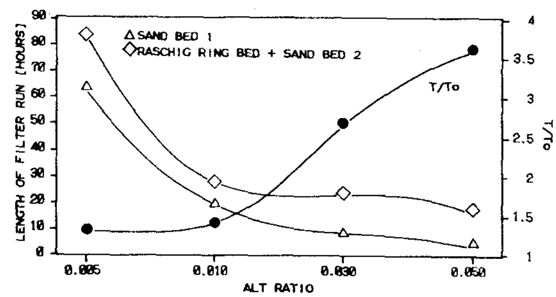

FIG. 6 LENGTH OF FILTER RUN AND ITS EXPANSIBILITY OF THE PROPOSED FILTER WITH ALT RATIO (V = 180 m/day)

4. CONCLUSIONS

Based on the experimental results, the following conclusions can be drawn.

1. Major parts of suspended matter in a coagulated water can be removed (40-80%) in the raschig ring bed with very little (2-6cm) head loss. Therefore an ample head to drive DF in the lower sand bed ensures a longer filter run than that of the conventional sand filters.

2. When ALT ratio was increased from 0.005 to 0.05, the expansibility of the filter run was increased from 1.3 to 3.6. But the length of filter run is longer for lower ALT ratios.

3. To receive an effluent of less than 2 mg/L, the minimum possible ALT ratio is 0.005.

4. For Raschig ring bed, filtration rates less than 240 m/day are considered to be giving optimum results.

REFERENCES

1. Tambo N., Kobayashi M. and Matsui Y., High Capacity Depth Filter Bulletin of Faculty of Engineering (No.118 - 1984), Hokkaido University, Japan.

2. Tambo N., Matsui Y., Performance of High Capacity Depth Filter Aqua No.2 pp 96 to 101, 1984.