Cationic polymers in water treatment
Part 2: Filterability of CPE-formed suspension

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Abstract

Part 2 of the paper compares filterability of CPE-formed and mineral coagulant-formed suspensions.

Introduction

The aim of coagulation is not only the formation of a readily settleable suspension, but also a suspension which is effectively filterable in order to obtain economic operation of filtration plants.

Particle aggregation and deep-bed filtration are interrelated processes because the effectiveness of filtration is determined by the properties of the formed aggregates. Those properties which are favourable for effective sedimentation may not necessarily be the most suitable for effective filtration and vice versa.

Suspensions of four different properties in respect of their filterability can be formed. A suspension which is completely retained in the filter bed at the expense of high head loss is not desirable. Similarly, a suspension which generates a low head loss but is poorly retained is also not desirable. A suspension which is poorly retained and generates high head loss is the worst of all. A suspension which is completely retained and generates a minimum head loss represents an ideal suspension, the formation of which should be aimed at.

The filterability of CPE-formed suspension compared with that of hydrolysing coagulant formed suspension is investigated in this paper.

Pilot plant

The pilot tests were carried out in a plant consisting of two complete filtration plants, each comprising a flocculation chamber and a filtration column. The plant arrangement is shown in Fig. 1 and Picture 1.

The flocculation chamber (A) was made of a 1 000 mm long perspex tube with an inner diameter D_{FC} = 125 mm and bottom inlet. It was furnished with a double frame, double anchor, two tier type stirrer (6) driven by a variable speed drive (7).

The filtration column (B, C) was made of 2 750 mm long perspex tube of 100 mm inner diameter. This column was provided at the top with an inlet connection (8) to the filter column and a drain overflow (9) maintaining the operating water level in the filter column constant. At the bottom, the filter column was provided with a false floor (10), drilled with 70 evenly spaced 1 mm diameter holes, on which the filter medium rested. The filtrate discharge (13) was below the false floor (10) on the bottom of of the column. The filter column was also provided with side taps (11) 100 mm apart for measurement of head loss through the filter bed depth; the lowest point was located 40 mm above the false floor. The loss of head was measured in a tube type pressure gauge (12). During testing, one of the filter columns was charged with sand only and the other one with sand and Hydro-anthrasit "H". The single medium filter column was charged (B1) with silica sand of grade 1.0 to 2.0 mm, d_{50} = 1.315 mm, UC < 1.25 to a depth L_F = 1 150 mm. The operating water depth was L_W = 1 600 mm. The dual media filter column was charged with (C1) Hydro-anthrasit "H" of grade 1.6-2.5 mm, d_{50} = 2.035 mm, UC < 1.4 to a depth L_F = 1 040 mm and (C2) silica sand of grade 0.7 to 1.1 mm, d_{50} = 0.91 mm, UC < 1.30 to a depth L_F = 440 mm. The operating water depth was L_W = 1 270 mm.

The bottom discharge (13) from the filter column (B, C) was connected to a positive displacement gear type pump (14) and driven by a variable speed drive. The gear pump was selected to ensure that the pre-set rate of flow through the filtration column was maintained constant at all times, irrespective of the loss of head generated by the filter bed during the filtration runs. The electrically controlled variable speed drive was used to vary the capacity of the gear pump, allowing selected preset flow rates through the filtration column.

Raw water inlet (1) to the plant was arranged via a flash mixing device consisting of a T-piece (3) and three valves (2, 4), one at each end of the T-piece (3). Each discharge (5) from the T-piece (3) was fitted with a valve (4) and connected via piping (5) to one of the flocculation chambers (A). The rate of flow to the pilot plant was measured upstream of the flash mixer and controlled by operating the inlet valve (2). The total flow through the pilot plant was split into each filtration unit at the T-piece (3). The valves (4) were used to control and balance the flow rate through the flocculation chambers (A). Discharge (8) from the flocculation chamber (A) was connected to the top of the filtration column (B, C). The flow control was designed to provide the same flow to each flocculation chamber. This was achieved as follows. The total flow through the pilot plant was slightly greater than that filtered by both filters. The portion of the flow of flocculated water that exceeded the filtered flow was drained continuously from the top of each filter column (9). The flow through each flocculation chamber was adjusted by the inlet valve (4) to the flocculation chamber in such a way that the flow drained from the top of each filter column was approximately the same, and hence, the retention times in both flocculation chambers were also approximately the same. The loss of head was measured by a tube-type pressure gauge (12).

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