CFD Analysis of Service Reservoir

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Introduction

The Simmonds Hill Service Reservoir takes water from a treatment works without a dedicated chlorine contact tank. Therefore, the service reservoir must provide sufficient contact time, as required by the asset standard, to enable adequate disinfection. The reservoir is a circular tank with a diameter of 79.9m and TWL of 7.62 m. It has two high level inlets above the water surface and two low level outlets diametrically opposite the inlets. There are no internal baffle walls, although there is a central 3.8 m high dividing wall, which enables maintenance to be conducted when one half of the tank is drained and the other half is operated at low water levels. The tank takes a maximum flow of 28 ML/d.

CFD analysis of the flow patterns and contact performance for the reservoir operating at the maximum flow identified significant short-circuiting, dead zones and a low hydraulic efficiency. This highlighted the need for internal baffles.

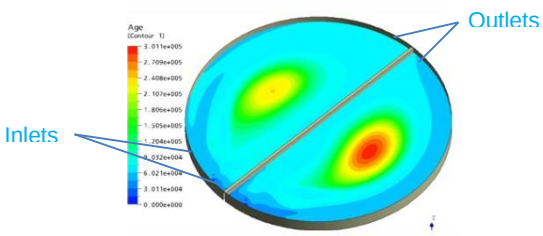

Figure 1: A scalar is used to show the youngest water (blue) and the oldest water (red)

Two new baffle arrangements were considered; a 6 wall and 9 wall configuration. The 9 wall baffle arrangement was the better of the two, with a significantly improved breakthrough time (5.6 hours) compared to the original configuration (1.8 hours) and 6 baffles (4.1 hours). This 9-baffle option had narrower lanes and shorter gaps at the lane ends, reducing short-circuiting and recirculation. Additionally, the 9-baffle option had a significantly improved contact time (Ct) of 15.5 mg.min/L, compared to the original 12.4 mg.min/L.

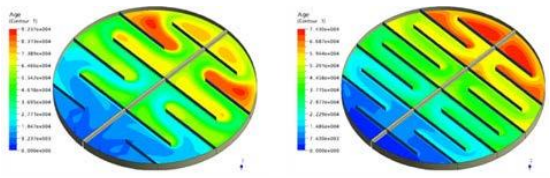

Figure 2: Water age in the 6 and 9 baffle configurations

The suitability for the 9-baffle configuration during maintenance conditions was assessed at a range of flow rates (16.8, 22.4 and 28 ML/d). The efficiency (breakthrough time / mean residence time) remained at 21% for all three conditions. This was only slightly lower than the full tank 9-baffle configuration efficiency of 26%. However, the Ct of 13.5 mg.min/L for the maximum flow rate was below the asset standard requirement of 15 mg.min/L, and therefore a maximum maintenance flow rate of 22.4 ML/d was recommended.

Residence Time Distributions (RTD's) were used to compare each simulation, as shown below. These curves show the poor performance of the unbaffled tank and the improved performance of the tank with 6 or 9 baffles. Additionally, the half-tank, 9-baffle results are shown.

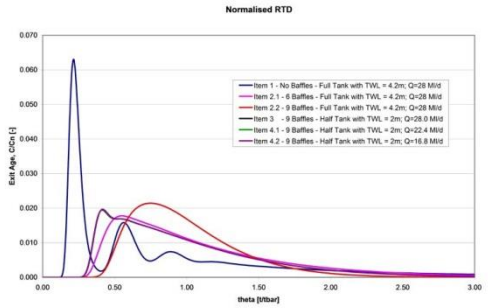

Figure 3: Residence Time Distribution for the full and half tank

Conclusion

The analysis demonstrated that the current tank was not fit for purpose and required modification by the retrofit of 9 internal baffle walls in each half of the tank. These internal baffle walls improved the flow patterns in the tank under normal and maximum flow conditions. This configuration met the asset standard requirements by:

- An improved breakthrough time
- An improved contact time
- Reduced regions of short-circuiting & recirculation

Additionally, the maximum flow rate for the revised configuration during maintenance periods was determined to ensure continued compliance with the asset standard.

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