Final Settlement Tanks
Thames Water
London

Introduction

As part of the Thames Tideway Quality Improvement programme, Thames Water were to install large (40m diameter, 4m deep), flat bottomed clarifiers / Final Settlement Tanks (FST's) at Crossness Wastewater Treatment Works (WwTW). The tanks were sized for the maximum permissible solid and hydraulic fluxes using mass flux theory. The unusual flat based tank design required a novel overhead suction lift system, with 6 suction pipes spread across the breadth of the tank, to remove the Return Activated Sludge (RAS).

In order to maximise the effectiveness of this design, Computational Fluid Dynamics (CFD) analysis was applied to a number of influents, including an Energy Dissipating Influent (EDI) structure and McKinney baffles combined with an inboard launder and side wall baffles. This ensured good performance across a range of operating conditions. These conditions captured the influent solids concentration, RAS recycle ratio, settleability and flow rates.

Figure 1: MMI Design of Counter Current EDI

However, FSTs never operate under steady conditions, as influent flow constantly changes. The largest fluctuations are caused by storm rainfall. Dynamic CFD analysis assessed the FST response to a severe storm event, where the flow rate tripled in the space of 8 hours, rising to a second peak at 15 hours.

Methodology

CFD modelling provided a static and dynamic 3D map of the flow and solids distribution in the FST's. MMI Engineering's model extended the IAWQ drift flux model for activated sludge and water mixtures in FST's and included drift flux sludge solids settling, Takać s exponent hindered settling, Larsen's sludge mixture density and a sludge rheology model for non-Newtonian flow in the settled sludge layer. In this multiphase method, the sludge solids travel with the water, but also fall independently.

The optimum EDI structure within the stilling zone was designed by MMI. This consisted of two rows of 12 counter current discharge ports, as shown in Figure 1. Analysis results are shown in Figure 2. The optimum effluent features were identified as a Stamford baffle (inclined at 45º) beneath the effluent weir. This deflected the rising flow from the side wall away from the weir.

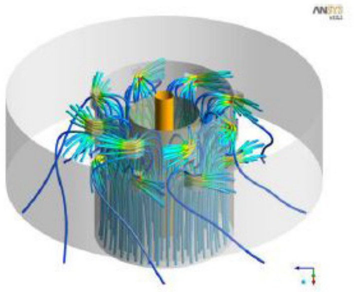

Figure 2: CFD results – EDI Streamlines

Conclusions

This validated CFD method calculated the concentration of settled sludge throughout the tank, hence determining the sludge bed height and the Effluent Suspended Solids (ESS) concentration, which established whether the tank design satisfied environmental regulation limits. The design of the flat floored FST was optimised with a novel Energy Dissipating Influent structure and an effluent baffle for a range of state points, then tested so that performance could be determined during a severe storm event when rapid influent changes occurred. The predicted effluent solids concentration and sludge bed height indicated a two hour delay between the storm flows entering the clarifier and the ESS peak response. In this extreme case, the ESS briefly exceeded the maximum consent, but quickly returned within acceptable limits.