Modelling of Humus Tanks

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The Problem

There are a large number of legacy biological filtration plants in the UK, dating back to the 1920's and 1930's. In such plants, the influent waste water is screened and settled in primary tanks prior to filtration in biological filter beds. Effluent from these beds passes to humus tanks, where residual solids are allowed to settle out. Final effluent may then be polished through sand filters prior to discharge. Humus tanks are similar in design to other types of primary and secondary settlement tanks. They can be of a radial flow, upward flow, or horizontal flow type. The sludge must be removed from the tanks regularly and in a large works continuously.

Figure 1: A typical humus tank

Long Marston sewage treatment works asked MMI Engineering to assess the retention performance of their existing tanks and investigate any potential influent modifications that could be implemented to improve the overall tank solid retention efficiency and improve effluent quality.

Our Approach

A transient CFD process model of the humus tank was used where the sludge phase was modelled using the drift flux method. The humus solids are divided into a number of discrete particle sizes and the CFD code is then augmented with an additional set of transport equations to represent the sludge [1]. Solids were calculated by using a discrete particle settling method, in which a characteristic settling velocity ("slip" velocity) was specified for each of the particle classes defined and a separate transport equation was solved to calculate mass fraction Yi for each of the ten particle classes.

Outcome

At average flow conditions, the retention efficiencies were similar for the different influent designs. However, at maximum flow conditions, the overall retention efficiency varied significantly between the different influent designs with the Energy Diffusion Influent (EDI) design clearly shown to give higher retention efficiencies, with the retention efficiency curve (Figure 2) showing a steeper gradient and greater solids at smaller size classes being retained. Figure 3 shows the CFD results for the tank with an EDI design with the contours showing the solids concentrations separated in the humus tank.

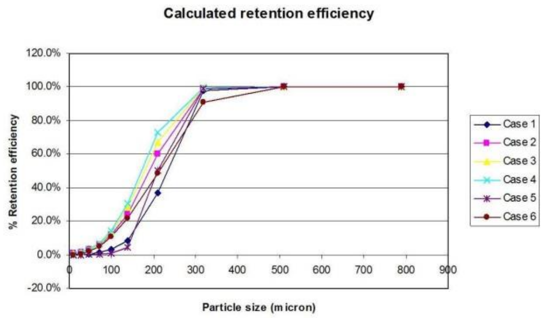

Figure 2: Solid retention efficiency curve

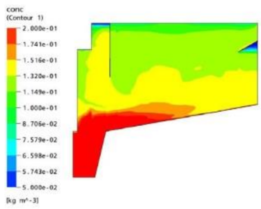

Figure 3: CFD results using an EDI influent design tank

CFD results showed that the standard humus tank with a central diffuser drum already made good use of the tank volume in radial flow, and only the EDI configuration (promoting some swirl) was shown to better this. A McKinney plate, which improves the situation in an FST by reducing the density current at influent, actually promoted short circuiting in the humus tank and shouldn't be used.

References

[1] Burt, D.J. and Gilbertson, M.A. "Extended Drift Flux Models for Waste Water Sludges", PSA 2005, Stratford, Sept 2005.