ANALYSING SECONDARY SETTLING TANK BEHAVIOUR BY *IN SITU* MEASUREMENTS AND CFD MODELLING

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In waste water treatment plants in the activated sludge process it is necessary to separate the treated wastewater from the activated sludge mass, thereby producing a clear effluent. This solid/liquid separation phase is traditionally achieved by gravity sedimentation in secondary settling tanks (SST). The SST is therefore a vital component of an activated sludge system. The behaviour of the settling tank in its clarification, thickening and storage functions is influenced by the settling tank design features and its operation. The factors affecting these include the hydraulic features such as flow rate, physical features such as inlet and sludge collections arrangements and sludge characteristics. Coupled fine scale measurements in operating tanks can give more insight into the interconnected flow and concentration patterns, furthermore, provide validation data for numerical models, which can then serve as design tool to optimize the performance by finding proper tank geometry, sludge recycling ratio etc.

The results of such an investigation in one of the circular SSTs at the Waste Water Treatment Plant of Graz are given in the paper. Circular SSTs can be reasonably analysed axisymmetrically. In the study 3D velocities were measured by ADV in raster; suspended solids (SS) concentrations were profiled by optical turbidity meter, calibrated for the SS of the tank. Measured velocity and SS concentration distribution are displayed in Fig. 1. It shows the inlet jet plunging with high vertical velocity components toward the bottom of the SST, thus penetrating to the dense sludge layer where a buoyancy force develops as a counter-action. All this mechanism leads to a wavy flow sludge interface pattern decaying radially.

The hydrodynamic numerical modelling has been carried out using the SST model by Hunze and Schumacher (2004). The axisymmetric turbulent model equations were solved by the CFD code FLUENT 5, in which special modules for settling, density and rheology features have been implemented. The governing equations are the ones of volume and momentum conservation, k-ε type turbulence closure, SS transport and various formulae for the modules mentioned above (Krebs, 1991). From modelling aspect the most important sludge characteristic is the settling velocity V_s of the sludge, as a function of the local concentration (Patry and Takács, 1992). This settling function of the SS of the Plant was determined in lab. In the CFD model the equations were solved on a boundary-fitted finite volume grid of sufficiently fine resolution. Starting with clear water, in the filling-up phase of the tank the simulation showed some well known hydraulic phenomena. Due to momentum and density differences the inlet jet initially turns downwards and impinges on the bottom of the tank. It is split then into two density currents, towards the effluent and towards the sludge hopper. The mass of the settled sludge detains the bottom current. A wave is induced where the inlet jet impinges the settled sludge. The inlet jet is forced then to flow upwards. The congregated sludge mass on the bottom begins to flow slowly towards the sludge hopper where the concentration becomes higher and higher. The stabilised velocity field and concentration distribution in the model preserves the wavy pattern as seen in Fig. 2, similarly to the measured ones. The results gave both overall information and details on the sludge-water interface. It supports the applicability of axisymmetric flow and coupled activated sludge transport modelling, promising for future investigations to enhance SST performance.

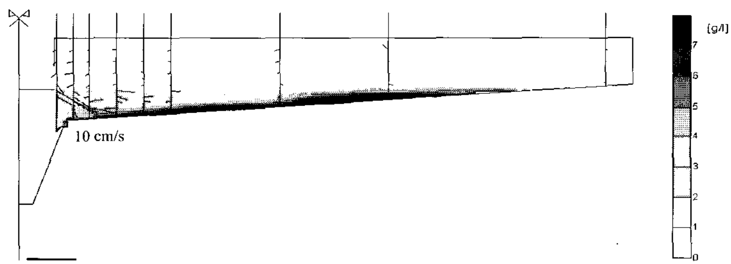

Fig. 1 Measured mean velocity vectors and concentration.

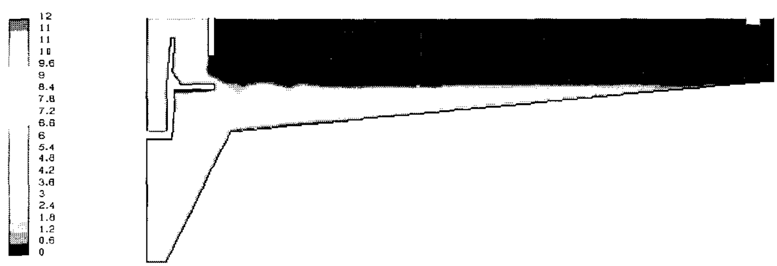

Fig. 2 Modelled suspended solids concentration distribution in typical operation conditions.

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