

# Multiphysics Simulations of Granular Sludge Characteristics on the Optimization of Effluent Treatment Plant

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**Introduction:** Activated sludge process (ASP) is a biological technique in any advanced Effluent Treatment Plant (ETP) operations. ASP though yields excellent COD, nitrogen and phosphate removal always had one flaw due to poor floc or granules settling. With the development of aerobic granular activated sludge the problem has been solved; with the microbiological mass being in the form of granules, a close approximation to spherical particles.

**Numerical Simulations:** The single-phase fluid flow is controlled by Navier-Stokes Equation:

$$\rho \frac{\partial u}{\partial t} + \rho(u \cdot \nabla)u = \nabla \cdot (-pI + \tau) + F$$

A COMSOL model has been developed to simulate settling behavior of the sludge granule in effluent / waste water.

**Results:** The sludge particle accelerates from a standstill position and rapidly reaches its terminal velocity. Hence, a set of velocity contour plots (Figure 1) simulated help us to identify flow pattern for optimal design of settling tank of the bio-process of ETP.

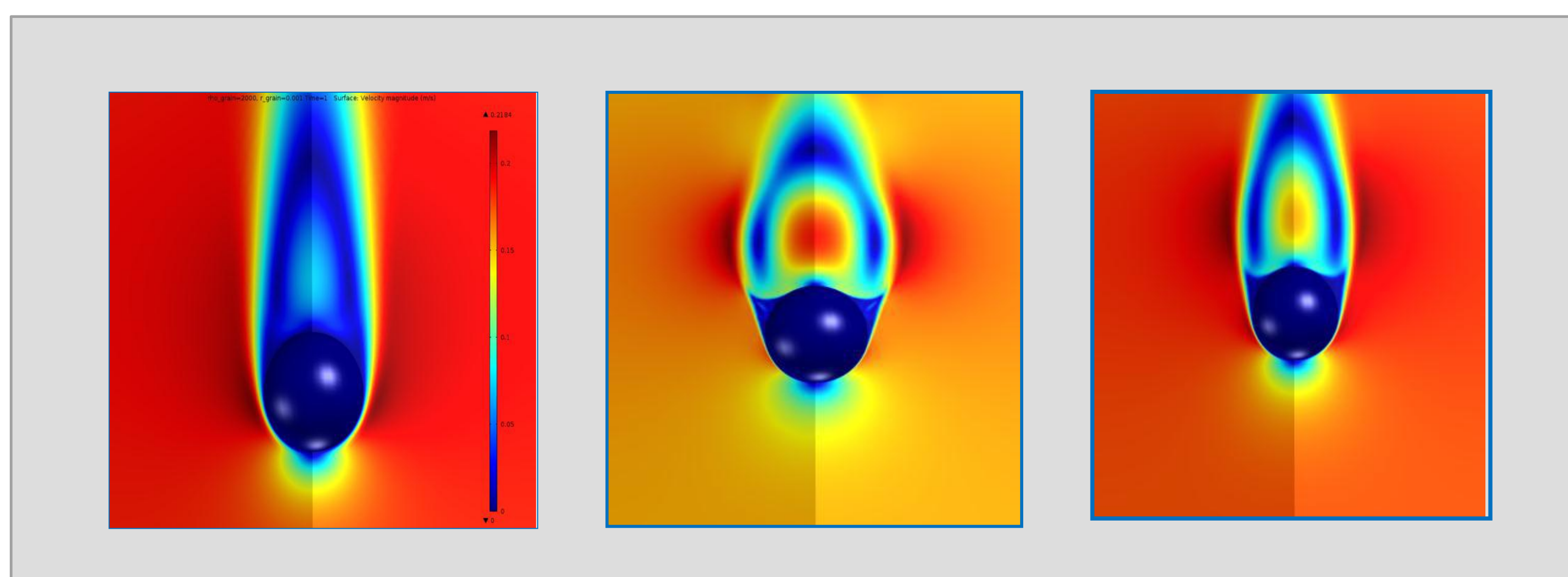


Figure 1. Velocity contour plots of a sludge particle

The reduction in effluent density increases the settling time (Figure 2). For a given density, increase in particle size also increases the settling time. Increase of both density and size of the sludge particle increases the settling time (Figure 3).

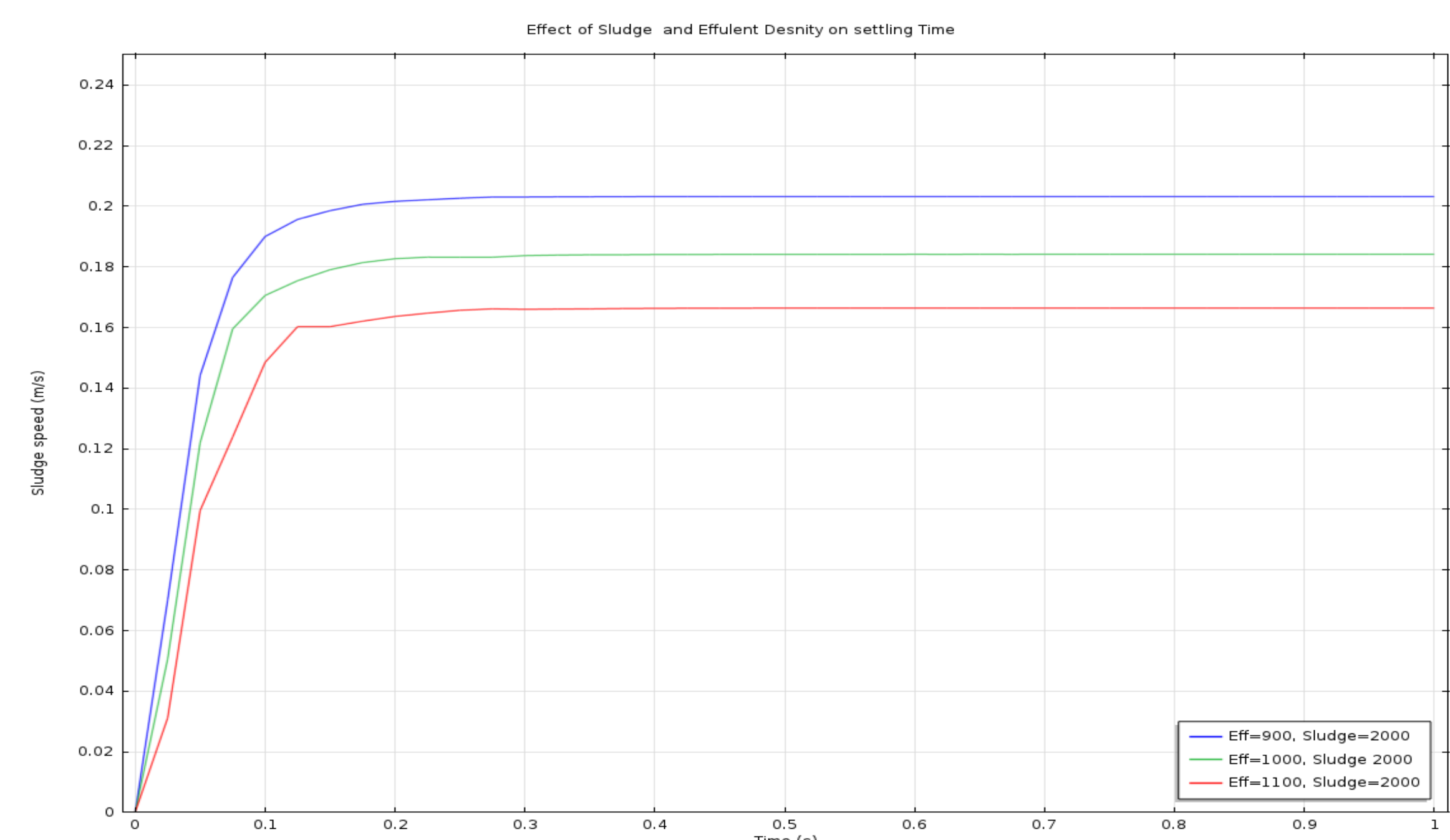


Figure 2. Effect of Effluent density on the settling speed of sludge particle

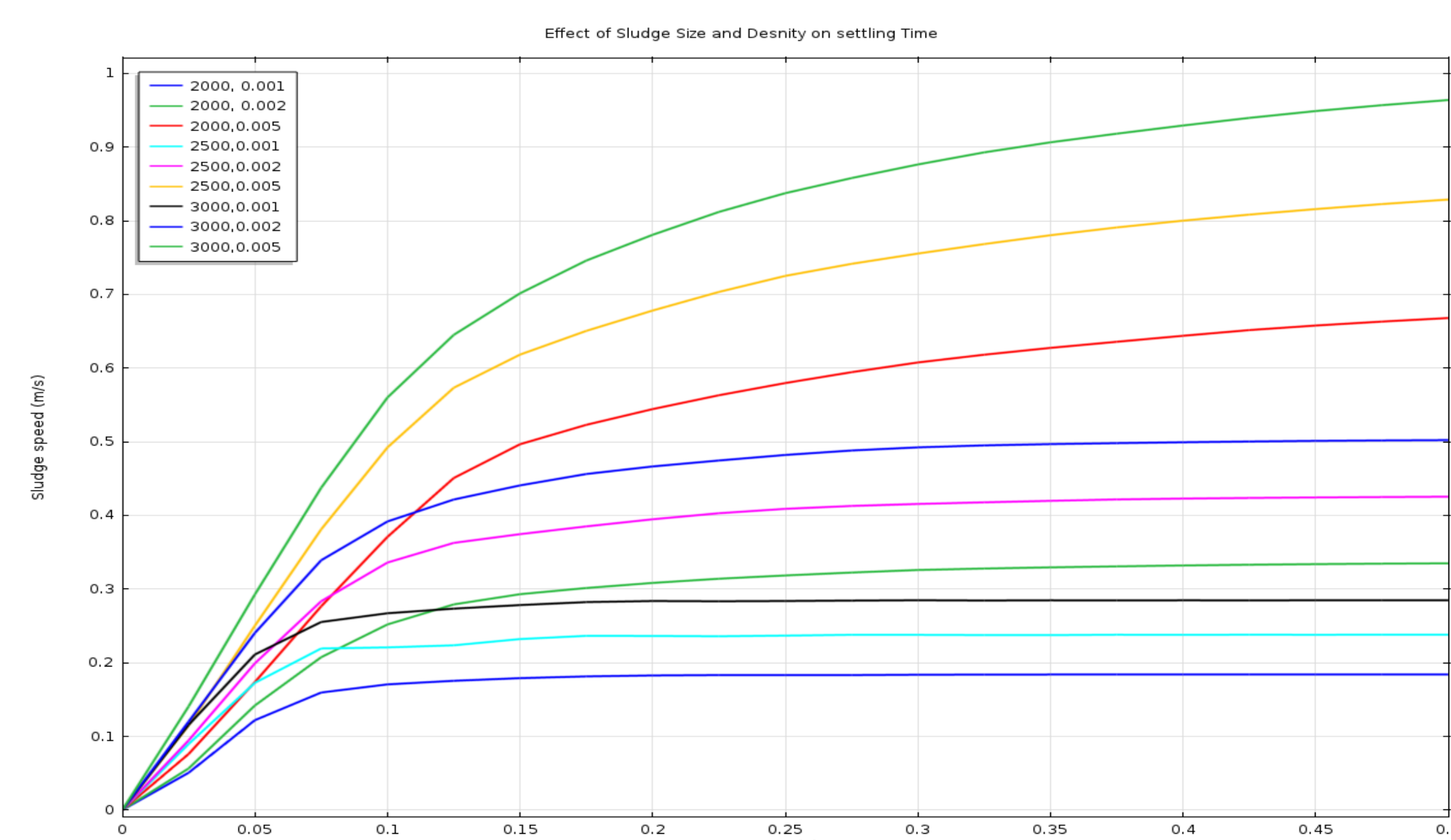


Figure 3. Effect of sludge density and granule size on the settling speed of sludge particle

**Conclusions:** The simulation data on the activated sludge settling compared well with the experimental observation and previously published results. The present efforts indicate that we can use COMSOL multiphysics modeling for optimizing ETP.

## References:

1. A. Nor Anuar et al., Water Science & Technology, **56**, 55- 63, QIWA (2007)
2. Dammel et al., Water Res. **25**(7), 841-846 (1991)
3. COMSOL Fluid Flow Interface Theory Manual (2012 )