Liquid-solid fluidisation experiments with perfectly round glass beads as a reference for irregularly shaped particles applied in drinking water treatment processes

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Abstract[1]

Historically, drinking water engineers have often worked with classical process state prediction models. The most frequently applied and the most popular classical models in liquid-solid fluidisation processes are the Ergun, Carman-Kozeny and Richardson-Zaki models. These semi-empirical porosity prediction models are derived for perfectly round spheres. However, in drinking water multiphase systems, applied particles are often natural - and therefore irregularly shaped. Examples of such particles are calcium carbonate pellets, rapid sand filter grains and granular activated carbon rods, to mention but a few examples. In addition, in these processes, the particles show a non-uniform particle size distribution, which leads to stratified beds in case beds have a fluidised state. The system becomes even more complex when, in pellet softening reactors, calcium carbonate pellets are crushed and re-used for sustainability reasons. To be able to predict bed porosity while considering irregularly shaped particles, an experimental set-up was built at Waternet and at the Applied University in Utrecht. The data obtained from the conducted experiments were compared with the classical models. To compare classical models and to develop more accurate prediction models, we used almost perfectly spherical mono-dispersed glass beads as a reference and compared them with our natural sized particles. Together with a number of Chemical Engineering students, we carried out the fluidisation experiments in an optimised set-up.
During this colloquium I will show the results of liquid fluidisation of the glass beads.
Onno Kramer is a process engineer at Waternet and a researcher/teacher at the HU; he is also a part-time PhD student at TU Delft supervised by co-promotor Johan Padding.

Figure 1 Garnet grains d_{50} = 0.25 mm.

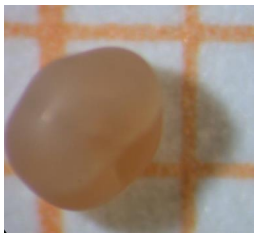

Figure 2 Calcite pellet pellets d_{50} = 1.05 mm.

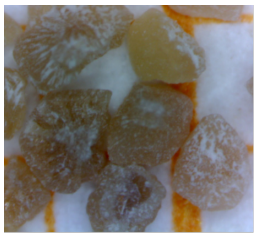

Figure 3 Crushed calcite pellets d_{50} = 0.50 mm.

Figure 4 Onno at the HU-ILC experimental set-up.

Figure 5 3.5mm round glass beds in the l-s column.

Figure 6 Full-scale pellet softeners at Waternet. Yearly, more than 400 million m^3 water is softened in the Netherlands.

[1] This research is part of the project "Hydraulic modelling of liquid-solid fluidisation in drinking water treatment processes" carried out by Waternet, Delft University of Technology and HU University of Applied Sciences Utrecht.