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Fluidisation experiments

Chemical Engineering students increase their professional skills considerably in a short period of time, while discovering the fundamentals and applications of a fluidisation process.
Calcite ($CaCO_3$) grains from a drinking water softening process are elevated in water flow to obtain a fluidised system.
They can see with their own eyes that the transition into a sustainable industrial process is possible.

A brand new experimental set-up

In March 2019 a brand-new liquid-solid fluidisation experimental set-up has been assembled in the Chemical Engineering labs at Queen Mary University Of London (QMUL). Dutch colleagues from Waternet (Public Water Cycle Organisation of Amsterdam) in collaboration with Delft University of Technology made this possible.
This so-called expansion column was designed in the Netherlands to conduct research with the aim to produce sustainable drinking water. In addition, the apparatus is very suitable for educational purposes where students can learn to work with a frequently applied unit operation in chemical engineering: fluidisation.

Fig. 1: Installation of the fluidisation expansion column at the QMUL Engineering Building in London.

Within a day after the assembly, second year Chemical Engineering students could directly start with a Problem Based Learning (PBL) experiment using this equipment. Groups of 5 students were asked to work on an industrial full-scale challenge, which should be solved on the fly.

Fig. 2: See yourself how the pellets fluidise in the expansion column.

Fig. 3. Evaluation questionnaire to improve the expansion column.

Students at work!

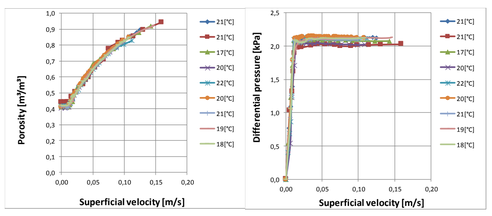

Fig. 4 and 5.: Motivated students determine the expansion characteristics of the calcite grains applied in drinking water.

Through a role-play-game, students had to supply the plant manager with an analysis of the problem. The technical issue was caused by air inclusion in a pressure sensor. The air trapped inside caused malfunctioning of the reactor and should be solved ASAP. One student had to block the water flow so that air trapping could be prevented in the highest-pressure tap. A second student had to control the water flow and a third student had to release air from the pressure sensor using a spanner. A fourth student had to monitor the pressure sensor display. A fifth student was responsible for effective communication, coordination and handling.
Students realised how hard it is to work together in a group with a healthy team spirit to obtain good results. The plant manager was watching the events closely!
After this challenge, students had to complete three assignments:
1) making expansion characteristics by increasing the water flow and measuring the process values; 2) linking fluidisation and terminal settling and 3) estimating an optimal process state using the specific crystallisation surface area of a full-scale drinking water softening reactor.

Where research, education and practice come together

The expansion column is suitable for educational purposes but also very adequate for research purposes.
The module evaluation showed that students liked working with the expansion column and made it clear that it was one of the most useful PBLs this academic year.
As a result, about 10 keen students were inspired to do a voluntary summer research project, supervised by Edo Boek and Onno Kramer.

Fig. 6-10. Weighing and dosing pellets. Differential pressure. Releasing trapped air from the sensor. PBL class instructions at QMUL.

Many students in the Netherlands and now also in England have worked with expansion columns through multi-disciplinary research projects, both at UG level and in PhD projects.
Are you interested? Please do not hesitate to ask for more information.
And… drinking (sustainable and reliable) water from the tap is our mission! Do you want to participate?

Fig. 11. Queen Mary University of London.

www.qmul.ac.uk

References
The expansion column was designed especially for the PhD project of Onno Kramer “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 in collaboration with Queen Mary University of London. The project was financially supported by Waternet’s Drinking Water Production Department.

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