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Subject Area	Energy and Environmental Technology
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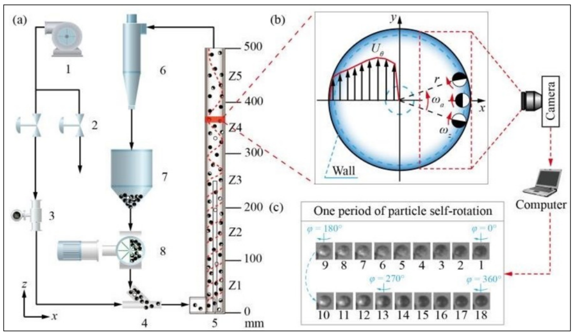
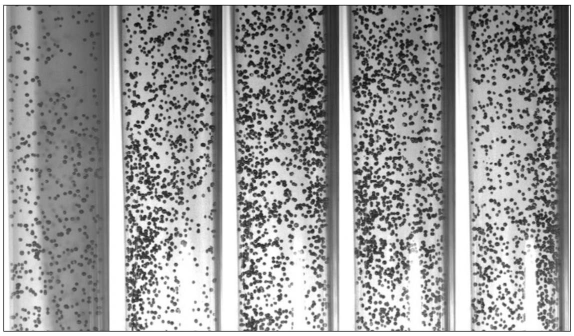
Particle movement in a circulating fluidized bed

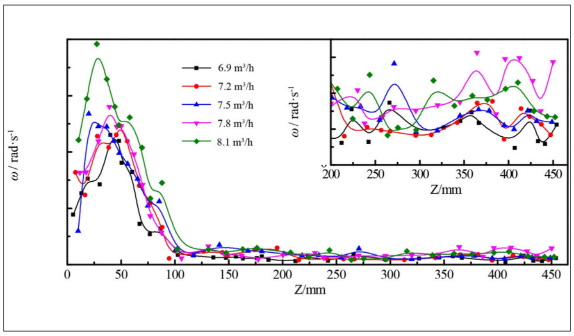
Adsorption of VOCs - volatile organic compounds in a circulating fluidized bed



Experimental apparatus and tracking method
Graphic by Lane Xavier (ECUST)



Fluidized particles in the tube - left: 0-100mm right: 400-500mm
Own presentment



Distribution of self-rotation speed over the tube length
Own presentment

Initial Situation: This thesis is carried out in the research group for hydrocyclones and air-pollutant treatment at the School for Resources and Environmental Engineering at the East China University of Science and Technology. VOC-treatment in fluidized beds is one of their main research topics. Volatile organic compounds (VOCs) are gases emitted by certain solids or liquids. Sources of VOCs can be biological, technical or chemical processes. Health implications by VOCs are widespread and may include irritations, headaches, organ damage or are suspected to cause cancer. The effect of VOCs on the environment highly depends on the source and concentration. Volatile organic compounds have been found to be co-responsible for ozone depletion, smog formation, climate change. The filtering of VOC-polluted air is an important research topic, current treatment methods are energy-intensive and complex. Fluidized beds with activated carbon particles can treat large volume flows and offer a sustainable and cheap method for VOC-treatment.

Definition of Task: In a circulating fluidized bed, the particles leave the cyclone at the top and are reused at the bottom. Due to the circular movement, it is possible to have a higher inflow velocity which shall increase the adsorption efficiency and the throughput. The efficiency of VOC-removal highly depends on the kinetic movement and self-rotation speed of activated carbon microspheres. This thesis investigates the particle movement in a circulating fluidized bed and compares the results with past research on cyclonic fluidized beds as well as with a CFD-simulation. Past research has shown that high self-rotation speeds are beneficial for VOC-adsorption. To measure the self-rotation and kinetic speed, tracer particles are produced. A high-speed camera with framerates up to 15'000 fps takes video footage, which is then being processed in an image-analysis software. The CFD-simulation should provide further knowledge on the flow field in a fluidized bed and can help to scale the project for industrial application.

Result: The flow field in the circulating fluidized bed is not predictable in most parts of the tube. Therefore, further studies with VOC-polluted air must be conducted to measure the adsorption efficiency. The distinct cyclonic movement is only observable in the lowest part of the tube. In parts above 100mm in the tube, no self-rotation or cyclonic movement is observable in most operating conditions. The achieved self-rotation speed in the circulating bed exceeds the one from the cyclonic bed. The measured self-rotation speed is 10 times higher than the achieved self-rotation in a cyclonic fluidized bed. The discharge rate of particles has a surprisingly small influence on the flow field in the tube. Therefore, many particles have a short residence time in the tube which is a disadvantage for VOC-adsorption. Different diameters of the core column are tested. The results show a high difference between a diameter of 6mm compared to a diameter of 8 mm. However, a diameter of 10 mm does not show higher self-rotation speeds than the 8 mm core.