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Streszczenie rozprawy doktorskiej

„Characteristics of hydraulic-oscillatory mixing using the image analysis method"

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Mechanical mixing is one of the most common unit operations in the chemical industry. It is usually carried out in a tank equipped with an agitator and flat baffles. However, the use of this type of mixing is not always recommended, especially due to the small volume of the mixed media, the sensitivity of the mixed media to mechanical stress and the fire or explosion hazards occurring during the process. Static, pneumatic, and ultrasonic mixers are used in these industrial cases. The hydraulic mixer is a new design solution that can be used at such areas.

The aim of this dissertation is to analyze hydraulic-oscillatory mixing in a mixer in which an alternation of pressure changes between inner and outer compartments of the mixer is the driving force.

The research involved the development and adaptation of a method for measuring changes of mixing in the mixer as well as changes in the height of the liquid level as a function of pressure. For this purpose, a self-developed measurement algorithm, generally based on Matlab programming language, was used to analyze changes in *RGB* and *HSL* color models during mixing. This method allows for the analysis of the mixing process in off-line mode and provides the possibility of working in on-line mode after adjusting accordingly and its application allows for a significant reduction in image analysis time. The method allows changes in mixing time to be determined as a function of oscillation amplitude and Reynolds number. The effects of process parameters and amplitude of fluid level changes on fluid mixing time, mixing hydrodynamics and unitary mixing power required for the process were analyzed. Mixing in the outer compartment has the most significant impact on the mixing time in the hydraulic mixer. Structures characteristic for laminar mixing were observed during mixing, particularly in the outer compartment. The amplitude of the liquid level change depends on the pressure of the gas pad and the ratio of the liquid level height to the diameter of the outer compartment, the amplitude of the liquid level change increases with pressure. Experimental results show that a smaller pressure difference between the inner and outer compartments causes faster mixing, therefore it is recommended to keep pressures p_1 and p_2 the same, an increase in the pressure of p_1 and p_2 reduces the mixing time.

In this study, the volumetric mass transfer coefficient for a hydraulic mixer was determined using process imaging method to compare the values obtained to the results for a standard stirred vessel. There was also an operational test of a hydraulic mixer with a modified profiled bottom made with use of 3D printing technology. The obtained k_La values for the hydraulic mixer are lower than the values for airlift type jet mixers and mechanical mixers with unsteady agitator motion. Airlift and mechanical mixers require a higher unitary power; however, the mixing time is shorter than in a hydraulic mixer.

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