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Assessment of the Performance of the Sonoreactors Operated at Different Ultrasound Frequencies, to Remove Pollutants from Aqueous Media

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Abstract : Ultrasonic degradation is currently being used in sonochemical reactors to degrade pollutant compounds from aqueous media, as emerging contaminants (e.g. pharmaceuticals, drugs and personal care products.) because they can produce possible ecological impacts on the environment. For this reason, it is important to develop appropriate water and wastewater treatments able to reduce pollution and increase reuse. Pollutants such as textile dyes, aromatic and phenolic compounds, cholorobenzene, bisphenol-A and carboxylic acid and other organic pollutants, can be removed from wastewaters by sonochemical oxidation. The effect on the removal of pollutants depends on the type of the ultrasonic frequency used; however, not much studies have been done related to the behavior of the fluid into the sonoreactors operated at different ultrasonic frequencies. Based on the above, it is necessary to study the hydrodynamic behavior of the liquid generated by the ultrasonic irradiation to design efficient sonoreactors to reduce treatment times and costs. In this work, it was studied the hydrodynamic behavior of the fluid in sonochemical reactors at different frequencies (250 kHz, 500 kHz and 1000 kHz). The performances of the sonoreactors at those frequencies were simulated using computational fluid dynamics (CFD). Due to there is great sound speed gradient between piezoelectric and fluid, k-e models were used. Piezoelectric was defined as a vibration surface, to evaluate the different frequencies effect on the fluid into sonochemical reactor. Structured hexahedral cells were used to mesh the computational liquid domain, and fine triangular cells were used to mesh the piezoelectric transducers. Unsteady state conditions were used in the solver. Estimation of the dissipation rate, flow field velocities, Reynolds stress and turbulent quantities were evaluated by CFD and 2D-PIV measurements. Test results show that there is no necessary correlation between an increase of the ultrasonic frequency and the pollutant degradation, moreover, the reactor geometry and power density are important factors that should be considered in the sonochemical reactor design.

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