COMSOL Multiphysics® Simulation of Ultrasonic Energy in Cleaning Tanks

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Abstract

Ultrasonic based cleaning process, widely used in various industries, mainly utilizes the cavitation effect to achieve contamination removal. For a given set of ultrasonic tank parameters, such as cleaning fluid, temperature, frequency etc, the cavitation effect is largely impacted by the amount of ultrasonic energy. Determining optimal ultrasonic energy level often becomes the key to the success of ultrasonic based cleaning. The ultrasonic energy requirement, usually represented by watts per gallon, developed in one ultrasonic cleaning tank often can not be used as a base to design another one with different geometry for the same process performance. It makes the process transfer from one system to another, especially process scaling up for large volume processing a challenge.

To study the ultrasonic energy as impacted by tank geometry parameters, we present a numerical study to evaluate the propagation of ultrasonic waves in cleaning fluid contained by a process tank. The linear acoustic pressure field is obtained by solving the Helmholtz equation using a COMSOL Multiphysics® simulation and coupling the structural acceleration and deformation at fluid and tank wall boundary. The ultrasonic intensity distribution is then calculated from the pressure field distribution. The results provide guidance on matching ultrasonic power density for cleaning tanks of different geometries. The distribution also provides prediction of active cavitation zones across tank geometry.