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Ultrasonic Separation of Suspended Particles and Splitting of Emulsions

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In the first part of the lecture, the forces on suspended particles in acoustic fields are reviewed and a better understanding of the physics behind the phenomenon is presented. Based on this theoretical description, a systematic quantitative investigation of the acoustically generated forces as a function of all relevant parameters, like density, speed of sound, compressibility of suspension and particle media, particle size, driving frequency, and acoustic energy density, is shown and the magnitudes of the acoustic forces are compared. In the second part, various flow-through resonator chamber concepts for particle (bio-cell) separation, like the coagulation approach, the drifting resonance field, the h-shape resonator, and the half-wavelength resonator approach are reviewed and analyzed utilizing appropriate mathematical models. The mathematical modelling of the laminar flow is combined with the acoustic force based velocity field of the particles relative to the suspension medium. This allows a complete modelling of the resonator's particle separation performance. Examples for separation chamber designs optimized by use of the mathematical model are presented and the calculated particle traces in the resonators are shown. The emulsion splitting performance is demonstrated with some gasoline- and oil-in-water emulsion samples. In the third part the dynamic performance of some of the discussed laboratory experimental set-ups of flow-through separation chambers is documented by a DV movie.