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Ultrasound-induced Softening of Nuclear Sludges

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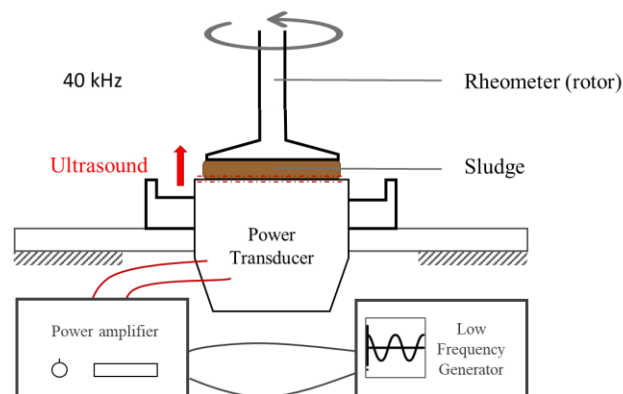
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Abstract: (250 Words Max) The nuclear industry produces radioactive waste of various typology. Nuclear sludges require specific attention as they must be pumped, conveyed, and mixed safely and efficiently. To aid in processing, they often need to be fluidized. High-power ultrasonic fields exhibit interesting interactions with liquid suspensions by modifying their microstructure and subsequently reducing their viscosity and yield stress. In this work, a set-up coupling rheological measurements with high-amplitude ultrasound generated by an ultrasonic transducer has been assembled. This set-up consists of a stress-imposed rheometer equipped with a parallel plate geometry, where the static lower plate of the geometry has been replaced by a 40 kHz plane transducer. The impact of ultrasound on a model carbon black gel is first studied and compared to previous results [1] in order to validate the setup. Special attention is given to separating the thermal and acoustic effects on the gel rheology. A surrogate sludge, mimicking a real nuclear sludge, then allows us to safely study the rheological properties of industrial sludges under ultrasonic waves. Additionally, different model suspensions are characterized in order to identify the individual roles of each constituent on the sludge behavior under ultrasound. While a drop in the storage modulus is observed in all cases, we find that the various samples behave differently under ultrasound depending on the size of the primary particles and aggregates. Furthermore, some samples exhibit significant restructuring after ultrasound is turned off, suggesting the formation of a denser microstructure due to the application of ultrasonic vibrations.

[1] T. Gibaud *et al.*, "Rheoacoustic gels: Tuning mechanical and flow properties of colloidal gels with ultrasonic vibrations", *Physical Review X*, **10**, 011028 (2020)



Experimental set-up coupling rheometry and power ultrasound