Intensification de la séparation d'émulsions par chauffage micro-ondes: application à l'extraction liquide-liquide de métaux critiques

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Abstract

This thesis focuses on the application of a microwave heating emulsion separation method to the phase separation of emulsion typical to the critical metal recovery processes. Following a literature review centered around emulsion separation, microwave heating in general, and the intensification of the separation of petroleum-based emulsions by microwave heating, the research work focuses firstly on physico-chemical properties relevant to the phase separation of the studied emulsions, and their evolution with temperature. Surface tension measurements, along with preliminary separation tests, show the important but hardly understood role of surface tension and its time evolution. Emulsion and single phase permittivities are then measured and modeled with equations available in the literature, allowing us to prefigure the penetration depth achievable in such materials with microwaves. The measured permittivities justify employing a laboratory scale, microwave intensified phase separator to observe, with small treatment volume and fluids throughput, the effect of microwaves on emulsion separation. Lastly, we study microwave heating numerically, with COMSOL Multiphysics, first with the aforementioned experimental geometry, then with simpler geometries, presenting problems that could arise, should an industrialization occur. Results obtained with the experimental set-up, as well as the simulations performed allow us to confirm the described method’s interest in the metal recovery context, and to prefigure scale-up. The annexes present further research axis identified during the thesis.