New developments in microwave demulsification of crude oil emulsions: Ionic liquids as demulsifiers

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Successful applications of microwave technology for water-in-oil demulsification have been reported in literature in the last twenty years [1]. Recent studies from our group have shown the effect of aqueous phase properties on the performance of microwave demulsification of crude oil emulsions [2,3]. According to these studies, the mechanisms that favor the destabilization of water-in-oil emulsions by microwave technology result from the interaction of microwaves with polar compounds and ions found in the dispersed and continuous phases. Besides, it has been observed that any factor that improves the absorption of the microwave energy by the emulsion may favor the demulsification, unless this factor also contributes to the emulsion stability.

Ionic liquids (ILs) are a new class of fluids that have attracted much recent attention as solvents for a number of processes. These species have been described as room temperature molten salts that have melting points below 100 °C. By selecting the appropriate cation and anion, one may design the ionic liquids to achieve specific melting point, viscosity, density and hydrophobicity, making these species very attractive for both microwave and conventional processes [4]. As ILs substances present amphiphilic features and dielectric properties, they have the potential to position themselves at interfaces and heat them through microwave irradiation. The properties of ionic liquids in association with microwave technology accelerate the destabilization process of emulsions.

The main objective of this work is to investigate the role of two types of ionic liquids – [OMIM] [BF4] and [OMIM] [PF6] - and a set of operation conditions of a microwave reactor system, including temperature and time, upon the microwave demulsification process. A series of batch demulsification runs were carried out to evaluate the final emulsified water content of emulsion samples after the exposure to microwaves at distinct ionic liquids concentrations. The experimental setup and analytical procedures for emulsion characterization were described elsewhere [3]. Tests were performed using high stable water-in-viscous crude oil emulsion samples containing different salt and water contents. Similar separation tests conducted under conventional heating were investigated for comparisons.

Results showed that increasing the concentration of each IL yields improved demulsification results in both microwave and conventional heating processes. However, microwave process was always much faster than the conventional case. Blank tests without IL have not produced water separation, which indicate the high stability of the investigated emulsions. Moreover, it can be concluded from the results that the ILs used here are acting as demulsifiers. As a further evidence of this demulsifier behavior, Fig. 1 shows how the microwave demulsification efficiency evolves with the temperature of the test. The concentration of each IL was kept at 5.56 μg/g for [OMIM][BF4] and at 0.56 μg/g for [OMIM][PF6] tests.

Results showed that the joint use of [OMIM][PF6] (even at low concentration) and microwave irradiation allows for the system demulsification with high efficiency at short time, even when high stable emulsions were employed in the process.

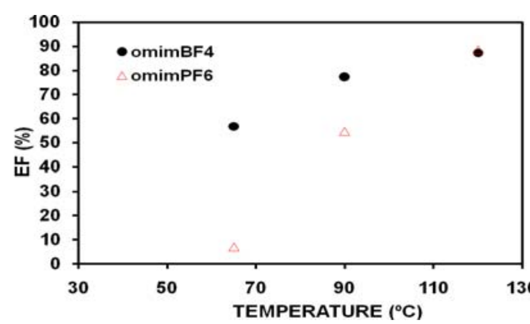

Fig. 1. Microwave demulsification efficiency at specific temperatures: [OMIM][BF4] = 5.56μg/g and [OMIM][PF6] = 0.56 μg/g;

References

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