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# Influence of Microwave Heating on Liquid-Liquid Phase Inversion and Temperature Rates for Immiscible Mixtures

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## ABSTRACT

Time dependencies of component temperatures for mixtures of immiscible liquids during microwave heating were studied for acetonitrile-cyclohexane and water-toluene. For the first time, we report microwave induced liquid-liquid phase inversion for acetonitrile-cyclohexane mixture: acetonitrile layer was initially at the bottom of the mixture, after 10 sec of microwave heating its density decreased and it inverted to the top of the mixture for the remainder of the microwave heating. This phase inversion could not be achieved by conventional radiant heating. The maximum rate of temperature growth for the polar component of the mixtures was 2 - 5 times larger than for the non-polar component. This suggests that microwave energy is absorbed by polar liquids (water or acetonitrile) and heat is transferred into the non-polar liquid (toluene or cyclohexane) in the mixture by conduction (in case of cyclohexane) or conduction and convection (in case of toluene). Comparison between experimental data and semi-empirical mathematical models, proposed in [Kennedy et al., 2009] showed good correlation. Average relative error between theoretical and experimental results did not exceed 7 %. These results can be used to model the temperature kinetics of components for other multiphase mixtures.

**KEYWORDS:** Microwave heating, immiscible liquids, inversion, mixture, temperature, time, wave, mathematical model

## INTRODUCTION

At the present time there is increasing interest in applying microwave heating to accelerate of chemical reactions and processes in liquids and multiphase systems to develop new chemical synthetic techniques and processes [Abramovitch, 1991; Mingos and Baghurst, 1991; Zhang, 2006]. This is related to advantages microwave heating has over conventional radiant heating: reducing the time and improving uniformity of heating [Prosetya and Datta, 1991; Datta and Hu, 1992; Roussy and Pearce, 1995; Lindstrom et al., 2001; Larhed et al., 2002]. Microwave heating is only produces significant increases in temperature for polar liquids with high dielectric loss factors (i.e. water). For non-polar liquids with lower values of dielectric loss factor (i.e. toluene or cyclohexane) the change of the temperature during microwave heating is very small [Barringer et al., 1995; Holzwarth et al., 1995; Hoffmann et al., 2003; Kennedy et al., 2009]. To increase the efficiency of microwave heating of non-polar liquids it has been