Development of an Automated Method for Acoustic Field Mapping in Ultrasound Bath

Gabriel T. Druzian (PG), Mariele S. Nascimento (PG), Matheus F. Pedrotti (PG), Fábio A. Duarte (PQ), Érico M.M. Flores (PQ) e Cezar A. Bizzi (PQ)

[1] Departamento de Química, Universidade Federal de Santa Maria, Santa Maria – RS, Brasil

Keywords: Automation, Acoustic field mapping, Ultrasonic bath.

Introduction

Ultrasound (US) energy presents widespread applications, with special attention to extraction, cleaning, cell disruption, and others that can be related to the sonochemical effects.[1] When US bath is used, its efficiency is critically dependent on a series of parameters related to the solvent used as viscosity, surface tension, vapor pressure, temperature, etc.[2,3] However, the intensity of US is one of the main parameters related to sonochemical effects, which increases with the increase of sonication intensity.[2,3] Additionally, the intensity of acoustic field is not equally distributed in the bulk of solvent. In recent years, some approaches have been made in order to map the acoustic field distribution in US bath, such as the use of aluminum foil,[3] equivalent velocity method,[4] hydrophone and infrared images. Considering these aspects, in the present work an automated system was developed for acoustic field distribution identification, which allows obtaining data for constructing 3D images.

Results and discussions

In the Figure 1 it is possible to observe the acoustic field distribution in a 130 kHz US bath (Elmasonics, 750 W, 300x240x110 mm, 4 transducers), which was performed in three different depth: bottom, medium and top (2, 5 and 8 cm from transducer, respectively). As it is observed, acoustic field distribution presents a clear indication that the highest intensity is presented over each transducer. Additionally, images obtained from data collected in the bottom of US bath (closer to the transducer), show a more concentrated energy immediately over the transducer (considering the difference between the lower and higher intensity, 20 to 180 V_{RMS}, respectively). When the distance of the sensor from transducer starts to increase (from medium to top), the distribution of the acoustic field was improved and less difference was observed from the lower to higher intensity (from 5 to 40 and 5 to 25 V_{RMS} at medium and top depth, respectively). It was considered an indicative that the acoustic field distribution increased from bottom to the top, while the intensity decreases. Similar results were obtained when aluminum foil was used for ultrasound bath mapping.

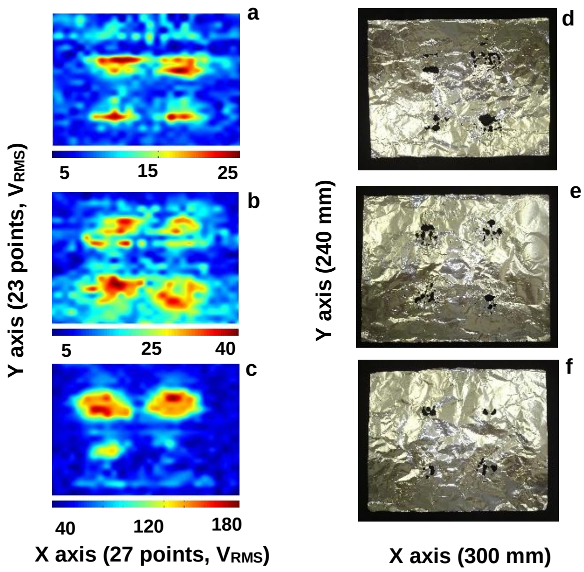

Figure 1. Top view of US mapping using automated approach in different depth: a) top, b) medium, and c) bottom: US mapping using aluminum foil: d) top, e) medium, and f) bottom

Conclusions

The proposed approach for US mapping was evaluated for a 130 kHz US bath, which was in agreement with results observed by using aluminum foil in the same depth. The possibility of performing an automated mapping, besides to allow a more precise data acquisition, decreases the time needed for mapping and allowed an easy data interpretation by images generated by Matlab software. Additionally, the measurement in different depth of the bath allows expressing the acoustic field layer-by-layer, resulting in a 3D distributions of the US energy, contributing to a better efficiency of ultrasonic bath for chemical applications.

Acknowledgements

FAPERGS, CAPES, CNPq and UFSM.

[1]R. Shirsath, S.H. et al., *Chem Eng Proces:* 53: 10-23. **2012.**

[2]T.J. Mason, J.P. Lorimer: 293. **2002.**

[3]M.D. Luque de Castro, F.P. Capote, Elsevier: 398. 2**007.**

[4]D. Chen, S. Sharma, A. Mudhoo, *CRC Press*. 696. **2012.**