Microwave and ultrasound - the advantages and limitations of combined use

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Abstract

Microwave and ultrasound are considered effective methods of process intensification.

The specific effects of microwaves are [1, 2]:

- High speed volumetric heating, because heat exchange with a surface is no longer involved and microwave energy can be transferred directly into the reaction volume - this aspect is very useful in the processing of homogeneous samples;
- Selective heating of the components of a heterogeneous system, when they have different dielectric properties;

The effects of ultrasound are related to the phenomenon of cavitation: the formation, growth and collapse of the cavitation bubbles generated by the passage of ultrasound through a liquid. The cavitational collapse generates radical active species influencing the chemical reactions that take place in the homogeneous environment and which involve an electron transfer [3]. When the environment is heterogeneous, ultrasound effects increase the mass and thermal transfer to the contact surface by asymmetrical collapse of cavitation bubbles [4].

The combined effect of microwave and ultrasound is very visible in heterogeneous environments. In these environments, although microwaves provide rapid heating of the reaction mixture, mass transfer limits the overall speed of the process. On the other hand ultrasound, although capable of greatly increasing mass transfer at the interface, does not ensure sufficient temperature rise to increase the speed of chemical reactions as well [5]. For this reason, the idea of combining the two techniques of process intensification appeared in the literature [6].

The paper presents the main types of equipment that allow the simultaneous use of microwaves and ultrasounds to intensify the processes. There are also presented the types of processes that can be intensified with each of these techniques as well as the restrictions on the combined use of ultrasound and microwave.

Here are some examples of processes that benefit from the combined effect of microwaves and ultrasounds.

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