VERSATILE RESONANCE-BASED MICROWAVES APPLICATOR. LOW VS HIGH LOSS TANGENT FLUIDS BEHAVIOR

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Microwaves (MWs) cover a broad spectrum of applications, all having in common the MWs capacity of deploying energy “in situ”, throughout the interactions matter-electromagnetic field, overcoming the losses implied when the same amount of energy should be transferred through one or several interfaces. In chemical engineering, a promising domain for MWs use is process intensification, physical, chemical or biochemical. When it comes to process intensification, the key is the efficiency of the deployed energy usage by the process. The current applicators can be divided, roughly, in two classes: multimode – working volumes rather large, but in which MWs have several nodes and venters, due to the interactions with the wall and superpositions of the waves, and monomode – the working volume main dimension is almost equal to the wavelength, the vessel being placed in the middle of the cavity, where stands the maximum of the wave.

In this work, we developed an applicator based upon the resonance concept. At resonance frequency, the cavity stores the MWs energy – therefore, no MWs will be reflected into the wave guide, but will remain inside the cavity. In the case of MWs with a frequency of 2.45 GHz, one of the resonant cavities could be a cube with the side equal to 86.5 mm. Unfortunately, when placing another device in the resonant cavity, the interactions matter-electromagnetic waves will change the latter, and, consequently, the cavity will be resonant no more, but neither will it be in multimode. Introducing the concept of absorbed energy yield and starting from the resonant cavity dimensions, we looked for the actual dimensions for which this yield would have the highest value. It must be emphasized that this dimension depends upon the form of the internal device and the dielectric properties of the working fluid. Therefore, a sliding short circuit was added to the cavity, on the opposite side of the wave guide wall.

This new applicator was tested, both in laboratory and COMSOL Multiphysics® modeling software, for three liquids contained in a special type of reactor, vertically coiled, with very different loss tangent magnitudes and temperature behavior, namely water, ethylene glycol and cyclohexane. The MWs generator is a solid-state Miniflow, with a maximum power of 200 W and a special integrated circuit to measure the direct and reflected power. A conventional multi-mode applicator especially adapted with a transition wr340 guide to coaxial adaptor to be able to employ the same solid-state generator was used as reference against the new applicator, doing the same experimental and simulation work.

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