ULTRASONIC CAPILLARY REACTOR WITH TEMPERATURE CONTROL AND HOMOGENEOUS VIBRATION

PATENTED TECHNOLOGY

CONTACT DETAILS:

Research Results Transfer Office-OTRI
University of Alicante
Tel.: +34 96 590 99 59
Email: areaempresas@ua.es
http://innoua.ua.es

ABSTRACT

The Photochemistry and Semiconductor Electrochemistry (GFES) research group of the University of Alicante has developed an ultrasonically-enhanced capillary reactor which achieves homogeneous, efficient and temperature-controlled multiphase flow. The reactor features a capillary tube in a helicoidal probe that homogenizes the acoustic field generated without the appearance of longitudinal nodes and antinodes. Continuous and/or oscillatory reactions including crystallization phenomena are enabled, allowing the handling of solids and/or the improvement of heterogeneous mixtures in capillary tubes of variable diameter and length with optimum temperature control. Therefore, this reactor provides an advantage in flow chemistry and process intensification which is common in the pharmaceutical industry, fine chemistry, and in sonochemistry.

The invention is protected by a patent application. The research group has a prototype on a laboratory scale. Companies interested in the commercial exploitation of this technology are sought through patent licensing agreements or technical cooperation agreements (R&D Projects).

ADVANTAGES AND INNOVATIVE ASPECTS

The main innovative aspect of the capillary sonoreactor is its scalability using ultrasound which enables process intensification via enhanced heat and mass transfer of multiphase (gas-liquid-solid) mediums.

The design of the ultrasonic capillary reactor gives it a number of advantages:

- **The homogeneous distribution of the acoustic field** eliminates the limitation imposed by longitudinal stationary waves, even at low ultrasonic frequencies (~20-40 kHz).
- The direct and efficient solid-solid-fluid transmission of acoustic power to the liquid contained in the capillary tube allows **the use of different materials, diameters and lengths.**
- Vibration is transmitted by the solid material of the probe, generally metallic, which **reduces attenuation losses** and enables **efficient sonication in long probes**, in the order of meters, to allocate different reactor lengths.
- **The efficiency of the desig**n allows to operate both at **low and high ultrasound power.** Thus, acoustic energy can be used to favour various physicochemical processes such as mixing in single- or multi-phase media with or without cavitation and/or to reduce the limitations of handling suspended solids, mitigating or eliminating clogging.
- Insulation of the reaction medium and the sonotrode which **avoids metal contamination due to cavitation erosion** independently of the capillary tubing material required (e.g. PFA polymers have been used successfully as capillary tube).
- The high surface/volume ratios of the capillary allow **optimal control of the reactor temperature** using forced ventilation or a thermal secondary tube in contact with the probe.
- The separation distance between the piezoelectric transducer and the sonicated medium **minimizes mechanical heat** and can also be used to **amplify the received acoustic power** by changing the probe's cross section.
- The probe design also supports an additional transducer at the free end of the probe for **excitation at secondary frequencies or energy recovery.**

• The helicoidal arrangement of the probe can be longitudinal, folded, curled or adapted to different shapes to reduce the space occupied by the reactor. The same ultrasonic transducer can emit a plurality of shaped probes.

• **To avoid clogging**, certain areas of interest, such as probe ends, can be used to house fittings, T-joints and/or mixing devices.

• Capillary tubes can be located on other surface of the sonotrode or via **tube-in-tube** configurations with different points of insertion.

MARKET APPLICATIONS

The invention provides an advantage in flow chemistry and process intensification with several applications in the pharmaceutical industry, fine chemistry, and in sonochemistry. The ultrasonic capillary reactor enables continuous manufacturing in chemical or physical processes (crystallization) allowing the handling of solids and/or the improvement of heterogeneous mixtures (gas-liquid-solid) in capillary tubes of variable diameter and length with optimal temperature control.

COLLABORATION SOUGHT

The research group is looking for companies interested in acquiring this technology for commercial exploitation through:

- Patent license agreements.
- Technical cooperation (R&D projects) to adapt the technology to the needs of the company.
- Etc.