EQUIPMENT FOR THE DETERMINATION OF THE ISOBARIC VAPOUR-LIQUID-SOLID AND VAPOUR-LIQUID-LIQUID-SOLID EQUILIBRIUM

PATENTED TECHNOLOGY

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ABSTRACT

The research group of the University of Alicante **"Phase equilibrium"** has developed an equipment for the determination of isobaric equilibrium in mixtures of phases when **solids are present**.

The equipment includes a boiler coupled with an ultrasonic probe that facilitates the reduction of the particle size of the solid, a separation chamber attached to the boiler that is connected to a condenser to carry out steam condensation and stable recirculation, and a mixing flask. In addition, with respect to the starting equipment, **the diameter of the pipe joining the boiler and the mixing flask has been increased** until it is sufficient to allow the circulation of solids without obstructions. Moreover, a recirculation device consisting of a recirculation channel with a controlled external electrical resistance has been incorporated to keep the mixture at **bubble temperature**. **Valves for cleaning and sampling** have also been installed on the equipment.

All these innovations have allowed the research group to obtain **accurate and thermodynamically consistent data of isobaric equilibrium vapour-liquid-solid (V-L-S) and vapour-liquid-liquid-solid (V-L-L-S)**.

The group has a **prototype developed on a pilot scale**. Companies interested in acquiring this technology for commercial exploitation are sought.

ADVANTAGES AND INNOVATIVE ASPECTS

The most outstanding advantages of the equipment recently described for determining isobaric equilibrium with samples of dissolved and suspended solids are the following:

- **No obstructions are produced** thanks to the fact that the inner diameter of the conduit that joins the boiler and the mixing flask is sufficient to allow the circulation of solids through its interior.
- It allows stable **recirculation at a temperature very close to that of the suspension bubble**, thus avoiding precipitation of the solid and clogging of the recirculation pipe.
- The application of ultrasound allows the **dispersion of the solid and liquid phases** and the **reduction of the particle size and suspension of the solid phases**. In this way the mass transfer rate between the different phases are increased and with it, the time to **reach equilibrium is greatly reduced.**
- **Sampling** is allowed through one of the new valves introduced in the equipment.
- It allows the **cleaning of the sample** taking conduits through the other valve, since through this one liquid can be added from the outside to dissolve the solids that have been deposited, in order to leave it ready for a new sampling.
- It allows **the dissolution of the solid precipitated from previous experiments** during the equipment start-up process thanks to the heating on the recirculation pipe and on the mixing flask.

- It allows to have accurate and thermodynamically consistent **experimental equilibrium data of different compound mixtures.**

The main innovative aspect of the equipment described is that it makes it possible to determine precisely the boiling point of an S-L-L mixture, to separate all **the phases present and to obtain their composition**, at a constant pressure.

This is achieved primarily thanks to the **modifications** made to the starting equipment so that it can be applied to the determination of the equilibrium when solids are present. The ultrasounds applied facilitate the reduction of the particle size of the solid and its suspension in the liquid, but the recirculation of the liquid and solid phases must be modified to avoid the precipitation of the solid. To this end, the following innovations have been made:

- **Increasing the diameter of some pipes.**
- Installation of external electrical resistances on other pipes and on the mixer, covered with insulation and controlled to **keep the mixture circulating inside at bubble temperature.**
- Installation of a new inlet for the **cleaning of the solid deposited during the sampling.**

MARKET APPLICATIONS

The present invention refers to an equipment that allows the determination of the isobaric thermodynamic V-L-S and V-L-L-S equilibrium in systems with solid phase and one or two liquid phases. The knowledge of this equilibrium is fundamental for **the design of equipment in industrial chemical processes** such as **extractive distillation with salts** or **regeneration of solvents.**

COLLABORATION SOUGHT

The research group looks for companies interested in acquiring this technology for **commercial exploitation** through:

- License agreements of the patent.
- Development of joint R&D projects to adapt the developed technology to the needs of the company.
- Technical cooperation, subcontracting and advice on R&D.