THE IMPORTANCE OF MINIATURIZATION FOR PROCESS INTENSIFICATION

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1. Introduction

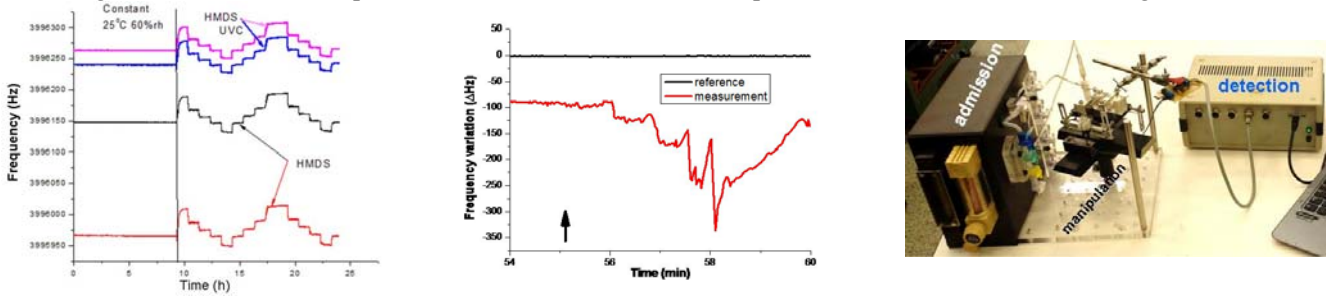
Process Intensification (PI) as strategy for increasing productivity in chemical engineering process has achieved importance on the last few decades. At the same time, miniaturization made possible new technological fields and created new milestones, such as microTAS and Lab-on-chip [1]. In order to develop these highly efficient, multi-functional and automated new devices, new ways of reactant/samples admission, manipulation and detection must be produced. This work aims the project, production and tests of a portable and small device useful for PI.

2. Experimental

This work used project guidelines approach for mechanic and electronic development of parts and pieces; therefore, after the definition of prototype expected functions, each autonomous part was projected, manufactured and individually tested. After that the whole device was assembled and tested again. Using tests was performed with PA organic reactants on large range of polarity and starch particles, 5 μm in diameter.

3. Results and Discussions

The features defined to the prototype were: a) be modular and portable; b) assemble planar and 3D miniaturized structures, such as microreactors, with total length of several centimeters; c) provide admission of liquid and gaseous samples (up to 10 μL); d) provide detection of organic volatile compounds, spray formation and particle presence on carrier gases. Other important requirements also are the low cost and easy handling.
After manufacturing and preliminary tests the prototype fulfill the following roles: a) the detection system, composed of a quartz crystal microbalance with 5 different piezoelectric quartz crystal that, due to distinct coverage with adsorbent plasma deposited thin films, is able to detect ppm of volatile organic compounds and to determine large range of relative humidity. Figure 1a shows typical results. Particles are also easily detected, as can be noticed in Figure 1b. In the figure it is also observed the signal of a reference detector, i.e., direct without contact with the sample. Similar results can be obtaining with spray formation during sample manipulation; b) admission system presents special miniaturized structure to mix particles with injected samples; for instance, on such condition it is possible to develop new ways of catalyst/sample contact whereas the exit of the reactor is continuously monitored. Moreover, the possibility of simultaneous monitoring of gaseous compounds and particles also allows understanding the fluid behavior of these miniaturized structures. Manipulation of miniaturized structures, useful for PI development of new routes for reaction mechanisms [1], is provided in this prototype by a xy table that is maintained outside of the main structure, which corresponds to the admission system, and near the detection apparatus. Finally, it is worthy point out that the whole system, showed in Figure 1c, was produced using components easily accessed on Brazilian market. Therefore, this approach proved to be advantageous for to PI development since several distinct unit operations can be fulfilled in a single instrument.



a b c

Fig. 1. *Detection system results: (a) relative humidity and (b) particle presence, arrow indicates injection; (c) whole system*

4. References

[1]- H. Freunda and K. Sundmachera, Chemical Engineering and Processing, **47,** 2051–2060, (2008).

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