Homogeneous Catalytic Hydrogenations and Photocatalytic Reactions in Microstructured Reactor Systems

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HOMOGENEOUS CATALYTIC HYDROGENATIONS AND PHOTOCATALYTIC REACTIONS IN MICROSTRUCTURED REACTOR SYSTEMS

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Microstructured reactor (MSR) systems play a key role in modern industrial processes which require obtaining products of predefined high purity and quality. MSR systems are being currently successfully used for this purpose. Their unique features rest in the high active surface to the reaction volume ratio ensuring easier and proper maintaining of reaction conditions as well as the fast heat, mass and momentum transfer. The use of MSR systems leads to the elimination of side products and consequently to the elimination of additional separation processes. This fact makes the microreactor technology more straightforward in comparison with the conventional batch reactor technology. MSR are being tested for the production of fine-chemical industry and special small-scale productions as well. Two different commercial MSR systems were tested: the microchip reactor system Labtrix (Fig. 1) and the photochemical microreactor based on the Modular Micro Reactor System (MMRS) platform. In this contribution we present these two MSR systems with their applications: the stereoselective hydrogenation, and the photochemical oxidation [1, 2].

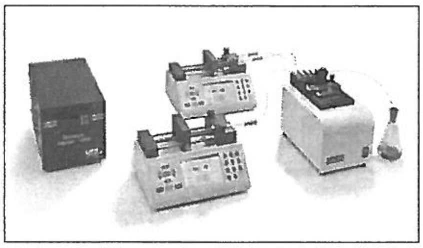

Figure 1. A microchip reactor system Labtrix®Start

One of the most discussed and attractive issues of the fine-chemical industry are homogeneous synthesis of optically pure products. In our case, a hydrogenation of methyl acetoacetate to methyl hydroxybutyrate in a presence of optically pure homogeneous chiral organometallic catalytic complex Ru-BINAP was selected as a model reaction. In this reaction an alcohol plays a key role of both a solvent and a hydrogen donor as well. This reaction was tested in a glass microfluidic flow chip reactor. By a set of microreactor chips (Fig. 2) this system represents all advantageous features which microreactors do have. Our aim was to reach the highest possible enantiomeric excess and reaction yield in comparison with the conventional reactor technology [3, 4].

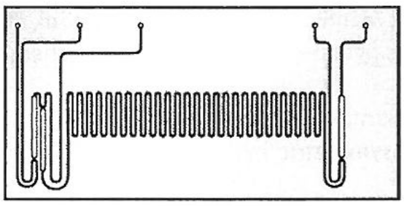

Figure 2. A glass microfluidic flow reactor chip

The second part of MSR systems application was a photocatalytic degradation of 4-chlorophenol, commonly occurred water pollutant, selected as a model reaction. A thin liquid layer photocatalytic MMRS (Fig. 3) was used for. A thin microreactor channel ensured efficient irradiation of the reaction mixture. UV/VIS light was generated by an integrated high pressure mercury lamp. Phthalocyanine was used as a catalyst for the generation of singlet oxygen [5, 6].

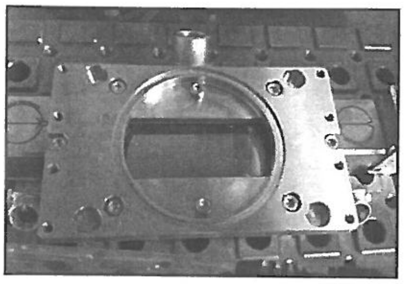

Figure 3. Thin liquid layer photocatalytic MSR

For the first experimental part distilled water was used as a solvent. All these experiments were repeated twice. Distilled water was then replaced by deuterium oxide and experiments were three times repeated for ensuring a proper experimental reproducibility. Results from these two experimental parts were compared (Fig. 4) and showed up to 100% degradation yield after using deuterium oxide as a solvent.

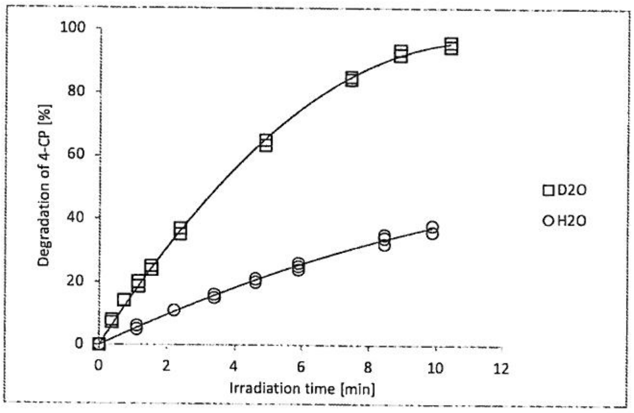

Figure 4. Photodegradation of 4-clorophenol

Results from the photocatalytic microreactor were then compared with the conventional batch reactor (previous cuvette tests) experiments and showed more than two times higher efficiency in degradation.
As discussed above, microreactor technology holds many advantageous features that lead to the process optimization giving a high reaction yields as well as a high experimental reproducibility.

LITERATURE

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