

Microreactor concepts for enhanced mass transfer in the two-phase hydroformylation of 1-octene

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The so-called two-phase technology in the homogeneous catalysed hydroformylation of short chain alkenes allows a rather simple workup of the reactor outlet stream, because the water-soluble homogeneous catalyst remains in an aqueous phase whereas the produced aldehyde forms an organic phase which can be easily decanted [1].

However, using higher olefins such as 1-octene in the two-phase hydroformylation technology, the observed reaction rates are much slower than that of short chain alkenes. Beside the low solubility of higher olefins in water, the mass transfer of 1-octene from the organic to the aqueous catalyst phase can be assumed as a rate limiting step [2]. Microreactors allow an enhancement of the mass transfer between different phases because of high specific interphase areas [3]. Thus, a process intensification should be achieved in the two-phase hydroformylation of higher olefins.

In preliminary studies we investigated different micromixing concepts for generating optimum and stable G/L/L-mixtures from water and 1-octene, which were subsequently fed to a capillary microreactor conducting the hydroformylation. Since the mass transport of 1-octene into the aqueous catalyst phase should be the mainly limiting step, it was the aim to achieve a maximum dispersion of the organic phase in the liquid phase. As the best G/L/L-mixing concept a microstructured baffle mixer (*Little Things Factory*) was found. It is made of borosilicate-glass and contains static mixing elements in the microchannels manufactured by sandblasting. Due to the hydrophilicity of the used glass material the aqueous phase forms the continuous phase wetting the microchannel surface and the organic phase is highly dispersed in the aqueous phase. The gas phase moves as plugs through the capillary.

For comparison purposes investigations of the two-phase hydroformylation of 1-octene in a continuous stirred autoclave (classical technology) are performed. With this equipment the influence of different reaction parameters such as stirring rate, temperature, synthesis gas pressure, solvent as well as catalyst amount can be determined. These experiments are the basis to evaluate and quantify a process intensification by the use of microreactors in the hydroformylation according to the two-phase technology.

References:

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