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# Water based recycling of molecular catalysts - from lab to miniplant

## AUTHORS
Andreas VORHOLT / MPI CHEMICAL ENERGY CONVERSION, STIFTSTRAßE 34, MÜLHEIM

## PURPOSE OF THE ABSTRACT

Recycling strategies for homogeneous catalysts are most relevant when dealing with scale-up and economic feasibility of new chemical conversions. The recycling approaches have to be developed in the lab and then transferred to a continuously operated setup in order to investigate the long-term stability of the catalyst and recycling system.
In recent years, biphasic solvent systems have been reported suitable to recover homogenous catalysts. Industrial applications like the SHOP process or the Ruhrchemie/Rhône Poulenc process showed that these have also an economic relevance.
In this contribution, we show the development of water-based two phase systems to convert long chain non-polar olefins. The low solubility of substrates leads to a very slow reaction rate, which has to be overcome. To tackle this challenge, two possibilities are intensified mixing or the use of the thermomorphic behaviour of water and further solvents.
Intensified mixing of a catalyst-containing water phase and the substrate 1-octene was studied intensively using hydroformylation as model reaction. It was found that with an optimal mixing setup the TOF could be increased to >10.000 h-1 in a lean water-octene mixture. These findings were used to set up a continuously operated jet-loop reactor setup to test very high interfacial areas in long running experiments. During a 75 h run, a TON of 130.000 was realised with negligible leaching of the Rhodium catalyst into the product phase.[1,2]
Taking advantage of the thermomorphic behaviour of water is another possibility to overcome the low miscibility of substrates in water. Hydroformylation of unsaturated fatty acids was used as a model reaction to show that it is possible to have low leaching and a fast reaction rate to ester aldehydes. This system was scaled-up to a continuously operated miniplant and showed long-term stability.

[1] H. Warmeling, D. Janz, M. Peters, A. J. Vorholt, , Chem. Eng. J., 2017, 330, 585-595
[2] H. Warmeling, D. Hafki, T. von Söhnen and A. J. Vorholt, Chem. Eng. J., 2017, 326, 298?307
[3] T. Gaide, J. Dreimann, A. Behr, A. J. Vorholt, Angew. Chem. Int. Ed., 2016, 55, 2924?2928

## FIGURES

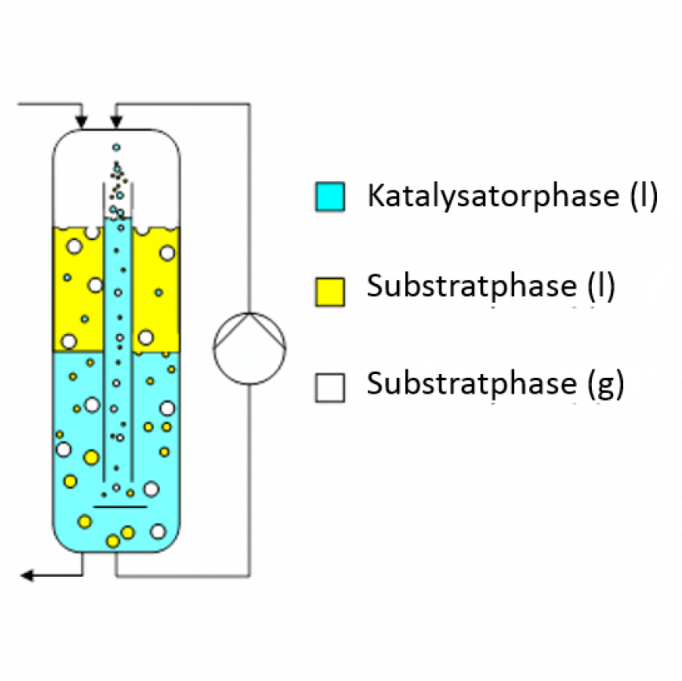


**FIGURE 1**
Jet Loop reactor
working principle

**FIGURE 2**


## KEYWORDS
molecular catalyis | recycling | Miniplant


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[2] H. Warmeling, D. Hafki, T. von Söhnen and A. J. Vorholt, Chem. Eng. J., 2017, 326, 298–307
[3] T. Gaide, J. Dreimann, A. Behr, A. J. Vorholt, Angew. Chem. Int. Ed., 2016, 55, 2924–2928