

Experimental Investigation of Gas-Liquid Mass Transfer in Periodic Open Cellular Structures (POCS)

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Mass transfer between liquid and gas phase in industrial trickle bed reactors (TBRs) can significantly influence the overall reactor performance and the reactions taking place. One particular challenge to be avoided in TBRs is an inhomogeneous distribution of the liquid over the reactor cross-sectional area. Therefore, in the design of TBRs mass transfer considerations as well as homogeneous liquid distribution are important aspects to be accounted for. In industrial scale TBRs with a random packing a homogeneous liquid distribution and a high gas-liquid transfer rate are both typically achieved by operating in the high interaction flow regime.

To intensify the gas-liquid mass transfer and improve the liquid distribution, structured packings can be applied to direct the liquid flow in the reactor. In this regard, periodic open cellular structures (POCS) are a particularly promising option as they offer high design flexibility. They can be tailor-made with regard to geometric properties such as porosity, thickness of the struts and the type of the unit cells themselves. The designed POCS can be fabricated using additive manufacturing techniques. This freedom in design offers various possibilities to improve liquid distribution and gas-liquid mass transfer in TBRs. In previous experimental investigations on liquid distribution in POCS [1] in our group, very promising results could be achieved. Compared to a conventional TBR with a random packing, the liquid maldistribution in the reactor could be reduced by more than a factor of two when using POCS.

In our current research, we focus on gas-liquid mass transfer in POCS. For this, an experimental setup was designed to measure the oxygen uptake of water.

First results show promising mass transfer rates even in the low interaction regime. Based on the measurements, we aim at developing an empirical correlation for predicting gas-liquid mass transfer coefficients in POCS, thereby enabling the design of industrial scale TBRs using POCS.

References

- [1] M. Lämmermann, W. Schwieger, H. Freund, *Catalysis Today* **2016**, 273, 161–171.
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