

Application of Jet Loop Reactors for the Selective Oxidation of Glycerol

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Abstract

A key aspect of integrating sustainable production processes is achieving economic competitiveness with established methods. Utilizing and valorizing by-products, such as glycerol from biodiesel production, are essential in this regard.^[1] One approach for glycerol valorization is its selective oxidation to higher-value C₃ components in aqueous media. However, the oxidation of glycerol is limited by the availability of dissolved oxygen in water.^[2] To overcome this limitation, the use of advanced reactor designs like the jet loop reactor, which ensures a high availability of dissolved oxygen, in combination with homogeneous catalysts for glycerol oxidation, is proposed.

In our work, we focus on the use of polyoxometalates (POM) for the selective oxidation of glycerol. Various POMs of the Keggin and Anderson-Evans types were synthesized within a molybdenum framework and screened for their activity and selectivity. In a scale-up phase, these experiments were transferred to a glass jet loop reactor with 2 L reaction volume. This multiphase reactor is capable of operating at pressures up to 8 bar and temperatures up to 120 °C. The chosen reactor increases the surface area for mass transfer and extends the contact time between the gaseous and liquid phases, effectively mitigating potential mass transfer limitations caused by dissolved oxygen during the oxidation process.^[3]

During the scale-up, the hydrodynamics and mass transfer coefficient for an aqueous glycerol solution were investigated. Based on these results, an appropriate catalyst was selected and tested in the jet loop reactor under various temperatures, pressures, and substrate concentrations (**Figure 1**). The use of optical oxygen sensors and sampling for offline analysis using HPLC enable time-resolved analysis of the reactants and products and allow for precise analysis of the reaction kinetics within the reactor used.



Figure 1: Oxidation of a glycerol solution within the jet loop reactor using a POM catalyst.

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