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Process Scale-Up for Tandem Catalytic Alcohol E-Fuel Production in the E-TANDEM project

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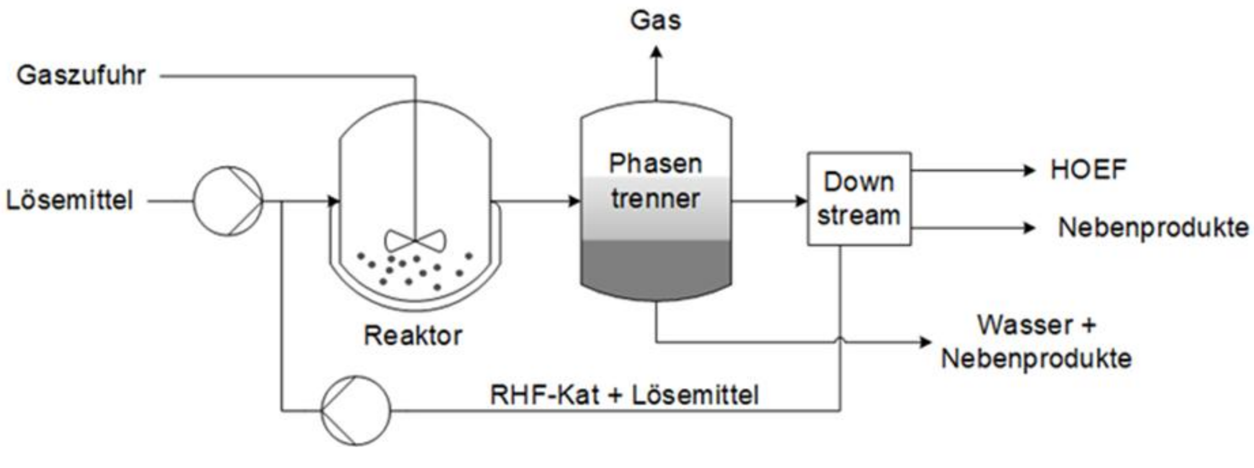
With the European Green Deal, the EU has decided to create a climate neutral economy by 2050, i.e. to reduce greenhouse gas emissions to zero. This is essential to stop global warming and its consequences for the climate [1]. At around 25 % (2019), the transport sector accounts for a large share of emissions, so a key aspect of the Green Deal is the substitution of fossil fuels for mobility and transport [2]. For the private transport sector, electrification is the preferred approach, but for other parts of the transport sector this is not considered realistic in the timeframe required. Other concepts are therefore needed for the decarbonisation of transport sectors, such as heavy goods vehicles, long-distance transport, shipping and aviation. One promising approach is the use of e-fuels. These greener, liquid energy sources are artificially produced only from renewable electricity and renewable resources and can also be used in conventional internal combustion engines. Overall, e-fuels can be classified as CO_2-neutral, as the amount of CO_2 emitted during combustion is equal to the amount absorbed from the atmosphere during the production of the fuel [3].
The EU project E-TANDEM aims to realise an efficient and direct production of a new, more oxygenated, diesel-like e-fuel for marine and heavy-duty transport. This involves the use of CO_2 as the only carbon source and renewable electricity as the only energy. The fuel is produced in a hybrid catalytic process that combines three catalytic pathways: High pressure electrocatalytic syngas production from CO_2 and water, coupled with a tandem catalytic e-syngas conversion. In this tandem reaction, the heterogeneously catalysed olefin-selective Fischer-Tropsch reaction is coupled with the homogeneously catalysed olefin-reducing hydroformylation reaction to produce long-chain alcohols, which can either be used directly as fuel or they can be converted into long-chain ethers in a further step [4]. The concept of the E-TANDEM project is shown in the figure below.
Having demonstrated that the tandem reaction of syngas to higher alcohols is feasible in batch mode in the laboratory, the new e-fuel production concept was scaled up in continuous operation in a miniplant as a first step towards industrial implementation [5].



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