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CFD simulation of Plastic Waste Pyrolysis Using Vortex Reactor

Aim

Applying computational fluid dynamics (CFD) to optimize the operating conditions of vortex reactor (VR) for pyrolysis of plastic waste to achieve higher yields of light hydrocarbons.

Justification

In recent years due to environmental issues caused by conventional plastic waste treatment methods such as landfilling and incineration, as well as the EU ambitions toward a circular economy, plastic waste recycling has become more popular. It is believed that by 2040, 100% of plastic packaging at the European level could be recycled. To reach this goal, chemical recycling as a promising technology has a high potential for heterogeneous and contaminated plastic waste material if mechanical recycling is neither economical nor completely technically feasible.

Chemical recycling is based on cracking the polymers into smaller molecules, which can be subsequently used for the production of chemicals, fuels, and virgin plastics with identical performance as the original material (Figure 1). Pyrolysis as one of the processes known for chemical recycling is the most promising option for plastic waste feeds that are difficult to depolymerize or separate mechanically, e.g. mixed PE/PP/PS.

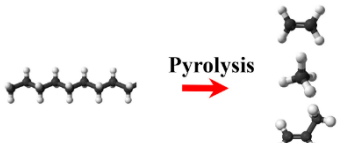

Figure 1 Pyrolysis of plastic waste

Apart from the intrinsic pyrolysis processes, it is crucial to design the reactor efficiently so that the production rate increases while equipment volume and environmental impact decrease (process intensification). Process intensification (PI) has received a lot of attention in the past few decades. Changing the design of the conventional fluidized bed with rotating bed e.g. VR, which introduces a controllable centrifugal force instead of gravity against the drag force, is one of the possible methodologies of PI. This change results in a higher slip velocity between two phases and subsequently intensified heat and mass transfer. This type of PI in a VR could also be interesting to increase the valuable product yield e.g. light olefins from plastic waste pyrolysis.

The study of such a system will be carried out via CFD simulations to find the well-suited reactor design to optimize the yield of valuable products followed by achieving the proper operating conditions.

Program

1. Literature study
   - Study on the different types of reactor and methodologies suitable to perform the plastic waste pyrolysis
2. Simulation of the plastic waste pyrolysis in VR (OpenFoam)
   - Non-reactive CFD model development
   - Evaluating the effect of physical properties of plastics and operating conditions on VR hydrodynamics.