A GAS-SOLID VORTEX REACTOR FOR THE FAST PYROLYSIS OF BIOMASS

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Fast pyrolysis is one of key potential technologies for the production of chemicals, fuels and energy from biomass. None of the current reactor concepts fully satisfies the main requirements of the fast pyrolysis process: high interfacial heat transfer, rapid removal of the pyrolysis vapours and precise temperature control. The presented work focuses on the design, construction and demonstration of a new reactor concept, the Gas-Solid Vortex Reactor (GSVR), which can benefit the fast pyrolysis process in terms of yields and bio-oil quality [1].
The GSVR enables fluidization in a centrifugal field with particle inertial forces that exceed the gravitational force. A dense and uniform bed of particles with bed width-to-height ratios and gas-solid slip velocities much higher than in conventional fluidized beds can be sustained. Larger gas-solid slip velocities lead to intensification of interfacial transfer of mass, energy and momentum and to drastic reduction of the gas-to-solid space time ratio. The enhanced heat transfer and bed uniformity allows gaining improved control of the pyrolysis temperature. As a consequence of the improved bed uniformity, temperature control and removal of the pyrolysis vapours it is possible to produce bio-oils with a higher selectivity towards targeted components such as bio-aromatics.
The GSVR design consists of two concentric cylinders in which the fluidization gas is distributed around the annulus and enters tangentially into the inner chamber via eight rectangular 1 mm width slots. The axial length and the internal diameter of the reactor are 15 mm and 80 mm, respectively. Biomass is fed next to the gas inlet slots through a circular conduit of 10 mm diameter as can be seen in Figure 1. Momentum is transferred from the gas to the particles, causing them to rotate and generating a large radially-outwards centrifugal force, which opposes the radially in-ward gas-solid drag force. Mass and energy balances on the GSVR showed that biomass mass flow rates from 1.4×10^{-4}-8.3×10^{-4} kg s^{-1} can be processed. The corresponding gas (N2) mass flow rates and inlet temperatures are respectively 5.0×10^{-3}-1.0×10^{-2} kg s^{-1} and 800-923 K. The experimental set-up and results obtained with this unit will be discussed, with emphasis on its process intensification capabilities.

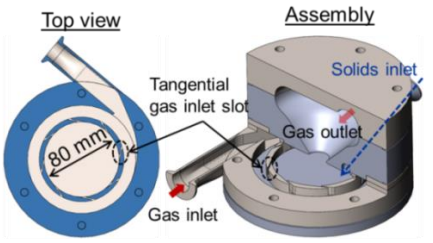

Figure 1. Gas-Solid Vortex Reactor schematics

References
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