Novel design of multiphase reactors for Biomass-To-Liquid synthesis

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Generation of liquid fuels from renewable sources such as biomass has been practiced since early 1900's. In view of the skyrocketing oil prices and the depleting reserves of natural gas, it has gained further interest. The Fischer-Tropsch synthesis is one of the main processes considered. It involves the reaction of syngas in presence of a catalyst to produce liquid fuels. Syngas sources are numerous ranging from waste gasification, anaerobic digestion to clean coal. The reactor of choice for gas to liquid conversion is a slurry bubble column. Although, these multiphase reactors offer several advantages including good heat and mass transfer, ease of construction and operation, the absence of moving parts, one of their main disadvantages is the difficulties associated with the scale-up. The latter is due to complex phases' interactions and significant backmixing of phases.

In general, the scaling rules are derived from mass and momentum balances resulting in dimensionless hydrodynamic numbers. For a proper scaling these numbers should be kept constant, together with dimensionless geometric numbers in order to ensure both dynamic and geometrical similarity. With the complex nature of the flow in these systems, this becomes very hard to achieve since it may result in the need for matching a large numbers of dimensionless quantities. Hence, different routes to provide a firm scale-up methodology are needed.

Controlling the effect of scale using heat exchanging internals by means of reactor compartmentalization is proposed in this study. The details of this methodology can be summarized as follows:

- The large reactor diameter is subdivided into similar, vertical compartments by means of the cooling tubes.
- The compartments are to have a diameter similar to that of a small scale column on which investigations can be (have been) performed.
- The various hydrodynamic parameters within each compartment are to be compared with those measured in a bubble column of the same diameter.

Preliminary results show that radial gas holdup profiles inside the compartments exhibited similar behavior as inside a solid wall column, with a close agreement between resulting gas holdup profile inside the single tube bundle compartment and data obtained in 6 inches steel bubble column.