**24g Residence Times in Fluidized Beds with Secondary Gas Injection**

*Dana O. Christensen, Marc-Olivier Coppens, and John Nijenhuis*

Results of residence time distribution experiments are presented for a fluidized bed with secondary gas injection, i.e., with gas injected at various locations throughout the bed and not only via the bottom distributor. Large bubbles may have a negative effect on the performance of fluidized beds due to mass-transfer limitations, inhomogeneity and back mixing. Secondary injection was shown to reduce bubble size and the total volume of gas in the form of bubbles, resulting in improved gas-solid contact and less back mixing. The residence time experiments aimed to prove this point explicitly, and to determine what effect a staggered secondary injection of gas has on the residence time. The latter is not obvious because the mixing and flow conditions inside the reactor are significantly changed by the secondary injection.

The experiments were conducted by injecting helium tracer pulses into either the primary or secondary flow streams. The helium exiting the bed is measured with a thermal conductivity detector. The data from helium injections into the two separate streams are then combined and a total residence time distribution is determined. These experiments are conducted for different total flow rates as well as for different secondary to primary flow ratios, but always maintaining sufficient primary flow to keep the entire bed fluidized.

Results indicate that, while the mean residence time is slightly reduced, the flow behavior is much closer to plug flow. The reduction in residence time is much less than would be expected given that a significant portion of the flow is introduced much higher in the bed. This is because there is an increase in the emulsion phase flow, while the bubbles in the bubble phase are much smaller and thus rise with a much lower velocity. These smaller bubbles take much longer to coalesce and this reduces the amount of back mixing that occurs, which contributes to the more plug flow-like behavior of the fluidized bed with secondary injection.