

HEAT TRANSFER STUDY IN CORRUGATED WALL BUBBLING FLUIDIZED BED REACTOR: EXPERIMENTS AND CFD SIMULATIONS

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Gasification technology must ideally be bestowed with the following traits: auto/allothermal process, non-diluted biosyngas abolishing downstream N₂ separation or upstream O₂ enrichment, thermal coupling via micro-segmentation between endothermic and exothermic steps to improve heat exchanges and enhance thermal efficiency, and high yield and heating value of biosyngas. These attributes represent the foremost challenges next-generation biomass steam gasifiers must cope with. With the endeavor of approaching such ideal configuration, Iliuta et al. proposed a reactor concept of allothermal cyclic multicompartment bubbling fluidized beds. Gas solid fluidized bed reactors would be used to obtain the enhanced heat and mass transport and conversion performances as compared to packed beds. Corrugated walls were installed in narrow gas-solid bubbling fluidized bed (CWBF) enclosures to decrease minimum bubbling velocity, reduce bubble sizes, improve gas distribution, offer stable operation and minimize the particles carryover or loss. Thorough analyses of wall-to-bed heat transfer coefficient in flat- (FWBF) and corrugated- (CWBF) wall bubbling fluidized beds were performed for a variety of wall declinations and operating conditions covering a range of corrugation angles, inter-wall clearances (C), initial rest bed heights (H_i) and ratios of gas superficial velocity to minimum bubbling velocity, U_g/U_{mb} (1-1.55). Fast response self-adhesive heat flux probes and thermocouples were employed to simultaneously measure the wall-to-bed heat flux, surface temperature and bed temperature. These instruments were used to measure the heat transfer coefficient (HTC) at different (18) axial and lateral locations. For a given set of parameters, significant increase in HTC was observed at lower gas flow rate in CWBF as compared to FWBF. It showed that CWBF inventory required lesser U_{mb} (gas flow rate) and offered more economical gas solid fluidization phenomena as compared to FWBF. Full 3-D transient Euler-Euler CFD simulations employing kinetic theory of granular flow were also carried out which corroborated with experimental findings.