Effect of Reynolds Number on Deposition of Endothermic Hydrocarbon Fuel in Inside Wall of the Pipe

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Endothermic hydrocarbon fuel has been used as an aircraft and engine coolant for decades. However, coking occurs with heating fuel. Most researches on the deposition have concerned on the effect of the dissolved oxygen, the fuel temperature, the chemistry of deposition and deposit model in recent years. Obviously, the fluid flow and flow mode have a significant effect on deposition of endothermic hydrocarbon fuel in inside wall of the pipe. In view of the literatures, the conflict result on the deposition changed with Reynolds number flowing inside the pipe, some reported the deposition increases with Reynolds number, the others gave opposite result. Thermal stressing of endothermic hydrocarbon fuel RP-3 and JP-10 have been carried out in an isothermal flow reactor when the fuel flow through the stainless steel (0.085 in.-i.d, 0.125 in.-o.d. ss316) pipe. The test temperature and pressure are between 150-200℃ and up to 2.5MPa, respectively. The deposition was only contributed from the single-phase autoxidation. Reynolds number varied only by changing mass flow rate of studied fuel. Deposition rates on the inside wall of the pipe were measured by using carbon burn-off. The results obtained show deposition rate of RP-3 and JP-10 increase with the Reynolds number in the experimental temperature range. An empirical equation for predicting the effect of Reynolds number on deposition is proposed based on the experimental data in this study. Moreover, we established a mathematical model to describe the experimental process using the computational fluid dynamics (CFD) base on simplified global chemistry model. Simulation results are compared with the experimental data, and it is sure that the new model can calculate the deposition rate of endothermic hydrocarbon fuel in inside wall of the pipe at different flow rate.