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Experimental study of partially decoupled oxidation of ethane for producing ethylene and acetylene

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Abstract

With increasing amount of unconventional natural gas, the production of ethane, propane and other low alkanes continues to increase. In our previous works, a partially decoupled process (PDP) was proposed for conversion of ethane based on numerical simulations, which showed higher acetylene and ethylene selectivities than the original partial oxidation process. In the current work, the PDP of ethane for producing acetylene and ethylene was studied experimentally to verify the PDP concept. In the PDP of ethane, coke-oven gas or other cheap gas combusts with stoichiometric oxygen as heat carrier, and ethane is mixed with the heat carrier and undergoes pyrolysis at high temperatures. The jet-in-cross-flow (JICF) reactor was designed and manufactured to realize the PDP. A positioning device of 0.1 mm accuracy and a mass spectrometer were used to measure the spatial profiles of the species concentrations. The maximum combined yield (52.7%) of acetylene and ethylene was obtained even at the condition of heat loss, confirming that the PDP of ethane was advantageous over the partial oxidation process and at least comparable to the steam cracking process.

Keywords: Partial oxidation; Experimental validation; Pyrolysis; Ethane conversion; Partially decoupled process (PDP); Jet-in-cross-flow (JICF) reactor.

1. Introduction

With the successful application of horizontal well and fracturing technology, the production of shale gas continues to increase [1–3]. Different from conventional natural gas, the shale gas contains a considerable amount of hydrocarbons heavier