Production of Syn-crude from Biomass/Oil Shale Using a Moving Bed Downdraft Reactor

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ABSTRACT

Following previous work focused on syn-crude generation from oil shale using an indirect heated rotary horizontal reactor, the present work focuses on:

1. Design and operation of a vertical downdraft reactor,
2. Establishing an optimum operating methodology to maximize crude production through process testing, and
3. Establishing optimum operating parameters required for Aspen based process modeling using established experimental design methodology and subsequent statistical analysis of test results.

The down draft reactor design is based on previous work completed at Brigham Young University-Idaho and subsequent design optimization to enhance the operating flexibility for both biomass and oil shale at a one ton per day rate. This reactor is equipped with reticulated ceramic foam low emissions natural gas fired burner to evenly supply heat to the reactor required for the pyrolysis step. The reactor is also equipped with internal heat transfer surfaces to enhance intra-bed heat and mass transfer inside the reactor. A cyclone separator is used to remove solids carried over from the reactor and to pre-clean the produced gas which is then collected and condensed to form the syn-crude. White river basin crushed oil shale plus three different woody biomass feedstocks have been examined in this work.

Specific work described in this paper focuses on identifying and characterizing the key operating factors (i.e., temperature profile, feed stock carbon/hydrogen mass ratio, particle size, residence time) required to optimize yield from this reactor system. To achieve the maximum production yield, experiments were developed and carried out based on classical experimental design methodology. Important factor effects and their two-way interactions were identified using the statistical software package SAS. This approach successfully analyzed experimental error to establish the operating factors for subsequent process modeling and scaling of the technology.