

CLAIMS

1. A method for operating a system having a first fluid catalytic cracking (FCC) unit and a second FCC unit for producing products from a hydrocarbon feed stream, the method comprising:

introducing the hydrocarbon feed stream to a feed separator;

separating the hydrocarbon feed stream into a lesser boiling point fraction and a greater boiling point fraction in the feed separator;

passing the greater boiling point fraction to the first FCC unit;

passing the lesser boiling point fraction to the second FCC unit, where the first FCC unit and the second FCC unit are downflow FCC units;

cracking at least a portion of the greater boiling point fraction in the first FCC unit in the presence of a first catalyst at a first cracking temperature of from 500 °C to 700 °C to produce a first cracking reaction product and a spent first catalyst;

cracking at least a portion of the lesser boiling point fraction in the second FCC unit in the presence of a second catalyst and at a second cracking temperature of from 500 °C to 700 °C to produce a second cracking reaction product and a spent second catalyst; and

passing at least a portion of the spent first catalyst or a portion of the spent second catalyst to the first FCC unit or the second FCC unit.

2. The method of claim 1 where the hydrocarbon feed stream comprises crude oil.

3. The method of either of claims 1 or 2 where the first FCC unit and the second FCC unit are High-Severity Fluidized Catalytic Cracking (HSFCC) units in which:

a weight ratio of catalyst to hydrocarbon in the first FCC unit and the second FCC unit is greater than 5; and

a residence time in the first FCC unit and the second FCC unit is less than 3 seconds.
4. The method of any of claims 1 through 3 further comprising regenerating a non-recycled portion of the spent first catalyst and a non-recycled portion of the spent second catalyst in a regeneration zone to produce a regenerated catalyst.
5. The method of any of claims 1 through 4 comprising passing the at least a portion of the spent first catalyst to the first FCC unit, the second FCC unit, or the first FCC unit and the second FCC unit.
6. The method of any one of claims 1 through 5 comprising passing the at least a portion of the spent first catalyst to the first FCC unit, where the first catalyst comprises the at least a portion of the spent first catalyst and the regenerated catalyst and the second catalyst comprises the regenerated catalyst, where the first catalyst comprises a weight ratio of the at least a portion of the spent first catalyst to the regenerated catalyst of from 1:99 to 99:1.

7. The method of claim 6 further comprising controlling the catalytic activity of the first catalyst in the first FCC unit or the first cracking temperature in the first FCC unit by adjusting a weight ratio of the at least a portion of the spent first catalyst to the regenerated catalyst in the first catalyst.

8. The method of any of claims 1 through 5 comprising passing the at least a portion of the spent first catalyst to the second FCC unit, where the second catalyst comprises:

the at least a portion of the spent first catalyst and the regenerated catalyst; and
a weight ratio of the at least a portion of the spent first catalyst to the regenerated catalyst of from 1:99 to 99:1, from 10:90 to 90:10, or from 25:75 to 75:25.

9. The method of claim 8 further comprising controlling a catalytic activity of the second catalyst in the second FCC unit or the second cracking temperature in the second FCC unit by adjusting a weight ratio of the at least a portion of the spent first catalyst to the regenerated catalyst in the second catalyst.

10. The method of any one of claims 1 through 4 comprising passing at least a portion of the spent second catalyst to the first FCC unit, the second FCC unit, or the first FCC unit and the second FCC unit.

11. The method of claim 10 comprising passing the at least a portion of the spent second catalyst to the second FCC unit, where the second catalyst comprises the at least

a portion of the spent second catalyst and the regenerated catalyst and a weight ratio of the at least a portion of the spent second catalyst to the regenerated catalyst of from 1:99 to 99:1.

12. The method of claim 11 further comprising controlling a catalytic activity of the second catalyst in the second FCC unit or the second cracking temperature in the second FCC unit by adjusting a weight ratio of the at least a portion of the spent second catalyst to the regenerated catalyst in the second catalyst.

13. The method of claim 10 comprising passing the at least a portion of the spent second catalyst to the first FCC unit where the first catalyst comprises the at least a portion of the spent second catalyst and the regenerated catalyst and a weight ratio of the at least a portion of the spent second catalyst to the regenerated catalyst of from 1:99 to 99:1.

14. The method of claim 13 further comprising controlling a catalytic activity of the first catalyst in the first FCC unit or the first cracking temperature in the first FCC unit by adjusting a weight ratio of the at least a portion of the spent second catalyst to the regenerated catalyst in the first catalyst.

15. The method of any of claims 1 through 14 where the first cracking reaction product or the second cracking reaction product comprises one or more of ethylene, propene, butene, or pentene.