selectivity of the acetylene hydrogenation unit caused by a sudden decrease in or complete loss of the flow of the FCDh effluent to the effluent processing system. The methods disclosed herein may reduce the probability of thermal runaway in the event that the FCDh system suddenly stops, thus reducing or preventing thermal damage to equipment and catalysts and reducing or preventing over-hydrogenation and loss of valuable olefin products produced in the steam cracking and FCDh systems.

[0009] There is provided a method for operating an acetylene hydrogenation unit in an integrated steam cracking-fluidized catalytic dehydrogenation (FCDh) system may include cracking at least a portion of a first hydrocarbon feed in a steam cracking system to produce a cracked gas comprising at least hydrogen, carbon monoxide (CO), and acetylene, dehydrogenating at least a portion of a second hydrocarbon feed in an FCDh system to produce an FCDh effluent comprising at least hydrogen and CO, and separating the cracked gas and at least a portion of the FCDh effluent into a hydrogenation feed and an acetylene-depleted stream. The hydrogenation feed may include at least hydrogen, CO, and acetylene. The hydrogenation feed may include at least 95% of the CO from the cracked gas and the FCDh effluent. During normal operating conditions, at least 20% of the CO in the hydrogenation feed may be from the cracked gas. The method may further include contacting the hydrogenation feed with an acetylene hydrogenation catalyst in an acetylene hydrogenation unit. The contacting may cause hydrogenation of at least a portion of the acetylene in the hydrogenation feed to produce a hydrogenated effluent. The steam cracking system may be operated under conditions that increase CO production such that a concentration of CO in the cracked gas may be great enough that when a flowrate of the FCDh effluent is zero, a CO concentration in the hydrogenation feed is at least 100 ppmv.

[0009a] In one aspect, there is provided a method for operating an acetylene hydrogenation unit in an integrated steam cracking-fluidized catalytic dehydrogenation (FCDh) system, the method comprising: cracking at least a portion of a first hydrocarbon feed in a steam cracking system to produce a cracked gas comprising at least hydrogen, carbon monoxide (CO), and acetylene; dehydrogenating at least a portion of a second hydrocarbon feed in an FCDh system to produce an FCDh effluent comprising at least hydrogen and CO; separating the cracked gas and at least a portion of the FCDh effluent into a hydrogenation feed and an acetylene-depleted stream, the hydrogenation feed comprising at least hydrogen, CO, and acetylene, wherein the hydrogenation feed comprises at least 95% of the CO from the cracked gas and the FCDh

effluent, and wherein during normal operating conditions at least 20% of the CO in the hydrogenation feed is from the cracked gas, wherein during normal operating conditions, both the steam cracking system and the FCDh system are operating at high temperatures and steady state; and contacting the hydrogenation feed with an acetylene hydrogenation catalyst in an acetylene hydrogenation unit, the contacting causing hydrogenation of at least a portion of the acetylene in the hydrogenation feed to produce a hydrogenated effluent; wherein the steam cracking system is operated under conditions that increase CO production such that a concentration of CO in the cracked gas is great enough that when a flowrate of the FCDh effluent is zero, a CO concentration in the hydrogenation feed is at least 100 ppmv.

[0010] In one or more examples, operating the steam cracking system under conditions that increase CO production such that the concentration of CO in the cracked gas is great enough that when the flowrate of the FCDh effluent is zero, the CO concentration in the hydrogenation feed is at least 100 ppmv, may reduce or prevent thermal runaway of the acetylene hydrogenation unit in response to a disruption in the flow of the FCDh effluent to the acetylene hydrogenation unit.

[0011] In one or more other examples, the concentration of CO in the cracked gas may be great enough that when the flowrate of the FCDh effluent is zero, the CO concentration in the hydrogenation feed may be from 100 ppmv to 450 ppmv.

[0012] In one or more examples, maintaining the amount of the CO from the cracked gas in the hydrogenation feed greater than or equal to 20% by mass of the total amount of CO in the hydrogenation feed may reduce or prevent thermal runaway of the acetylene hydrogenation unit in response to a disruption in flow of the FCDh effluent to the acetylene hydrogenation unit.

[0013] In one or more examples the steam cracking system may be operated under conditions that increase CO production by modifying an amount of sulfur-containing compounds, methanol, or both, introduced to the steam cracking system. The sulfur-containing compounds may include at least one of dimethyl disulfide (DMDS), dimethyl sulfide (DMS), diethyl disulfide (DEDS), methyl mercaptan (MM), or combinations thereof.

[0014] In one or more examples, the method may further include increasing a temperature of the hydrogenation feed in response to increasing an amount of CO in the cracked gas to maintain a concentration of acetylene in the hydrogenated effluent less than a target acetylene concentration.

[0015] In some examples, the acetylene hydrogenation unit may include at least a first hydrogenation reactor and a second hydrogenation reactor downstream of the first hydrogenation reactor. Maintaining the amount of CO from the cracked gas in the hydrogenation feed greater than or equal to 20% of the total amount of CO in the hydrogenation feed may maintain a conversion of acetylene in the first hydrogenation reactor greater than or equal to 80% in response to a decrease in the flow of the FCDh effluent to the acetylene hydrogenation unit.

[0016] In one or more example, in response to a decrease in flow of the at least a portion of the FCDh effluent to the separator, an absolute value of a change in a Delta T of a first hydrogenation reactor of the acetylene hydrogenation unit may be less than 10 °C. The Delta T of the first hydrogenation reactor may be a difference between an inlet temperature and an outlet temperature of the first hydrogenation reactor.

[0017] In some examples, a flow ratio may be less than or equal to 1/2. The flow ratio may be the mass flow rate of the portion of the FCDh effluent passed to the separation system divided by the mass flow rate of the portion of the cracked gas in the hydrogenation feed.

[0018] In some examples, the hydrogenation feed may include methyl acetylene, propadiene, and at least one cracker product, the at least one cracker product comprising one or more of ethylene, propylene, methane, ethane, propane, or combinations of these.

[0019] In some examples, the hydrogenated effluent may have a concentration of acetylene of less than or equal to 2 ppm by volume.

[0020] In some examples, the FCDh effluent may include at least one FCDh product, wherein the at least one FCDh product comprises ethylene, propylene, or both.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The following detailed description of specific embodiments of the present disclosure can be best understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

[0022] FIG. 1 schematically depicts an integrated process for producing olefins that includes an FCDh system integrated with a steam cracking system and a shared effluent processing system, according to one or more embodiments shown and described herein;

[0023] FIG. 2 schematically depicts the steam cracking system of the integrated process of FIG. 1, according to one or more embodiments shown and described herein;

[0024] FIG. 3 schematically depicts the FCDh system of the integrated process of FIG. 1, according to one or more embodiments shown and described herein;

[0025] FIG. 4 schematically depicts a portion of the effluent processing system of the integrated process of FIG. 1, according to one or more embodiments shown and described herein; and

[0026] FIG. 5 graphically depicts a concentration of acetylene (y-axis-left) and an ethylene selectivity (y-axis-right) for an acetylene hydrogenation unit as a function of a temperature (x-axis) of a hydrogenation feed passed to the acetylene hydrogenation unit, according to one or more embodiments shown and described herein.

[0027] It should be understood that the drawings are schematic in nature, and may not include some components of reactor systems commonly employed in the art, such as, without limitation, sensors, temperature transmitters, pressure transmitters, flow meters, pumps, valves, heat exchangers, internal reactor structures, and the like. It would be known that these components are within the spirit and scope of the present embodiments disclosed. However, operational components, such as those described in the present disclosure, may be added to the embodiments described in this disclosure.

CLAIMS

1. A method for operating an acetylene hydrogenation unit in an integrated steam cracking-fluidized catalytic dehydrogenation (FCDh) system, the method comprising:

cracking at least a portion of a first hydrocarbon feed in a steam cracking system to produce a cracked gas comprising at least hydrogen, carbon monoxide (CO), and acetylene;

dehydrogenating at least a portion of a second hydrocarbon feed in an FCDh system to produce an FCDh effluent comprising at least hydrogen and CO;

separating the cracked gas and at least a portion of the FCDh effluent into a hydrogenation feed and an acetylene-depleted stream, the hydrogenation feed comprising at least hydrogen, CO, and acetylene, wherein the hydrogenation feed comprises at least 95% of the CO from the cracked gas and the FCDh effluent, and wherein during normal operating conditions at least 20% of the CO in the hydrogenation feed is from the cracked gas, wherein during normal operating conditions, both the steam cracking system and the FCDh system are operating at high temperatures and steady state; and

contacting the hydrogenation feed with an acetylene hydrogenation catalyst in an acetylene hydrogenation unit, the contacting causing hydrogenation of at least a portion of the acetylene in the hydrogenation feed to produce a hydrogenated effluent;

wherein the steam cracking system is operated under conditions that increase CO production such that a concentration of CO in the cracked gas is great enough that when a flowrate of the FCDh effluent is zero, a CO concentration in the hydrogenation feed is at least 100 ppmv.

2. The method of claim 1, wherein operating the steam cracking system under conditions that increase CO production such that the concentration of CO in the cracked gas is great enough that when the flowrate of the FCDh effluent is zero, the CO concentration in the hydrogenation feed is at least 100 ppmv reduces or prevents thermal runaway of the acetylene hydrogenation unit in response to a disruption in the flow of the FCDh effluent to the acetylene hydrogenation unit.

3. The method of either of claims 1 or 2, wherein the concentration of CO in the cracked gas is great enough that when the flowrate of the FCDh effluent is zero, the CO concentration in the hydrogenation feed is from 100 ppmv to 450 ppmv.

4. The method of any of the preceding claims, wherein maintaining the amount of the CO from the cracked gas in the hydrogenation feed greater than or equal to 20% by mass of the total amount of CO in the hydrogenation feed reduces or prevents thermal runaway of the acetylene hydrogenation unit in response to a disruption in flow of the FCDh effluent to the acetylene hydrogenation unit.

5. The method of any of the preceding claims, wherein the steam cracking system is operated under conditions that increase CO production by modifying an amount of sulfur-containing compounds, methanol, or both, introduced to the steam cracking system.

6. The method of claim 5, wherein the sulfur-containing compounds comprise at least one of dimethyl disulfide (DMDS), dimethyl sulfide (DMS), diethyl disulfide (DEDS), methyl mercaptan (MM), or combinations thereof.

7. The method of any one of the preceding claims, further comprising increasing a temperature of the hydrogenation feed in response to increasing an amount of CO in the cracked gas to maintain a concentration of acetylene in the hydrogenated effluent less than a target acetylene concentration.

8. The method of any one of the preceding claims, wherein the acetylene hydrogenation unit comprises at least a first hydrogenation reactor and a second hydrogenation reactor downstream of the first hydrogenation reactor, and wherein maintaining the amount of CO from the cracked gas in the hydrogenation feed greater than or equal to 20% of the total amount of CO in the hydrogenation feed maintains a loss in overall ethylene selectivity of less than or equal to 80% in response to a decrease in the flow of the FCDh effluent to the acetylene hydrogenation unit.

9. The method of any one of the preceding claims, in which in response to a decrease in flow of the at least a portion of the FCDh effluent to the separator, an absolute value of a change in a Delta T of a first hydrogenation reactor of the acetylene hydrogenation unit is less than 10 °C, wherein the Delta T of the first hydrogenation reactor is a difference between an inlet temperature and an outlet temperature of the first hydrogenation reactor.

10. The method of any one of the preceding claims, wherein a flow ratio is less than or equal to 1/2, wherein the flow ratio is the mass flow rate of the portion of the FCDh effluent passed to the separation system divided by the mass flow rate of the portion of the cracked gas in the hydrogenation feed.

11. The method of any one of the preceding claims, wherein the hydrogenation feed comprises methyl acetylene, propadiene, and at least one cracker product, the at least one cracker product comprising one or more of ethylene, propylene, methane, ethane, propane, or combinations of these.

12. The method of any one of the preceding claims, wherein the hydrogenated effluent has a concentration of acetylene of less than or equal to 2 ppm by volume.

13. The method of any one of the preceding claims, wherein the FCDh effluent comprises at least one FCDh product, wherein the at least one FCDh product comprises ethylene, propylene, or both.

14. The method of any one of the preceding claims, wherein during normal operating conditions the steam cracking system is operated at a temperature of greater than 550 °C.

15. The method of any one of the preceding claims, wherein during normal operating conditions the FCDh system is operated at a temperature of greater than 550 °C.