CLAIMS:

What is claimed is:

1. A hydrocarbon pyrolysis process, comprising:

introducing a hydrocarbon feed into a pyrolysis furnace comprising a first radiant coil and a second radiant coil;

pyrolysing at least a portion of the hydrocarbon feed in the first radiant coil to produce a first hydrocarbon effluent and to deposit coke on an inner surface of the first radiant coil;

pyrolysing at least a portion of the hydrocarbon feed in the second radiant coil to produce a second hydrocarbon effluent and to deposit coke on an inner surface of the second radiant coil;

decreasing a flow rate of the hydrocarbon feed into the first radiant coil while maintaining a flow rate of the hydrocarbon feed into the second radiant coil;

introducing a decoking feed comprising steam or a mixture of steam and air into the first radiant coil of the pyrolysis furnace to remove at least a portion of the coke deposited on the inner surface of the first radiant coil and to produce a de-coking effluent comprising steam and a plurality of coke particles;

indirectly exchanging heat from the second hydrocarbon effluent to water, steam, or a mixture thereof to produce a cooled second hydrocarbon effluent;

indirectly exchanging heat from the de-coking effluent to water, steam, or a mixture thereof to produce a cooled de-coking effluent;

mixing the cooled second hydrocarbon effluent and the cooled de-coking effluent to produce a combined effluent;

introducing the combined effluent into an inlet conduit of a separator under conditions that provide ≥ 80 wt. % of the plurality of coke particles with a Stokes number of ≥ 10;

removing ≥ 55 wt. % of the plurality of coke particles in the combined effluent from a first exit conduit of the separator, and

removing a coke-lean hydrocarbon effluent comprising ≤ 45 wt. % of the plurality of coke particles in the combined effluent from a second exit conduit of the separator, wherein the first exit conduit is coupled to the inlet conduit, and wherein the second exit conduit is coupled to the inlet conduit, wherein:

the plurality of coke particles is introduced into a coke catch apparatus,

a flow control device couples the first exit conduit to the coke catch apparatus and

a total length of the first exit conduit and the flow control device is ≤ 8 times an inner diameter of the first exit conduit.

2. The process of claim 1, wherein steam is introduced into the coke catch apparatus adjacent the location the flow control device couples the first exit conduit to the coke catch apparatus.

3. The process of claim 1 or 2, wherein the combined effluent is introduced into the inlet conduit of the separator under conditions that provide ≥ 80 wt. % of the plurality of coke particles with a Stokes number of ≥ 10 to 15,000, and wherein ≥ 70 wt. % of the plurality of coke particles in the combined effluent is recovered from the first exit conduit.

4. The process of any one of claims 1 to 3, wherein a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit, and wherein the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 20° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 160° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit.

5. The process of any one of clams 1 to 3, wherein a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit, and wherein the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 45° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 135° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit.

6. The process of any one of claims 1 to 5, wherein the hydrocarbon feed comprises ethane, propane, naphtha, gas oil, vacuum gas oil, waxy residues, atmospheric residues, residue admixtures, crude oil, or a mixture thereof.

7. The process of any one of claims 1 to 6, wherein the decoking feed comprises a mixture of steam and air.

8. The process of any one of claims 1 to 7, wherein a flow path from the inlet conduit into the first exit conduit is free of any obstruction, and wherein a flow path from the inlet conduit into the second exit conduit is free of any obstruction.

9. The process of any one of claims 1 to 8, wherein a longitudinal axis of the first exit conduit is oriented at an angle of 0° to 90° with respect to a surface of the earth.

10. The process of any one of claims 1 to 9, further comprising indirectly exchanging heat from the combined effluent to water, steam, or a mixture of water and steam to produce a cooled combined effluent, wherein the cooled combined effluent is introduced into the inlet conduit.

11. A process for separating particles from a fluid, comprising:

introducing a mixture comprising a gaseous hydrocarbon and a plurality of particles into an inlet conduit under conditions that provide ≥ 80 wt. % of the plurality of particles with a Stokes number of ≥ 10,

recovering ≥ 55 wt. % of the plurality of particles in the mixture from a first exit conduit coupled to the inlet conduit, wherein

the plurality of particles recovered from the first exit conduit is introduced into a particle receiving apparatus,

a flow control device couples the first exit conduit to the particle receiving apparatus, and

a total length of the first exit conduit and the flow control device is ≤ 8 times an inner diameter of the first exit conduit; and

recovering a particle-lean gaseous hydrocarbon comprising ≤ 45 wt. % of the plurality of particles present in the mixture from a second exit conduit coupled to the inlet conduit.

12. The process of claim 11, wherein a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit, and wherein the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 20° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 160° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit.

13. The process of claim 11, wherein a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit, and wherein the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 45° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 135° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit.

14. The process of any one of claims 11 to 13, wherein ≥ 60 wt. % of the plurality of particles in the mixture is recovered from the first exit conduit.

15. The process of any one of claims 11 to 14, wherein a flow path from the inlet conduit into the first exit conduit is free of any obstruction, and wherein a flow path from the inlet conduit into the second exit conduit is free of any obstruction.

16. The process of any one of claims 11 to 15, wherein the plurality of particles have a Stokes number of 100 to 10,000.

17. The process of any one of claims 11 to 15, wherein the plurality of particles have a Stokes number of 1,000 to 20,000.

18. The process of any one of claims 11 to 17, wherein the mixture further comprises steam, wherein the gaseous hydrocarbon comprises ethylene, and wherein the plurality of particles comprises coke removed from an inner surface of a radiant coil disposed within a steam cracking furnace.

19. The process of claim 18, wherein the mixture introduced into the inlet conduit is recovered from a secondary transfer line heat exchanger.

20. A separator for separating particles from a fluid, comprising:

an inlet conduit configured to receive an effluent comprising hydrocarbons, steam, and a plurality of coke particles, wherein the inlet conduit is further configured to provide ≥ 80 wt. % of the plurality of coke particles with a Stokes number of ≥ 10;

a first exit conduit coupled to the inlet conduit;

a second exit conduit coupled to the inlet conduit;

a particle receiving apparatus in fluid communication with the first exit conduit, the particle receiving apparatus configured to receive coke particles; and

a flow control device that couples the first exit conduit to the particle receiving apparatus, wherein:

a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit,

the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 20° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 160° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit, and

a total length of the first exit conduit and the flow control device is ≤ 8 times an inner diameter of the first exit conduit.

21. The separator of claim 20, wherein the inlet conduit is configured to provide ≥ 80 wt. % of the plurality of coke particles with a Stokes number of ≥ 10 to 20,000, and wherein the first exit segment is configured to direct 70 wt. % to 97 wt. % of the plurality of coke particles in the effluent into the container.

22. The separator of claim 20 or 21, wherein the longitudinal axis of the inlet conduit and the longitudinal axis of the first exit conduit are substantially parallel to a surface of the earth, substantially perpendicular to a surface of the earth, or oriented at an angle anywhere between 0° and 90° with respect to a surface of the earth.

23. The separator of any one of claims 20 to 22, wherein a flow path from the inlet conduit into the first exit conduit is free of any obstruction, and wherein a flow path from the inlet conduit into the second exit conduit is free of any obstruction.

24. A hydrocarbon pyrolysis process, comprising:

introducing a hydrocarbon feed into a pyrolysis furnace comprising a first radiant coil and a second radiant coil, wherein the hydrocarbon feed comprises ethane, propane, naphtha, gas oil, vacuum gas oil, waxy residues, atmospheric residues, residue admixtures, crude oil, or a mixture thereof;

pyrolysing at least a portion of the hydrocarbon feed in the first radiant coil to produce a first hydrocarbon effluent and to deposit coke on an inner surface of the first radiant coil;

pyrolysing at least a portion of the hydrocarbon feed in the second radiant coil to produce a second hydrocarbon effluent and to deposit coke on an inner surface of the second radiant coil;

decreasing a flow rate of the hydrocarbon feed into the first radiant coil while maintaining a flow rate of the hydrocarbon feed into the second radiant coil;

introducing a decoking feed comprising steam or a mixture of steam and air into the first radiant coil of the pyrolysis furnace to remove at least a portion of the coke deposited on the inner surface of the first radiant coil and to produce a de-coking effluent comprising steam and a plurality of coke particles;

indirectly exchanging heat from the second hydrocarbon effluent to water, steam, or a mixture thereof to produce a cooled second hydrocarbon effluent;

indirectly exchanging heat from the de-coking effluent to water, steam, or a mixture thereof to produce a cooled de-coking effluent;

mixing the cooled second hydrocarbon effluent and the cooled de-coking effluent to produce a combined effluent;

introducing the combined effluent into an inlet conduit of a separator under conditions that provide ≥ 80 wt. % of the plurality of coke particles with a Stokes number of ≥ 10 to 20,000;

removing ≥ 70 wt. % of the plurality of coke particles in the combined effluent from a first exit conduit of the separator, and

removing a coke-lean hydrocarbon effluent comprising ≤ 30 wt. % of the plurality of coke particles in the combined effluent from a second exit conduit of the separator, wherein:

the first exit conduit is coupled to the inlet conduit,

the second exit conduit is coupled to the inlet conduit,

a longitudinal axis of the first exit conduit is substantially aligned with a longitudinal axis of the inlet conduit,

the second exit conduit is angled with respect to the inlet conduit and the first exit conduit to provide an angle of 45° to 90° between a longitudinal axis of the second exit conduit and the longitudinal axis of the inlet conduit and an angle of 90° to 135° between the longitudinal axis of the second exit conduit and the longitudinal axis of the first exit conduit,

the plurality of coke particles is introduced into a coke catch apparatus,

a flow control device couples the first exit conduit to the coke catch apparatus and

a total length of the first exit conduit and the flow control device is ≤ 8 times an inner diameter of the first exit conduit.

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