**CLAIMS:**

*What is claimed is:*

1. A hydrocarbon pyrolysis process, comprising:

vaporizing at least a portion of a non-vapor phase hydrocarbon of a hydrocarbon stream to form a second stream comprising at least a portion of a vaporized stream formed during the vaporization, wherein the vaporization includes depressurizing the hydrocarbon stream by establishing a flow of the hydrocarbon stream through a valve from a first pressure upstream of the valve to a second lesser pressure downstream of the valve, and wherein depressurizing further comprises reducing a first temperature of the hydrocarbon stream before depressurizing to a second temperature, wherein the first temperature is about 10°C to about 35 °C and the second temperature is about - 25°C to about -40°C;

separating a first product and a second product from the second stream, wherein (i) the first product comprises at least a portion of the vaporized stream formed during vaporization and at least a portion of any non-vapor phase compositions, and (ii) the second product comprises at least a portion of the second stream remaining as non-vapor during the vaporization;

removing the at least a portion of any non-vapor phase compositions from the first product to form a third product; and

pyrolysing at least a portion of the third product to produce a fourth product comprising saturated and unsaturated hydrocarbon.

2. The process of claim 1, wherein the hydrocarbon stream comprises ethane, propane, or a combination thereof.

3. The process of claim 1 or claim 2, wherein (i) the separation includes filtration, and (ii) the second product comprises particulates having a size ≥10 μm.

4. The process of claim 3, wherein at least part of the filtration is carried out in one or more of a knockout drum with or without demister pads (CWMS), a cyclonic device, and a vane pack device.

5. The process of claim 3 or claim 4, wherein the filtration transfers to the second product (i) ≥ 90 wt. % of particulates having a size in a range of from at least 3 μm to less than 10 μm and (ii) ≥ 99 wt. % of the particulates having a size ≥10 μm.

6. The process of any of the preceding claims, wherein the hydrocarbon stream comprises ethane, and the hydrocarbon stream has a density of about 280 kg/m$^3$ to 410 kg/m$^3$.

7. The process of any of the preceding claims, wherein (i) the removal of at least a portion of any non-vapor phase compositions from the first product comprises removing at least a portion of liquid-phase droplets in the first product, and (ii) the droplet removal is carried out at least in part by droplet coalescence in the presence of a coalescing element capable of removing from the first product ≥99 wt. % of droplets having a size in a range of from 0.3 μm to about 0.6 μm.

8. The process of claim 7, wherein the coalescing element comprises borosilicate.

9. The process of any of the preceding claims, further comprising mixing the third product and a recycle stream before the pyrolysis, wherein the recycle stream comprises at least a portion of the fourth product's saturated hydrocarbon.

10. The process of any of the preceding claims, further comprising mixing (i) a recycle stream and (ii) the second stream and/or the first product, wherein the mixing is carried out before the removal of non-vapor phase compositions, and wherein the recycle stream comprises at least a portion of the fourth product's saturated hydrocarbon.

11. The process of claim 1, wherein non-vapor phase compositions comprise water, C3+ hydrocarbons, glycol, or combination(s) thereof.

12. The process of any of the preceding claims, further comprising indirectly heating the third product before the pyrolysis.

13. The process of any of the preceding claims, wherein the first pressure is about 5515 kPa to about 8274 kPa and the second lesser pressure is about 689 kPa to about 2068 kPa.

14. The method of claim 1, wherein the temperature of the hydrocarbon stream is reduced by depressurizing the hydrocarbon under adiabatic conditions.

15. A method of producing an alkene comprising:

depressurizing an alkane stream to form a mixed phase stream comprising a non-vapor phase hydrocarbon;

vaporizing at least a portion of the non-vapor phase hydrocarbon to form a vaporized stream;

separating a first product and a second product from the vaporized stream, wherein (i) the first product comprises at least a portion of the vaporized stream and non-vapor phase droplets, and (ii) the second product comprises at least a portion of the vaporized stream remaining as non-vapor during the vaporization, wherein the separation includes filtration carried out in one or more knock-out drums optionally having a demister pad, a cyclonic device, a vane pack device, or combination(s) thereof;

removing the non-vapor phase droplets from the first product in a coalescer comprising coalescing elements to form a third product;

pyrolysing a mixture of the third product with steam under pyrolysis conditions that include a temperature in a range of from about 815°C to about 925°C to produce C2+ unsaturates.

16. A hydrocarbon processing system comprising:

a depressurization unit configured to reduce a pressure of a hydrocarbon stream;

a vaporization unit in fluid communication with the depressurization unit and configured to vaporize at least a portion of a non-vapor phase hydrocarbon of the hydrocarbon stream;

a separation system in fluid communication with the vaporization unit, the separation system comprising a coalescing element; and

a pyrolysis reactor in fluid communication with the separation system.

17. The system of claim 16, wherein the separation system comprises:

a phase separator configured to separate particulates having a size ≥10 μm from a first product that includes at least a portion of a vaporized portion of the stream; and

a coalescer comprising coalescing elements configured to remove liquid-phase droplets

having a size ≥0.3 μm from the first product.

18. The system of claim 17, wherein the phase separator comprises a knockout drum, a cyclonic device, a vane pack device, a knock-out drum with demister pad, or combination(s) thereof.

19. The system of claim 17, wherein the phase separator and the coalescer are disposed in a single separating unit.

20. The system of any of claims 16 to 19, further comprising a feed preheater coupled to the separation system.

21. The system of any of claims 16 to 20, further comprising a heat exchanger in fluid communication with the depressurization unit, the heat exchanger configured to heat the hydrocarbon stream.

22. The system of any of claims 16 to 21, wherein the coalescing element comprise borosilicate.

23. The system of any of claims 16 to 22, further comprising a bypass system configured to direct the stream from the vaporization unit to the pyrolysis reactor.

24. A system for producing alkenes from alkanes comprising:

a heat exchanger in fluid communication with an alkane stream feed and configured to heat an alkane stream;

a depressurization unit in fluid communication with the heat exchanger and configured to reduce a pressure of the alkane stream;

a vaporizing unit in fluid communication with the depressurization unit and configured to vaporize at least a portion of a non-vapor phase hydrocarbon of the alkane stream;

a separation system in fluid communication with the vaporizing unit, the separation system comprising coalescing elements; and

a pyrolysis reactor in fluid communication with the separation system.