CLAIMS

What is claimed:

1. A process for thermally cracking a hydrocarbon mixture to produce olefins, the process comprising:

   heating a hydrocarbon mixture in a heater to vaporize a portion of the hydrocarbons in the hydrocarbon mixture and form a heated hydrocarbon mixture;

   separating the heated hydrocarbon mixture, in a first separator, into a first vapor fraction and a first liquid fraction;

   heating the first liquid fraction in a convection zone of a pyrolysis reactor to vaporize a portion of the hydrocarbons in the first liquid fraction and form a second heated hydrocarbon mixture;

   separating the second heated hydrocarbon mixture, in a second separator, into a second vapor fraction and a second liquid fraction;

   mixing steam with the first vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a first radiant coil in a radiant zone of the pyrolysis reactor; and

   mixing steam with the second vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a second radiant coil in a radiant zone of the pyrolysis reactor.

2. The process of claim 1, further comprising mixing the first liquid fraction with steam prior to heating the first liquid fraction in the convection zone.

3. The process of claim 1, further comprising feeding steam to at least one of the first and second separators.

4. The process of claim 1, further comprising:

   mixing the second liquid fraction with steam to form a steam/oil mixture;

   heating the steam/oil mixture in the convection zone of the pyrolysis reactor to vaporize a portion of the hydrocarbons in the steam/oil mixture and form a third heated hydrocarbon mixture;

separating the third heated hydrocarbon mixture, in a third separator, into a third vapor fraction and a third liquid fraction;

mixing steam with the third vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a third radiant coil in a radiant zone of the pyrolysis reactor.

5. The process of claim 4, further comprising

withdrawing a portion of a stream steam and using the portion as the steam for mixing with at least one of the hydrocarbon mixture, the first liquid fraction, the first vapor fraction, and the second liquid fraction;

superheating a remaining portion of the steam stream in the convection zone of the pyrolysis reactor; and

feeding the superheated steam to at least one of the first separator, the second separator, and the third separator.

6. The process of claim 5, further comprising using a portion of the superheated steam as the steam form mixing with the third vapor fraction.

7. The process of claim 4, wherein a temperature of a flue gas in the convection zone is higher when heating the second liquid fraction than when heating the first liquid fraction.

8. The process of claim 7, wherein a temperature of the flue gas in the convection zone is higher when superheating the first, second, and third vapor fractions than when heating the second liquid fraction.

9. The process of claim 1, wherein the hydrocarbon mixture comprises a whole crude or a hydrocarbon mixture including hydrocarbons having a normal boiling point of at least 550°C.

10. The process of claim 1, further comprising hydroprocessing the hydrocarbon mixture to reduce a content of at least one of nitrogen, sulfur, metals, and Conradson Carbon in the hydrocarbon mixture.

11. The process of claim 1, further comprising recovering heat from the effluent, condensing at least a portion of the effluent, and/or separating the effluent into one or more fractions.

12. The process of claim 1, wherein, within the convection zone, the third indirect heat exchange coil is disposed at a higher temperature region of the convection zone than the fourth indirect heat exchange coil.

13. A process for thermally cracking a hydrocarbon mixture, comprising hydrocarbons boiling from naphtha range hydrocarbons to hydrocarbons boiling at a temperature greater than 550°C, to produce olefins, the process comprising:

heating a hydrocarbon mixture in a convection zone of a pyrolysis reactor to vaporize a portion of the hydrocarbons in the hydrocarbon mixture and form a heated hydrocarbon mixture;

separating the heated hydrocarbon mixture, in a first separator, into a first vapor fraction comprising naphtha range hydrocarbons and a first liquid fraction;

mixing the first liquid fraction with steam to form a first steam/oil mixture;

heating the first steam/oil mixture in the convection zone of the pyrolysis reactor to vaporize a portion of the hydrocarbons in the first steam/oil mixture and form a second heated hydrocarbon mixture;

separating the second heated hydrocarbon mixture, in a second separator, into a second vapor fraction comprising gas oil range hydrocarbons and a second liquid fraction;

mixing steam with the first vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a first radiant coil in a radiant zone of the pyrolysis reactor; and

mixing steam with the second vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a second radiant coil in a radiant zone of the pyrolysis reactor.

14. The process of claim 13, further comprising feeding steam to at least one of the first and second separators.

15. The process of claim 13, wherein the first separator comprises a flash drum and wherein the second separator comprises a heavy oil processing system tower.

16. The process of claim 13, further comprising:

mixing the second liquid fraction with steam to form a second steam/oil mixture;

heating the second steam/oil mixture in the convection zone of the pyrolysis reactor to vaporize a portion of the hydrocarbons in the first steam/oil mixture and form a third heated hydrocarbon mixture;

separating the third heated hydrocarbon mixture, in a third separator, into a third vapor fraction comprising vacuum gas oil range hydrocarbons and a third liquid fraction;

mixing steam with the third vapor fraction, superheating the resulting mixture in the convection zone, and feeding the superheated mixture to a third radiant coil in a radiant zone of the pyrolysis reactor.

17. The process of claim 16, further comprising feeding steam to at least one of the first, second, and third separators.

18. The process of claim 16, wherein the first separator comprises a flash drum and wherein the third separator comprises a heavy oil processing system tower.

19. The process of claim 16, wherein the third liquid fraction comprises hydrocarbons boiling at a temperature greater than 550°C.

20. The process of claim 13, further comprising contacting a flue gas of the pyrolysis reactor in indirect heat exchange for the superheating of the first vapor fraction / steam mixture prior to contacting the flue gas in indirect heat exchange for the superheating of the second vapor fraction / steam mixture.