CLAIMS

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

   a heater;

   a pyrolysis reactor comprising a radiant zone and a convection zone;

   a first indirect heat exchange coil for heating a hydrocarbon mixture in the heater forming a heated hydrocarbon mixture;

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

   a second indirect heat exchange coil for heating the first liquid fraction in the convection zone forming a second heated hydrocarbon mixture;

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

   a third and fourth indirect heat exchange coils for superheating the first and second vapor fractions, respectively, in the convection zone;

   a first radiant coil in a radiant zone of the pyrolysis reactor for thermally cracking hydrocarbons in the superheated first vapor fraction; and

   a second radiant coil in a radiant zone of the pyrolysis reactor for thermally cracking hydrocarbons in the superheated second vapor fraction.

2. The system of claim 1, further comprising one or more mixing devices for mixing steam with at least one of the hydrocarbon mixture, the heated hydrocarbon mixture, the first vapor fraction, and the first liquid fraction.

3. The system of claim 1, further comprising:

   a fifth indirect heat exchange coil for heating the second liquid fraction in the convection zone forming a third heated hydrocarbon mixture;

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

   a sixth indirect heat exchange coil for superheating the third liquid fraction in the convection zone;

   a third radiant coil in a radiant zone of the pyrolysis reactor for thermally cracking hydrocarbons in the superheated third vapor fraction.

4. The system of claim 3, further comprising a seventh indirect heat exchange coil for superheating steam in the convection zone.

5. The system of claim 4, further comprising one or more mixing devices for mixing superheated steam with at least one of the second vapor fraction and the third vapor fraction.
6. The system of claim 5, further comprising one or more flow conduits for introducing superheated steam to at least one of the first, second, and third separators.
7. The system of claim 6, further comprising one or more coils for heating a process fluid disposed respectively intermediate one or more of the first, second, third, fourth, fifth, sixth, and seventh indirect heat exchange coils.
8. The system 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.
9. A system for cracking a hydrocarbon mixture to form olefins, the system comprising:
   a first heater comprising a radiant zone and a convection zone;
   one or more second heaters comprising a radiant zone and a convection zone;
   a first heating coil disposed in the convection zone of the first heater for partially vaporizing a mixed hydrocarbon feed;
   a first separation system for separating the partially vaporized mixed hydrocarbon feed into a first vapor fraction and a first liquid fraction;
   a second heating coil disposed in the convection zone of the first heater for partially vaporizing the first liquid fraction;
   a second separation system for separating the partially vaporized first liquid fraction into a second vapor fraction and a second liquid fraction;
   a third heating coil disposed in the convection zone of the first heater for partially vaporizing the second liquid fraction;
   a third separation system for separating the partially vaporized second liquid fraction into a third vapor fraction and a third liquid fraction;
   a first radiant coil disposed in the radiant zone of one of the one or more second heaters for cracking the first vapor fraction to form olefins; and
   a second radiant coil disposed in the radiant zone of one of the one or more second heaters for cracking the second vapor fraction to form olefins.
10. The system of claim 9, further comprising a fourth heating coil disposed in the convection zone of one of the one or more second heaters for superheating one or more of the first, second, and third vapor fractions.

11. The system of claim 10, further comprising a fifth heating coil disposed in the convection zone of the first heater or one or more second heaters for superheating steam.

12. A process, comprising:

generating a first flue gas in a first heater;

generating a second flue gas in a second heater;

recovering heat from the first flue gas in a convection zone of the first heater, thereby cooling the first flue gas;

recovering heat from the second flue gas in a convection zone of the second heater, thereby cooling the second flue gas;

combining the cooled first and second flue gases to form a combined flue gas stream; and

recovering heat from the combined flue gas stream.