CLAIMS

1. A process for reducing coke formation during hydrocarbon upgrading reactions using a double-wall reactor, the process comprising the steps of:

feeding a heated feed water to a shell-side volume of the double-wall reactor to produce a heat transfer stream, the double-wall reactor comprising:

an exterior wall and an interior wall, the exterior wall and the interior wall defining the shell-side volume disposed between,

a reaction section volume bounded by the interior wall,

a heating element, the heating element adjacent to the exterior wall, wherein the heating element is configured to heat the heat transfer stream to create a hot water return, such that the heat transfer stream is above the critical temperature of water, wherein heat is transferred from the heat transfer stream through the interior wall to the reaction section volume, wherein the hot water return exits the shell-side volume,

wherein the heat transfer stream is at a temperature greater than the critical temperature of water and is at a pressure greater than the critical pressure of water;

feeding the hot water return exiting the shell-side volume of the double-wall reactor through a filter, the filter is configured to remove particulates to form a filtered water stream;

mixing the filtered water stream with a heated hydrocarbon feedstock in a mixer to produce a mixed stream, wherein the heated hydrocarbon feedstock is at a pressure greater than the critical pressure of water and at a temperature greater than 50°C;

feeding the mixed stream to the reaction section volume of the double-wall reactor in a flow configuration counter-current to the heat transfer stream to create a reaction flow stream;

reacting the reaction flow stream at a reaction temperature in the reaction section volume to produce a reactor effluent, wherein the heat transferred to the reaction section volume

from the heat transfer stream is operable to maintain the reaction temperature above the critical temperature of water;

cooling the reactor effluent in a reactor cooler to produce a cooled effluent;

de-pressurizing the cooled effluent in a pressure reducer to produce a depressurized effluent;

separating the depressurized effluent in a phase separator to produce a gas phase product and a liquid phase product; and

separating the liquid phase product in a product separator to produce a separated water stream and an upgraded hydrocarbon stream.

2. The process of claim 1, further comprising the step of:

recycling the separated water stream to combine with a feed water upstream of the double-wall reactor.

3. The process of claim 1, wherein the double-wall reactor further comprises:

a shell-side inlet, the shell-side inlet configured to receive the heated feed water;

a shell-side outlet, the shell-side outlet configured to eject the heat transfer stream as the hot water return;

a reaction inlet, the reaction inlet configured to receive the mixed stream; and

a reaction outlet, the reaction outlet configured to eject the reaction flow stream as the reactor effluent,

wherein the shell-side inlet, the shell-side outlet, the reaction inlet, and the reaction outlet are configured to create the flow configuration counter-current between the heat transfer stream and the reaction flow stream.

4. The process of claim 1, wherein the double-wall reactor further comprises:

baffles extending from the exterior wall into the shell-side volume, the baffles configured to increase heat transfer from the heating element and the exterior wall to the heat transfer stream.

5. The process of claim 1, further comprising the step of:

feeding the hot water return to a mixer pre-heater, the mixer pre-heater configured to increase the temperature of the hot water return to produce a hot mixer feed; and

feeding the hot mixer feed to the filter to produce the filtered water stream.

6. The process of claim 1, further comprising the step of:

feeding the heated feed water to a water super heater, the water super heater configured to increase the temperature of the heated feed water to produce a hot water supply; and

feeding the hot water supply to the shell-side volume of the double-wall reactor.

7. The process of claim 1, further comprising the steps of:

feeding the reactor effluent to a supercritical water reactor, the supercritical water reactor configured to upgrade hydrocarbons present in the reactor effluent, wherein the temperature of the supercritical water reactor is greater than the critical temperature of water, wherein the pressure of the supercritical water reactor is greater than the critical pressure of water;

reacting the reactor effluent to produce a product stream; and

feeding the product stream to the reactor cooler.

8. The process of claim 1, wherein a liquid yield of the upgraded hydrocarbon is greater than 98% by volume.

9. The process of claim 1, wherein the upgraded hydrocarbon stream has reduced amounts of asphaltene, sulfur, and other impurities relative to the hydrocarbon feedstock.

10. The process of claim 1, wherein a residence time of the reaction flow stream in the double-wall reactor is greater than 10 seconds.