

Claims:

1. An integrated hydrotreating and steam pyrolysis process for the direct processing of crude oil to produce olefinic and aromatic petrochemicals, the process comprising:
 - a. separating the crude oil into light components and heavy components;
 - b. charging the heavy components and hydrogen to a hydroprocessing zone operating under conditions effective to produce a hydroprocessed effluent having a reduced content of contaminants, an increased paraffinicity, reduced Bureau of Mines Correlation Index, and an increased American Petroleum Institute gravity;
 - c. charging the hydroprocessed effluent and steam to a convection section of a steam pyrolysis zone;
 - d. heating the mixture from step (c) and passing it to a vapor-liquid separation section;
 - e. removing from the steam pyrolysis zone a residual portion from the vapor-liquid separation section;
 - f. charging light components from step (a), a light portion from the vapor-liquid separation section, and steam to a pyrolysis section of the steam pyrolysis zone for thermal cracking;
 - g. recovering a mixed product stream from the steam pyrolysis zone;
 - h. separating the thermally cracked mixed product stream;
 - i. purifying hydrogen recovered in step (h) and recycling it to step (b);
 - j. recovering olefins and aromatics from the separated mixed product stream; and
 - k. recovering pyrolysis fuel oil from the separated mixed product stream.

2. The integrated process of claim 1, wherein

step (h) comprises

compressing the thermally cracked mixed product stream with plural compression stages;

subjecting the compressed thermally cracked mixed product stream to caustic treatment to produce a thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

compressing the thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

dehydrating the compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

recovering hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide; and

obtaining olefins and aromatics as in step (j) and pyrolysis fuel oil as in step (k) from the remainder of the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

and

step (i) comprises purifying recovered hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide for recycle to the hydroprocessing zone.

3. The integrated process of claim 2, wherein recovering hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide

and carbon dioxide further comprises separately recovering methane for use as fuel for burners and/or heaters in the thermal cracking step.

4. The integrated process of claim 1 wherein the residual portion from the vapor-liquid separation section is blended with pyrolysis fuel oil recovered in step (k).
5. The integrated process of claim 1 wherein separating the heated hydroprocessed effluent into a vapor fraction and a liquid fraction is with a vapor-liquid separation device based on physical and mechanical separation.
6. The integrated process of claim 5 wherein the vapor-liquid separation device includes
 - a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving the flowing fluid mixture and a curvilinear conduit,
 - a controlled cyclonic section having
 - an inlet adjoined to the pre-rotational element through convergence of the curvilinear conduit and the cyclonic section,
 - a riser section at an upper end of the cyclonic member through which vapors pass;
 - and
 - a liquid collector/settling section through which liquid passes.

7. The integrated process of claim 1, further comprising

separating the hydroprocessing zone reactor effluents in a high pressure separator to recover a gas portion that is cleaned and recycled to the hydroprocessing zone as an additional source of hydrogen, and liquid portion, and

separating the liquid portion from the high pressure separator in a low pressure separator into a gas portion and a liquid portion, wherein the liquid portion from the low pressure separator is the hydroprocessed effluent subjected to thermal cracking and the gas portion from the low pressure separator is combined with the mixed product stream after the steam pyrolysis zone and before separation in step (h).

CLAIMS

1. An integrated hydrotreating and steam pyrolysis process for the direct processing of a crude oil to produce olefinic and aromatic petrochemicals, the process comprising:
 - a. separating the crude oil into light components and heavy components;
 - b. charging the heavy components and hydrogen to a hydroprocessing zone operating under conditions effective to produce a hydroprocessed effluent having a reduced content of contaminants, an increased paraffinicity, reduced Bureau of Mines Correlation Index, and an increased American Petroleum Institute gravity;
 - c. charging hydroprocessed effluent and steam to a convection section of a steam pyrolysis zone for heating;
 - d. separating the heated hydroprocessed effluent into a light fraction and a heavy fraction with a vapor-liquid separation section that includes
 - a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving a flowing fluid mixture and a curvilinear conduit,
 - a controlled cyclonic section having an inlet adjoined to the pre-rotational element through convergence of the curvilinear conduit and the cyclonic section and a riser section at an upper end of the cyclonic member through which the light fraction passes, and
 - a liquid collector/settling section through which the heavy fraction is discharged;
 - e. charging light components from step (a) and at least a portion of the light fraction of the heated hydroprocessed effluent to a pyrolysis section of the steam pyrolysis zone for thermal cracking;

- f. recovering a mixed product stream from the steam pyrolysis zone;
 - g. separating the thermally cracked mixed product stream;
 - h. purifying hydrogen recovered in step (g) and recycling it to step (b);
 - i. recovering olefins and aromatics from the separated mixed product stream; and
 - j. recovering pyrolysis fuel oil from the separated mixed product stream.
2. The integrated process of claim 1, wherein
- step (g) comprises
- compressing the thermally cracked mixed product stream with plural compression stages;
 - subjecting the compressed thermally cracked mixed product stream to caustic treatment to produce a thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;
 - compressing the thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;
 - dehydrating the compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;
 - recovering hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide; and
 - obtaining olefins and aromatics as in step (i) and pyrolysis fuel oil as in step (j) from the remainder of the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;
- and

step (h) comprises purifying recovered hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide for recycle to the hydroprocessing zone.

3. The integrated process of claim 2, wherein recovering hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide further comprises separately recovering methane for use as fuel for burners and/or heaters in the thermal cracking step.
4. The integrated process of claim 1 wherein the heavy fraction from the vapor-liquid separation section is blended with pyrolysis fuel oil recovered in step (j).
5. The integrated process of claim 1, further comprising
separating the hydroprocessing zone reactor effluents in a high pressure separator to recover a gas portion that is cleaned and recycled to the hydroprocessing zone as an additional source of hydrogen, and a liquid portion, and
separating the liquid portion from the high pressure separator in a low pressure separator into a gas portion and a liquid portion, wherein the liquid portion from the low pressure separator is the hydroprocessed effluent subjected to thermal cracking and the gas portion from the low pressure separator is combined with the mixed product stream after the steam pyrolysis zone and before separation in step (g).
6. The integrated process of claim 1, further comprising separating the hydroprocessed effluent from step (b) into a heavy hydroprocessed effluent fraction and a light hydroprocessed

effluent fraction in a hydroprocessed effluent separation zone, wherein the light fraction is the thermal cracking feed to the pyrolysis section in step (e).

7. The integrated process of claim 6, wherein the hydroprocessed effluent separation zone is a flash separation apparatus.

8. The integrated process of claim 6, wherein the hydroprocessed effluent separation zone is a physical or mechanical apparatus for separation of vapors and liquids.

9. The integrated process of claim 6, further comprising blending the separated heavy hydroprocessed effluent fraction with pyrolysis fuel oil recovered in step (j).