Claims:

1. An integrated hydroprocessing, steam pyrolysis and slurry hydroprocessing process for direct conversion of crude oil to produce olefinic and aromatic petrochemicals, the process comprising:

a. hydroprocessing the crude oil and a slurry process product in the presence of hydrogen 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;

b. thermally cracking hydroprocessed effluent in the presence of steam in a steam pyrolysis zone under conditions effective to produce a mixed product stream;

c. processing heavy components derived from one or more of the hydroprocessed effluent, a heated stream within the steam pyrolysis zone, or the mixed product stream, in a slurry hydroprocessing zone to produce slurry intermediate product;

d. conveying the slurry intermediate product to the step of thermally cracking;

e. separating a combined product stream including thermally cracked product and slurry intermediate product;

f. purifying hydrogen recovered in step (e) and recycling it to the step of hydroprocessing; and

g. recovering olefins and aromatics from the separated combined product stream.

2. The integrated process of claim 1, further comprising recovering pyrolysis fuel oil from the combined mixed product stream for use as at least a portion of the heavy components cracked in step (c).

3. The integrated process of claim 1, further comprising separating the hydroprocessed effluent from step (a) into a vapor phase and a liquid phase in a vapor-liquid separation zone, wherein the vapor phase is thermally cracked in step (b), and at least a portion of the liquid phase is processed in step (c).

4. The integrated process of claim 3, wherein the vapor-liquid separation zone is a flash separation apparatus.

5. The integrated process of claim 3, wherein the vapor-liquid separation zone is a physical or mechanical apparatus for separation of vapors and liquids.

6. The integrated process of claim 3, wherein the vapor-liquid separation zone comprises a flash vessel having at its inlet a vapor-liquid separation device including

a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving the hydroprocessed effluent 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 vapors pass,

wherein a bottom portion of the flash vessel serves as a collection and settling zone for the liquid phase prior to passage of all or a portion of said liquid phase to step (c).

7. The integrated process of claim 1, wherein step (b) further comprises

heating hydroprocessed effluent in a convection section of the steam pyrolysis zone,

separating the heated hydroprocessed effluent into a vapor phase and a liquid phase,

passing the vapor phase to a pyrolysis section of the steam pyrolysis zone, and

discharging the liquid phase for use as at least a portion of the heavy components processed in step (c).

8. The integrated process of claim 7 wherein separating the heated hydroprocessed effluent into a vapor phase and a liquid phase is with a vapor-liquid separation device based on physical and mechanical separation.

9. The integrated process of claim 8 wherein separating the heated hydroprocessed effluent into a vapor phase and a liquid phase is with a vapor-liquid separation device that includes

a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving the heated hydroprocessed effluent 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 vapor phase passes;

and

a liquid collector/settling section through which the liquid phase passes prior to conveyance of all or a portion of said liquid phase to step (c).

10. The integrated process of claim 1 wherein

step (e) 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 from the remainder of the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

and

step (f) 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.

11. The integrated process of claim 10, 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.

12. The integrated process of claim 3, further comprising

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

13. The integrated process of claim 7, further comprising

separating the hydroprocessed 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 derived from the high pressure separator into a gas portion and a liquid portion in a low pressure separator, wherein the liquid portion derived from the low pressure separator is the feed to the vapor-liquid separation zone and the gas portion derived

from the low pressure separator is combined with the combined product stream after the steam pyrolysis zone and before separation in step (e).

The invention claimed is:

1. An integrated hydroprocessing, steam pyrolysis and slurry hydroprocessing process for direct conversion of crude oil to produce olefinic and aromatic petrochemicals, the process comprising:

a. hydroprocessing the crude oil in the presence of hydrogen 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;

b. thermally cracking hydroprocessed effluent and a slurry process product in the presence of steam in a steam pyrolysis zone under conditions effective to produce a mixed product stream;

c. processing residuals or bottoms derived from one or more of the hydroprocessed effluent, a heated stream within the steam pyrolysis zone, or the mixed product stream, in a slurry hydroprocessing zone to produce the slurry process product;

d. separating the mixed product stream;

e. purifying hydrogen recovered in step (d) and recycling it to the step of hydroprocessing; and

f. recovering olefins and aromatics from at least a portion of the separated mixed product stream.

2. The integrated process of claim **1**, further comprising recovering pyrolysis fuel oil from at least a portion of the mixed product stream for use as at least a portion of the residual or bottoms cracked in step (c).

3. The integrated process of claim **1**, further comprising separating the hydroprocessed effluent from step (a) into a vapor phase and a liquid phase in a vapor-liquid separation zone, wherein the vapor phase is thermally cracked in step (b), and at least a portion of the liquid phase is processed in step (c).

4. The integrated process of claim **3**, wherein the vapor-liquid separation zone is a flash separation apparatus.

5. The integrated process of claim **3**, wherein the vapor-liquid separation zone is a physical or mechanical apparatus for separation of vapors and liquids.

6. The integrated process of claim 3, wherein the vapor-liquid separation zone comprises a flash vessel having at its inlet a vapor-liquid separation device including

a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving the hydroprocessed effluent 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 vapors pass,

wherein a bottom portion of the flash vessel serves as a collection and settling zone for the liquid phase prior to passage of all or a portion of said liquid phase to step (c).

7. The integrated process of claim 3, further comprising

separating the hydroprocessed 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 derived from the high pressure separator into a gas portion and a liquid portion in a low pressure separator, wherein the liquid portion derived from the low pressure separator is the feed to the vapor-liquid separation zone and the gas portion derived from the low pressure separator is combined with the combined product stream after the steam pyrolysis zone and before separation in step (d).

8. The integrated process of claim 1, wherein step (b) further comprises heating hydroprocessed effluent in a convection section of the steam pyrolysis zone, separating the heated hydroprocessed effluent into a vapor phase and a liquid phase, passing the vapor phase to a pyrolysis section of the steam pyrolysis zone, and discharging the liquid phase for use as at least a portion of the residuals or bottoms processed in step (c).

9. The integrated process of claim 8 wherein separating the heated hydroprocessed effluent into a vapor phase and a liquid phase is with a vapor-liquid separation device based on physical and mechanical separation.

10. The integrated process of claim 9 wherein separating the heated hydroprocessed effluent into a vapor phase and a liquid phase is with a vapor-liquid separation device that includes

a pre-rotational element having an entry portion and a transition portion, the entry portion having an inlet for receiving the heated hydroprocessed effluent 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 vapor phase passes;

and

a liquid collector/settling section through which the liquid phase passes prior to conveyance of all or a portion of said liquid phase to step (c).

11. The integrated process of claim 1 wherein

step (d) 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 from the remainder of the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide;

and

step (e) 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.

12. The integrated process of claim **11**, 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.

13. The integrated process of claim **1**, further comprising

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