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:

(a1) separating the crude oil into light components and heavy components;

(b1) charging the heavy components to a solvent deasphalting zone with an effective amount of solvent for producing a deasphalted and demetalized oil stream and a bottom asphalt phase; wherein the solvent comprises a pure liquid hydrocarbon such as propane, butanes and pentanes, as well as their mixtures, and wherein deasphalting is a temperature at or below critical point of the solvent; a solvent-to-oil ratio is in the range of from 2: 1 to 50: 1; and pressure is in a range effective to maintain the solvent/feed mixture in the settlers is in the liquid state;

(c1) charging the deasphalted and demetalized oil stream and hydrogen to a hydroprocessing zone operating under conditions effective to produce a hydroprocessed effluent reduced having a reduced content of contaminants, an increased paraffinicity, reduced Bureau of Mines Correlation Index, and an increased American Petroleum Institute gravity, wherein the hydroprocessing zone is operated at a temperature in the range of from 300°C to 450°C, a pressure in the range of from 30 bars to 180 bars; and a liquid hour space velocity in the range of from 0.1 h^{-1} to 10 h^{-1};

(d1) thermally cracking the hydroprocessed effluent and the light components in the presence of steam to produce a mixed product stream;

(e1) separating the thermally cracked mixed product stream;

(f1) purifying hydrogen recovered in step (e1) and recycling it to step (c1);

(g1) recovering olefins and aromatics from the separated mixed product stream; and

(h1) recovering a combined stream of pyrolysis fuel oil from the separated mixed product stream and heavy components from step (b1) as a fuel oil blend; wherein the thermal cracking step comprises heating hydroprocessed effluent in a convection section of a steam pyrolysis zone,

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

passing the vapor fraction to a pyrolysis section of a steam pyrolysis zone, and discharging the liquid fraction;

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 (d1);

wherein make-up hydrogen is also provided in step (c1);

wherein the thermal cracking step includes the steps of heating hydroprocessed effluent in a convection section of a steam pyrolysis zone, separating the heated hydroprocessed effluent into a vapor fraction and a liquid fraction, passing the vapor fraction to a pyrolysis section of a steam pyrolysis zone, and discharging the liquid fraction;

wherein the discharged liquid fraction is blended with pyrolysis fuel oil recovered in step (g1);

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;

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;

wherein step (d1) includes the steps of 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 (el) and pyrolysis fuel oil as in step (f1) from the remainder of the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide; and

wherein step (e1) 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;

wherein recovering hydrogen from the dehydrated compressed thermally cracked mixed product stream with a reduced content of hydrogen sulfide and carbon dioxide further includes the step of separately recovering methane for use as fuel for burners and/or heaters in the thermal cracking step.

2. The integrated process of claim 1, wherein the hydroprocessing zone can include one or more beds containing an effective amount of hydrodemetallization catalyst, and one or more beds containing an effective amount of hydroprocessing catalyst having hydrodearomatization, hydrodenitrogenation, hydrodesulfurization and/or hydrocracking functions

3. The integrated process of claim 1, wherein the hydroprocessing zone includes more than two catalyst beds.

4. The integrated process of claim 2, wherein the hydroprocessing zone includes one or more beds containing an effective amount of hydrodemetallization catalyst.

5. The integrated process of claim 2, wherein the hydroprocessing zone includes one or more beds containing an effective amount of hydrodemetallization catalyst one or more beds contain an effective amount of hydroprocessing catalyst having hydrodearomatization, hydrodenitrogenation, hydrodesulfurization and/or hydrocracking functions.

6. The integrated process of claim 1, wherein the hydroprocessing reaction zone includes plurality of reaction vessels each containing one or more catalyst beds of different function.