The resulting concentrated thermally-affected asphaltenes can be successfully processed in an inertial separator such as a centrifugal collector or settling chamber to generate a dry, solid asphaltene by-product.

In another aspect, there is provided an optimized, integrated process for producing a pipeline- or refinery-ready feedstock and a dry thermally-affected asphaltene solid from heavy, high asphaltene feedstock process fluid, said process comprising:

(a) Pre-Heating a process fluid in a heater to a designed temperature;

(b) Moving the pre-heated process fluid to a reactor, and optimally converting asphaltenes in the process fluid within the reactor to produce a first stream of thermally affected asphaltene-rich fraction(s), and a second stream of vapour;

(c) Separating the second stream of vapour into a third stream of non-condensable vapour and a fourth stream of lighter liquid hydrocarbon(s);

(d) Deasphalting the first stream's thermally affected asphaltene-rich fraction with a solvent extraction process into a fifth stream of heavy deasphalted oil (DAO) and a sixth stream of concentrated asphaltene;

(e) Blending the fifth stream's heavy DAO and the fourth stream's liquid hydrocarbon to become the pipeline- or refinery-ready feedstock; and

(f) Separating the sixth stream of concentrated asphaltene in an inertial separation unit into a seventh stream of dry, solid asphaltene, and an eighth stream of solvent for re-use in the process.

In another aspect, there is provided a process for producing pipeline-ready or refinery-ready feedstock from heavy hydrocarbons using a high-performance solvent extraction process with high local solvent-to-process fluid ratios yet maintaining low overall solvent-to-process fluid ratios, by first performing mild thermal cracking on the heavy hydrocarbons and then separating asphaltene-rich fractions from a resulting thermally affected fluid so that the high solvent-to-oil ratio portion of the process acts only on those asphaltene-rich fractions, and producing a dry, solid asphaltene as an end-product.

In another aspect, there is provided a process apparatus for processing heavy hydrocarbons to produce pipeline-ready or refinery-ready feedstock, comprising:

a) a process fluid preparation component for mixing heavy hydrocarbon with other substances as required to prepare a process fluid;

b) transport means to move the process fluid to a pre-heater;

c) the pre-heater capable of heating the process fluid to a temperature close to or at a desired operating temperature of a reactor;

d) transport means to move the heated process fluid to the reactor;

e) the reactor having heat exchange means to provide a desired heat flux to the process fluid and maintain the process fluid in-reactor at a substantially uniform desired temperature for a desired residence time;

f) means to provide sweep gas to the process fluid in the reactor;

g) means to remove various produced substances from the reactor at the end of the residence time, those substances comprising at least:

i. non-condensable vapours

ii. light liquid hydrocarbons

iii. thermally-affected asphaltene-rich fractions

h) means to separate non-condensable vapours from light liquid hydrocarbons;

i) transport means to move the thermally affected asphaltene-rich fractions to a solvent extraction processor;

j) the solvent extraction processor, with means to remove extracted products from the thermally affected asphaltene-rich fractions , those products being:

i. deasphalted oils

ii. resins

iii. concentrated dry, solid asphaltenes

k) means to collect the deasphalted oils, resins and the light liquid hydrocarbons in appropriate quantities and blend them together to provide the pipeline-ready or refinery-ready feedstock.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings wherein like reference numerals indicate similar parts throughout the several views, several aspects of the present invention are illustrated by way of example, and not by way of limitation, in detail in the figures, wherein:

Fig. 1 is a process diagram for forming a pipeline transportable hydrocarbon product from a heavy hydrocarbon feedstock; and

Fig. 2 is a process diagram pertaining specifically to a cracking process and liquid separation process and a solids separation process; and

FIG. 3 depicts an illustrative application of an integrated mild thermal cracking and improved solvent deasphalting process with appropriately placed shear mixing devices within an existing upgrader or refinery with a vacuum and/or coking unit according to one or more embodiments described.

FIG. 4 depicts a specific illustrative application from FIG. 3 of an integrated mild thermal cracking and improved solvent deasphalting process fed a vacuum bottoms stream from an existing upgrader or refinery with the various products from the integrated cracker/SDA sent to hydrocracking, residual hydrocracking and gasification units according to one or more embodiments described.