It is therefore an object of the present invention to be able to control the heat release of reactive liquid feedstocks, in particular liquid oils, such as HTL oils or pyrolysis oils, particularly after their stabilization in a stabilization reactor.

It is another object of the present invention to reduce the need of using recycling streams for controlling the heat release of reactive liquid feedstocks, in particular liquid oils, such as HTL oils or pyrolysis oils, particularly after their stabilization in a stabilization reactor.

These and other objects are solved by the present invention.

Summary

In a first aspect of the present disclosure, there is provided a process for hydrotreating a liquid oil feedstock stream comprising the steps of:

i) conducting the liquid oil feedstock stream to a stabilization step by reacting the liquid oil stream with hydrogen in the presence of a catalyst for producing a stabilized composition, and separating therefrom:

- a stabilized stream comprising a gas phase, and
- a stabilized liquid oil stream;

ii) providing a main hydrodeoxygenation (HDO) step, comprising:

ii)-1 conducting at least a portion of said stabilized stream comprising a gas phase , or a stabilized feed stream combining at least a portion of said stabilized stream comprising a gas phase and a portion of said stabilized liquid oil stream, to a main hydrodeoxygenation (HDO) step in a first bed active in hydrodeoxygenation (HDO), thereby producing a first main hydrotreated effluent stream;

ii-2) combining at least a portion of said stabilized liquid oil stream with said first main hydrotreated effluent stream, thereby producing a first mixed stabilized gas-liquid oil stream;

ii-3) conducting said first mixed stabilized gas-liquid oil stream to a subsequent bed active in HDO, thereby producing a main hydrotreated effluent stream;

wherein step ii-1) comprises: diverting a portion of said stabilized liquid oil stream from step i) and combining it with a first portion of said stabilized stream comprising a gas phase from step i), thus forming a stabilized gas-liquid stream; preheating said stabilized gas-liquid stream and combining it with a second portion of said stabilized stream comprising a gas phase from step i), for forming said stabilized feed stream.

In another aspect of the present disclosure, there is provided a plant for carrying out the process according to any of claims 1-14, comprising:

- a stabilization reactor arranged to receive a liquid oil feed stream and withdraw:
  - a stabilized stream comprising a gas phase, and
  - a stabilized liquid oil stream;
- a splitting point arranged to divert a portion of said stabilized liquid oil stream;
- a splitting point arranged to divert a first portion of said stabilized stream comprising a gas phase;
- a mixing point, such as a junction, arranged to combine said portion of said stabilized liquid oil stream with said first portion of said stabilized stream comprising a gas phase, and provide a stabilized gas-liquid stream;
- a pre-heater arranged to preheat said stabilized gas-liquid stream, and provide a preheated stabilized gas-liquid stream;
- a mixing point, such as junction, arranged to combine the preheated stabilized gas-liquid stream with a second portion of said stabilized stream comprising a gas phase, and provide a stabilized feed stream;
- a main hydrodeoxygenation (HDO) reactor comprising a first bed active in HDO which is arranged to receive:
  - at least a portion of said stabilized stream comprising a gas phase, or
  - said stabilized feed stream,

  and withdraw a first main hydrotreated effluent stream;
- a mixing point, arranged to combine at least a portion of said stabilized liquid oil stream with said first main hydrotreated effluent stream, and provide a first mixed stabilized gas-liquid oil stream;
- a subsequent bed active in HDO arranged downstream said first bed active in HDO, in which said subsequent bed active in HDO is arranged to receive said first mixed stabilized gas-liquid oil stream, and withdraw a main hydrotreated effluent stream.

Description

Accordingly, there is provided a process for hydrotreating a liquid oil feedstock stream comprising the steps of:

i) conducting the liquid oil feedstock stream to a stabilization step by reacting the liquid oil stream with hydrogen in the presence of a catalyst for producing a stabilized composition, and separating therefrom:

- a stabilized stream comprising a gas phase, and
- a stabilized liquid oil stream;

ii) providing a main hydrodeoxygenation (HDO) step, comprising:

ii)-1 conducting at least a portion of said stabilized stream comprising a gas phase, or a stabilized feed stream combining at least a portion of said stabilized stream comprising a gas phase and a portion of said stabilized liquid oil stream, to a main hydrodeoxygenation (HDO) step in a first bed active in hydrodeoxygenation (HDO), thereby producing a first main hydrotreated effluent stream;

ii-2) combining at least a portion of said stabilized liquid oil stream with said first main hydrotreated effluent stream, thereby producing a first mixed stabilized gas-liquid oil stream;

ii-3) conducting said first mixed stabilized gas-liquid oil stream to a subsequent bed active in HDO, thereby producing a main hydrotreated effluent stream;

wherein step ii-1) comprises:

CLAIMS

1. Process for hydrotreating a liquid oil feedstock stream comprising the steps of:
i) conducting the liquid oil feedstock stream to a stabilization step by reacting the liquid oil stream with hydrogen in the presence of a catalyst for producing a stabilized composition, and separating therefrom:
- a stabilized stream comprising a gas phase, and
- a stabilized liquid oil stream;
ii) providing a main hydrodeoxygenation (HDO) step, comprising:
ii)-1 conducting at least a portion of said stabilized stream comprising a gas phase , or a stabilized feed stream combining at least a portion of said stabilized stream comprising a gas phase and a portion of said stabilized liquid oil stream, to a main hydrodeoxygenation (HDO) step in a first bed active in hydrodeoxygenation (HDO), thereby producing a first main hydrotreated effluent stream;
ii-2) combining at least a portion of said stabilized liquid oil stream with said first main hydrotreated effluent stream, thereby producing a first mixed stabilized gas-liquid oil stream;
ii-3) conducting said first mixed stabilized gas-liquid oil stream to a subsequent bed active in HDO, thereby producing a main hydrotreated effluent stream;
wherein step ii-1) comprises: diverting a portion of said stabilized liquid oil stream from step i) and combining it with a first portion of said stabilized stream comprising a gas phase from step i), thus forming a stabilized gas-liquid stream; preheating said stabilized gas-liquid stream and combining it with a second portion of said stabilized stream comprising a gas phase from step i), for forming said stabilized feed stream.

2. Process according to claim 1, wherein in step ii-1) said pre-heating of the stabilized gas-liquid stream is conducted by heat exchange with said main hydrotreated effluent stream in a feed/effluent heat exchanger.

3. Process according to any of claims 1-2, comprising: recycling to the stabilization step, a portion of said stabilized liquid oil stream.

4. Process according to any of claims 1-3, wherein the main HDO step is operated in once-through mode.

5. Process according to any of claims 1-4, wherein the split of stabilized liquid oil to the beds active in HDO, which is defined by the proportion of the flow of said stabilized liquid oil stream sent to any of the beds active in HDO, increases from first bed to subsequent bed.

6. Process according to any of claims 1-5, wherein said main HDO step is conducted in at least three beds active in HDO, such as in four beds active in HDO.

7. Process according to any of claims 1-6, wherein said first bed active in HDO is active in removing impurities, i.e. a metal guard bed active in hydrodemetalation (HDM) and/or HDO, for thereby producing said first main hydrotreated effluent stream as a first purified main hydrotreated effluent stream.

8. Process according to any of claims 1-7, wherein said main HDO step is conducted in a single unit.

9. Process according to any of claims 1-8, further comprising conducting said main hydrotreated effluent stream, or a portion thereof, to any of the steps: hydrodewaxing, hydrocracking, isomerization, or hydrodearomatization, for thereby producing a hydroprocessed hydrocarbon product.

10. Process according to claims 7-9, wherein the single unit comprises a one or more metal guard beds active in HDM and/or HDO, one or more beds active in HDO, and one or more beds comprising a catalyst active in hydrodewaxing, hydrocracking, isomerization, or hydrodearomatization.

11. Process according to any of claims 1-10, wherein the stabilization step is conducted at a temperature of 20-240°C, a pressure of 100-200 barg, a liquid hourly space velocity (LHSV) of 0.1-1.1 h^{-1}, and a hydrogen to liquid oil ratio is 1000-6000 NL/L, such as 2000-5000 NL/L, suitably in any of: a fixed bed reactor, a slurry bed reactor, trickle bed reactor, and a fluidized bed reactor.

12. Process according to claim 11, wherein the stabilization step is conducted in a fixed bed reactor, wherein the catalyst is a supported molybdenum (Ni-Mo) based catalyst having a Ni content of 3-5 wt%, Mo content of 15-25 wt%, and optionally also a P content of 1-3 wt%, based on the total weight of the catalyst, suitably wherein the support is selected from alumina, silica, titania and combinations thereof; optionally in combination with a molecular sieve having topology MFI, BEA or FAU.

13. Process according to any of claims 11-12, wherein in the stabilization step, said stabilized composition is separated inside the stabilization reactor into said stabilized gas phase stream and said stabilized liquid oil stream.

14. Process according to any of claims 1-13, comprising a step of: thermal decomposition of a solid renewable feedstock for producing said liquid oil feedstock stream, such as hydrothermal liquefaction or pyrolysis.

15. Plant for carrying out the process according to any of claims 1-14, comprising:
- a stabilization reactor arranged to receive a liquid oil feed stream and withdraw:
    a stabilized stream comprising a gas phase, and
    a stabilized liquid oil stream;
- a splitting point arranged to divert a portion of said stabilized liquid oil stream;
- a splitting point arranged to divert a first portion of said stabilized stream comprising a gas phase;
- a mixing point, such as a junction, arranged to combine said portion of said stabilized liquid oil stream with said first portion of said stabilized stream comprising a gas phase, and provide a stabilized gas-liquid stream;
- a pre-heater arranged to preheat said stabilized gas-liquid stream, and provide a preheated stabilized gas-liquid stream;
- a mixing point, such as junction, arranged to combine the preheated stabilized gas-liquid stream with a second portion of said stabilized stream comprising a gas phase, and provide a stabilized feed stream;
- a main hydrodeoxygenation (HDO) reactor comprising a first bed active in HDO which is arranged to receive:
    at least a portion of said stabilized stream comprising a gas phase, or
    said stabilized feed stream,

and withdraw a first main hydrotreated effluent stream;

- a mixing point, arranged to combine at least a portion of said stabilized liquid oil stream with said first main hydrotreated effluent stream, and provide a first mixed stabilized gas-liquid oil stream;

- a subsequent bed active in HDO arranged downstream said first bed active in HDO, in which said subsequent bed active in HDO is arranged to receive said first mixed stabilized gas-liquid oil stream, and withdraw a main hydrotreated effluent stream.