

Title: Hydroprocessing of bio-crude oil with vegetable and/or fatty material

The present invention relates to a process and plant for hydroprocessing of a bio-crude oil feed produced from the thermal decomposition of a solid feed stream, together with a vegetable and/or fatty material feed.

The co-processing hydrocarbon fuel feeds by combining a fossil fuel feed such as petroleum feed with a vegetable oil feed in hydroprocessing, is well-known. However, bio-crude oils produced by thermal decomposition such as by pyrolysis, hydrothermal liquefaction (HTL) or solvolysis of a solid renewable feed, e.g. lignocellulosic biomass, are generally not miscible with vegetable oils and/or fatty materials including fatty acids, thus co-processing of these feeds in a hydroprocessing step such as hydrodeoxygenation (HDO) has so far been a significant challenge to overcome.

Stummann et al. "Hydrotreatment of Catalytic Fast Pyrolysis Oil to Renewable Fuels", NAM27, The 27th North American Catalysis Society Meeting, May 22-27, 2022 New York, NY, discloses a study where a Catalytic Fast Pyrolysis (CFP) oil is combined with a vegetable oil, here soy oil, in a stirred batch reactor.

Still, Applicant finds that vegetable oil is not miscible with most untreated catalytic pyrolysis oils, hence it is highly difficult to make it work in an industrial hydrotreating reactor. The hydrotreating reactor processing the co-feed will plug after few days when running at industrially relevant conditions.

It has now been found that despite that vegetable oil is not miscible with catalytic and non-catalytic pyrolysis and hydrothermal liquefaction (HTL) bio-crude oil, it is miscible in partly deoxygenated bio-crude oil, e.g. partly deoxygenated catalytic pyrolysis oil, having an oxygen content between 2 and 10 wt% oxygen (O), such as between 2 and 8 wt% O, or between 2 and 7 wt% O.

SUMMARY

In one aspect, the present disclosure relates to a process for producing a hydrocarbon feed, comprising the steps of:

- providing a bio-crude oil feed comprising more than 10 wt% oxygen (O);
- supplying the bio-crude oil feed to a stabilization step in a stabilization reactor for producing a stabilized bio-crude oil feed comprising less O than said bio-crude oil feed;
- supplying the stabilized bio-crude oil feed to a hydrodeoxygenation or deoxygenation (HDO/DO) step in a HDO/DO reactor, for producing a partly deoxygenated bio-crude oil feed comprising 2-10 wt% O and less O than said stabilized bio-crude oil feed;
- providing a vegetable oil and/or a fatty material feed;
- combining the partly deoxygenated bio-crude oil feed with the vegetable oil and/or a fatty material feed, for producing said hydrocarbon feed.

In another aspect, the present disclosure relates to a process for producing a hydrocarbon feed, comprising:

- a hydrothermal liquefaction (HTL) step in a HTL unit, or a solvolysis step in a solvolysis unit, of a solid feed stream for producing a bio-crude oil feed stream comprising no more than 10 wt% O;
- supplying the bio-crude oil feed to a hydrodeoxygenation or deoxygenation (HDO/DO) step in a HDO/DO reactor, for producing a partly upgraded (partly deoxygenated) bio-crude oil feed comprising 2-8 wt% O;
- providing a vegetable oil and/or a fatty material feed;
- combining the partly deoxygenated bio-crude oil feed with the vegetable oil and/or a fatty material feed, optionally further in combination with an additional feed, for producing said hydrocarbon feed;
- the process being absent of a stabilization step in a stabilization reactor prior to supplying the bio-crude oil feed to said HDO/DO step.

In yet another aspect, the present disclosure relates to a plant for conducting the process as described herein, comprising:

- a stabilization reactor arranged to receive a bio-crude oil comprising more than 10 wt% oxygen (O) and provide a stabilized bio-crude oil feed comprising less O than said bio-crude oil feed;
- a hydrodeoxygenation or deoxygenation (HDO/DO) reactor (HDO/DO reactor) arranged to receive said stabilized bio-crude oil feed and provide a partly deoxygenated bio-crude oil feed comprising 2-10 wt% O and less O than said stabilized bio-crude oil feed;

- a conduit providing a vegetable oil and/or a fatty material feed;
- a mixing point for combining the partly deoxygenated bio-crude oil feed with the vegetable oil and/or a fatty material feed, and providing a hydrocarbon feed.

5 In yet another aspect, the present disclosure relates to a plant for conducting the process as described herein, comprising:

- a hydrothermal liquefaction (HTL) unit, or a solvolysis unit, arranged to receive a solid feed stream for producing a bio-crude oil feed stream comprising no more than 10 wt% O;
- 10 - a hydrodeoxygenation or deoxygenation (HDO/DO) reactor (HDO/DO reactor) arranged to receive said bio-crude oil feed stream and provide a partly deoxygenated bio-crude oil feed comprising 2-8 wt% O;
- a conduit providing a vegetable oil and/or a fatty material feed;
- a mixing point for combining the partly deoxygenated bio-crude oil feed with the vegetable oil and/or a fatty material feed, and providing a hydrocarbon feed;
- 15 - the plant further being absent of a stabilization reactor upstream said HDO/DO reactor.

DETAILED DESCRIPTION

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Accordingly, in a first general embodiment according to a first aspect of the invention, there is provided a process for producing a hydrocarbon feed, comprising the steps of:

- providing a bio-crude oil feed comprising more than 10 wt% oxygen (O), for instance up to 70 wt% O or up to 60 wt% O;