Title: A process for hydrotreatment of aromatic nitrogen compounds

The present invention relates to a process for efficient removal of nitrogen from hydrocarbons derived from aromatic feedstocks such as pyrolysis oil.

Liquid products of thermal decomposition (for convenience pyrolysis oil), such as pyrolysis or hydrothermal liquefaction (HTL), of certain raw materials, such as lignocellulosic biomass or certain types of plastics (such as polyamides, polyurethanes) commonly have a high nitrogen content, and the denitrogenation of such products has proven difficult, with only moderate levels of denitrogenation being possible in spite of processes employing severe conditions.

We have now identified a process with a potential for obtaining such desired high denitrogenation, which involves a combination of initial denitrogenation with subsequent dearomatization, based on an analysis indicating that the majority of refractive nitrogen compounds are likely to be aromatic.

The proposed process involves initial hydrotreatment at high temperatures, followed by a second hydrotreatment at conditions shifting thermodynamic equilibrium from aromatic nitrogen-containing compounds to non-aromatic nitrogen-free compounds, such as lower temperatures or after removal of ammonia by washing with water, benefiting from the fact that the thermodynamic equilibrium favors non-aromatic structures at moderate temperatures and that removal of ammonia product favors the reaction forming ammonia.

Summary

In a first aspect of the present disclosure, there is provided a process for conversion of a feedstock originating from thermal decomposition of solids, containing from at least 0.5 wt% nitrogen, at least 2 wt% nitrogen or at least 5 wt% nitrogen and less than 10 wt% or less than 15 wt% nitrogen, comprising the steps of

a. directing the feedstock to contact a material catalytically active in hydrotreatment under active hydrotreatment conditions in the presence of dihydrogen, to provide a hydrotreated intermediate,

b. adjusting one or more conditions of the hydrotreated intermediate stream to active hydrodearomatization conditions where the equilibrium between aromatic nitrogen compounds and non-aromatic nitrogen-free compounds is shifted towards non-aromatic nitrogen-free compounds,

c. directing at least an amount of the hydrotreated intermediate to contact a material catalytically active in hydrodearomatization under said active hydrodearomatization conditions, in the presence of dihydrogen, to provide a further converted intermediate.

In another aspect of the present disclosure, there is provided a pyrolysis oil conversion plant, comprising a first reactor containing a material catalytically active in hydrotreatment, and a second reactor containing a material catalytically active in hydrodearomatization, wherein said second reactor is configured for receiving the outlet from the first reactor, and the pyrolysis oil conversion plant is configured for reducing the inlet temperature to the second reactor, for increasing the pressure before the second reactor or for washing the outlet from the first reactor with an amount of water.

In a further aspect of the present disclosure, there is provided a pyrolysis plant, comprising a pyrolizer, a first reactor containing a material catalytically active in hydrotreatment, and a second reactor containing a material catalytically active in hydrodearomatization, wherein the pyrolizer is configured to provide a pyrolysis oil feedstock to the first reactor, wherein said second reactor is configured for receiving the outlet from the first reactor, and wherein the pyrolysis oil conversion plant is configured for reducing the inlet temperature to the second reactor, for increasing the pressure before the second reactor or for washing the outlet from the first reactor with an amount of water.

Description

As used herein, the term “thermal decomposition” shall for convenience be used broadly for any decomposition process, in which a material is partially decomposed at elevated temperature (typically 250°C to 800°C or even 1000°C), in the presence of substoichiometric amount of oxygen (including no oxygen). The product will typically be a combined liquid and gaseous stream, as well as an amount of solid char. The term shall be construed to include processes known as pyrolysis and hydrothermal liquefaction, both in the presence and absence of a catalyst.