According to the present invention it has now been identified that by recuperating the thermal energy of the effluent in a hot stream of heat exchange medium, the operation of a hydrotreatment process for removal of organically bound halides and nitrogen will be robust. Such a hot stream may be a heat transfer oil, i.e. a liquid oil in a heat exchange circuit or a boiling liquid, typically water, in a pressurized boiler.

WO 2015/050635 relates to a process for hydrotreating and removing halides from a hydrocarbon stream by hydrotreatment. The document is silent on the presence of nitrogen in the reactor effluent stream, and contrary to the present disclosure it explicitly recommends recuperation of heat from the hydrotreated product by heat exchange with chilled water, which is highly likely to cause precipitation of salts, if nitrogen was present.

BRIEF SUMMARY

A broad example of the present disclosure relates to a process for conversion of a hydrocarbonaceous feed, having a feed temperature, to a hydrocarbonaceous effluent, having an effluent temperature, by hydrotreatment, in the presence of a material catalytically active in hydrotreatment and an amount of hydrogen,
wherein said conversion is exothermal and wherein an amount of said effluent will solidify at a solidification temperature above said feed temperature and below said effluent temperature,
and wherein said feed is preheated by heat exchange, utilizing thermal energy from said effluent,
characterized in said heat exchange being mediated by a fluid heat exchange medium being physically separated from said feed and said effluent and having a temperature above said solidification temperature,
with the associated benefit of such a process being highly energy effective, while avoiding solidification in the process lines when hydrotreating feedstocks comprising halides, such as waste plastic or the product from thermal decomposition of waste plastic, other products of thermal decomposition processes, as well as fossil feedstock comprising halides, including kerogenic feeds such as coke oven tar, coal tar or shale oil.

In one aspect of the present disclosure, there is provided a process for conversion of a hydrocarbonaceous feed, having a feed temperature, to a hydrocarbonaceous effluent, having an effluent temperature, by hydrotreatment, in presence of a material catalytically active in hydrotreatment and an amount of hydrogen,
wherein said conversion is exothermal and wherein an amount of said hydrocarbonaceous effluent will solidify at a solidification temperature above said feed temperature and below said effluent temperature,
and wherein said feed is preheated by heat exchange, utilizing thermal energy from said effluent,
characterized in said heat exchange being mediated by a fluid heat exchange medium being physically separated from said feed and said effluent and having a temperature above said solidification temperature.

In another aspect of the present disclosure, there is provided a process for hydro-treating a hydrocarbon stream comprising the process disclosed herein, followed by the step of:
further treating the first liquid phase from said separator unit in order to provide a hydrocarbon product.

In a further aspect of the present disclosure, there is provided a system for hydrotreatment of a hydrocarbon stream comprising

(a) a hydroprocessing reactor containing a material catalytically active in hydroprocessing, said hydroprocessing reactor comprising an inlet for inletting a hydrogen enriched hydrocarbon stream and an outlet for outletting a first product stream,

(b) a feed heat exchanger upstream said hydroprocessing reactor and an effluent heat exchanger downstream said hydroprocessing reactor, being in thermal communication via a heat exchange medium.

In a further example said heat exchange medium is a vapor generated from a liquid when heated by said effluent in a boiler, with the associated benefit of a boiler providing a stable temperature defined by the pressure of the liquid.

In a further example said heat exchange medium is a liquid at the temperature of said effluent with the associated benefit of a liquid heat exchange medium being simpler to handle than a boiling liquid.

In a further example said hydrocarbonaceous feed comprises one or more organically bound halides and organically bound nitrogen and said material catalytically active in hydrotreatment is active in converting organically bound halides and organically bound nitrogen into inorganic halides and ammonia, with the associated benefit of such a process avoiding the risk of solidification of ammonium-halides due to cold spots in the heat exchange circuits.

In a further example said effluent is separated into a first vapor phase and a first liquid phase in a separator unit, and inorganic halides are removed from said first vapor phase by contact with an amount of water, with the associated benefit of providing an intermediate product free of halides.

In a further example the one or more halides comprise chloride, with the associated benefit of such a process being suited to purify e.g. thermal decomposition products of chloride containing plastic waste or salt containing biological material.

In a further example the material catalytically active in converting organically bound halides into inorganic halides is also catalytically active in olefin saturation, with the associated benefit of such a material being able to provide a simpler process for treating olefinic feedstocks, such as waste plastic or products from thermal decomposition of waste plastic, comprising e.g. PVC, other products of thermal decomposition or hydrothermal liquefication processes, kerogenic feeds such as coal tar or shale oil, as well as feed originating from algae lipids, especially when grown in salt water, or other biological feeds comprising hydrocarbons and chloride.

In a further example the material catalytically active in converting organically bound halides into inorganic halides comprises: (i) a group VIII metal, (ii) a group VIB metal,

and (iii) a support, said support comprising one or more of the following: aluminum oxide, silicium oxide, and titanium oxide, with the associated benefit of such materials being cost effective catalysts for hydroprocessing. The catalytic material could e.g. be a nickel molybdenum catalyst on a support or a cobalt-molybdenum catalyst on a support.

In a further example the process is followed by the step of:
further treating the first liquid phase from said separator unit in order to provide a hydrocarbon product, with the associated benefit of such a product being suited for use as a transportation fuel or as an intermediate raw material in chemical processes. Such further treatment may e.g. be hydro-treating, for example including distilling, fractionation, and/or stripping.

In a further example the process is followed by the step of directing the hydrocarbon product to a steam-cracking process, with the associated benefit of providing raw material for petrochemical processes, from e.g. waste products, biological material or low cost resources.

A further example of the disclosure relates to a system for hydrotreatment of a hydrocarbon stream comprising

(a) a hydroprocessing reactor containing a material catalytically active in hydroprocessing, said hydroprocessing reactor comprising an inlet for inletting a hydrogen enriched hydrocarbon stream and an outlet for outletting a first product stream,

(b) a feed heat exchanger upstream said hydroprocessing reactor and an effluent heat exchange downstream said hydroprocessing reactor, being in thermal communication via a heat exchange medium

with the associated benefit of such a system being well suited for treating processes where there is a risk of solidification of the products.

A system disclosed herein wherein said effluent heat exchanger is a boiler, with the associated benefit of a boiler providing a stable temperature defined by the pressure of the liquid.

From 30% or 80% to 90% or 100% of the organic halides in a hydrocarbonaceous feedstock, may be converted to inorganic halides in a hydrocarbon product stream by one example of the disclosure. A similar amount of organic nitrogen is converted to ammonia by one example of the disclosure. The hydrocarbon product is washed with water which binds inorganic halides and ammonia and is separated from the hydrocarbon stream is separated from the hydrocarbon stream. To save energy, it is beneficial to use the heat of the effluent to pre-heat the feed, but inorganic halides and ammonia may react and precipitate as e.g. ammonium chloride if the temperature is too low. A normal feed/effluent heat exchanger may have cool spots where such precipitation may occur, and therefore cooling must be carried in a way avoiding this negative effect.

By the wash with water, the inorganic halides from the hydrocarbon stream are removed from the product. These inorganic halides removed from the hydrocarbon stream are taken away from the system, e.g. by regenerating the wash water by evaporation.

The process of the present disclosure may advantageously be a part of a process for treating a hydrocarbon stream.

In an example, a make-up hydrogen stream is added to the hydrogen rich gas phase prior to the recycling into the hydroprocessing reactor. This is in order to ensure the required hydrogen to be present within the hydroprocessing reactor for the conversion of organic halides into inorganic halides, and possibly also further reactions, such as olefin saturation.

Throughout this text, the term “a material catalytically active in converting organic halides into inorganic halides” is meant to denote catalyst material arranged for and/or suitable for catalyzing the conversion. “Organic halides” are chemical compounds in which one or more carbon atoms are linked by covalent bonds with one or more halogen atoms (fluorine, chlorine, bromine, iodine or astatine – group 17 in current IUPAC terminology). “Inorganic halides” are chemical compounds between a halogen atom and an element or radical that is less electronegative (or more electropositive) than the halogen, to make a fluoride, chloride, bromide, iodide, or astatide compound, with the