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(54) Title: METHOD FOR THE MANUFACTURE OF LIQUID HYDROCARBONS AND PLANT FOR THE MANUFACTURE OF LIQUID HYDROCARBONS

(57) Abstract: The present invention regards a method for obtaining a product having optimum technical characteristics while minimising the consumption of utilities including electricity. A method for the manufacture of liquid hydrocarbons wherein the plastic waste is first subjected to a process of mechanical pressing on a press 1, next it is subjected to drying in a dryer 2, after which the raw material is subjected to a melting process in a melter 3 at a temperature of 120-400 ° C, and the molten raw material is transferred from the melter 3 via a screw conveyor 5 directly to a tubular reactor 6 where a process of primary thermal cracking is run at 380-500°C. In a chamber of a separator 8 a process of separating the liquid phase from the gaseous phase is carried out, and combustible gases, hydrocarbon vapours and wax vapours are subjected to a process of separation in a separator 9 while hydrocarbon product vapours are subjected to a process of condensation and the condensate is separated from the combustible gases in a separator 13, and then stored in a storage tank 14. A plant comprises a mechanical press (1) and a tubular screw conveyor (5) connected to a tubular reactor (6), and a tubular reactor (12) equipped with ceramic insulated electric band heaters (7), whereas situated between the two reactors is a separation chamber (8) connected with a column separator (9).

Method for the manufacture of liquid hydrocarbons and plant for the manufacture of liquid hydrocarbons

The subject of the present invention is a process for the manufacture of liquid hydrocarbons and a plant for the manufacture of liquid hydrocarbons from plastic waste, especially from polyolefin waste.

There are many equipment and methods known for continuous processing of waste plastics, embodied in plants comprising reactors of various construction designs, where the so called cracking process is carried out. As a result of this process, high-molecular polymer chains are broken to form hydrocarbons with boiling points of motor fuels, ie. petrol: 30-200°C, diesel: 200-360°C, and distillates boiling above 360°C; whereas it is possible to achieve total conversion of polymers, obtaining more than 95% of liquid and gaseous hydrocarbon fractions, the remainder having a solid consistency.

Known from the patent specification PL197096 is a system for waste plastics cracking comprising a tubular reactor in the form of at least one tube equipped with a screw mixer adjacent to its wall, said tube connected to an outlet of a gas-solid separator in the form of a separation column. The reactor and the separation column cooperate with a section of continuous reception of solid residue, equipped with a collecting device, adjacent to the sides of the separation column and a screw conveyor that discharges the material into a solid product storage tank. The method for cracking molten plastics is operated with continuous mixing and continuous removal of coke and solids formed in the process from the reaction zone, in a tubular

reactor equipped with a screw mixer. In the tubes of the reactor, molten waste, possibly with a catalyst added, is pumped into the lower part of the tubes and heated to a temperature of 380-450°C and a cracking process is run during which the reaction mass is intensively contacted with the heated walls and, at the same time, coke and solid waste are scraped from reactor walls and conveyed for separation. The separation is carried out at 380-450°C in a separation column, where the vapour phase is separated from the solid phase and simultaneously the residue is subjected to further cracking and the solid material is scraped from the walls and removed from the reaction zone.

Polish patent application No P-388102 discloses a method for the production of high-value hydrocarbon products from plastic waste under an inert gas atmosphere. The waste is continuously fed to an extruder and plastified, followed by depolymerisation in a thermolysis reactor, whereas vapours of the depolymerisation products are directed to a primary separation system. The fractions obtained are subjected to hydrorefining and fed to a secondary separation unit and an additional finishing operations unit. All product fractions are subjected to hydrorefining, catalytic hydrogenation and catalytic hydrodesulphurisation, followed by catalytic dewaxing.

Patent specification PL 196880 discloses a method for waste plastics processing by cracking, said method consisting in that comminuted plastics are fed from a storage bin to a hopper of an extruder or any other equipment that feeds comminuted plastics along with a cracking catalyst, said plastic being fed to the lower part of a reactor where, at a temperature of 380-500°C, the cracking of polymeric chains and the formation of light hydrocarbons occur, which are directed from the reactor to an air cooler from which a vapour-liquid mixture is fed to a separator and a warm

fraction is recycled back to the reactor, and the vapour phase is fed to a water cooler. The vapour phase is fed to a separator where the gas phase is directed to a cracking gas tank, and the liquid fraction is separated in a distillation column into a petrol fraction directed to a petrol tank and fuel oil, also directed to an appropriate tank. The waste plastics cracking reactor has in its upper part a tubular heat exchanger connected to burners supplied with gas or fuel oil, and above the heat exchanger, there is installed a device for monitoring the level of the molten plastic in the reactor.

The description of the invention WO9503375 discloses a method for the processing of waste plastics by cracking, wherein plastics are melted before entering the reactor at a temperature of 400-550°C and a low-boiling fraction recovered by distillation from decomposition products is recycled back to the cracking process in the reactor.

The purpose of the present invention is to develop a method for obtaining a product having optimum technical characteristics while minimising the consumption of utilities including electricity.

The essence of the method for the manufacture of liquid hydrocarbons from waste plastics is that plastic wastes are first subjected to a mechanical compression process in a press, then they undergo a process of drying, after which the raw material is subjected to a process of melting in a melter heated by a gas burner at a temperature of 120-400 ° C, preferably at 220-250°C, and the molten material is transferred via a screw conveyor directly to the tubular reactor where the process of primary thermal cracking is carried out at 380-500°C, preferably at 420-470 ° C, after which in a separator chamber a process of separating the liquid phase from the gaseous phase is carried out, and flammable gases, hydrocarbon vapours and wax vapours are subjected to a process of separation in a separator while hydrocarbon product vapours are subjected to a process of

condensation by cooling with cold air in the chamber and then with cold water in the chamber, after which the condensate is separated from the flammable gases in the separator and then stored in a storage tank, while liquid waxes and solids after exiting the separator are subjected to a secondary cracking process at 380-500°C, preferably 420-470°C, in a reactor, followed by separation in a separator where the liquid waxes obtained are fed to an air cooler, wherefrom they are recycled to melt again in the melter, while the recovered hot air is conveyed to a dryer and solids from the separator are discharged beyond the plant system.

The essence of the plant for the manufacture of liquid hydrocarbons from waste plastic, according to the present invention, is that it is equipped with a mechanical press and has a tubular screw conveyor connected directly to a tubular reactor and a tubular reactor equipped with ceramic insulated electric band heaters with resistance heating element temperature up to 1100°C, preferably 750-900°C, whereas situated between the two reactors is a separation chamber to separate the liquid and the gaseous phase.

An advantage of running the process according to the present invention is that a product having optimal technical characteristics is obtained with reduced utilities consumption including electricity.

A plant to carry out the process according to the present invention features simplicity of design and arrangement of the individual elements of this installation, allowing for reduction of energy consumption, including electricity.

The subject of the present invention is explained in more detail in an exemplary embodiment and in a drawing showing a plant for the manufacture of liquid hydrocarbons from waste plastics, in general view.

Example:

In accordance with the present invention, thermoplastic plastic waste is first subjected to a process of mechanical pressing in a press 1 in order to remove as much water as possible, and then subjected to a drying process with streams of hot air in a dryer 2, after which the raw material is subjected to a process of melting in a melter 3 heated by a gas burner 4 at 120-400 ° C, preferably at a temperature of 220-250°C. Molten raw material is transferred from the melter 3 by a screw conveyor 5 directly to a tubular reactor 6 where the primary cracking process is carried out. Both the screw conveyor 5 and the reactor 6 are equipped with ceramic insulated electrical band heaters 7 with resistance element temperature up to 1100°C, preferably 750 -900°C.

In the reactor 6 the process of thermal cracking is carried out at a temperature of 380-500°C, preferably at 420-470°C. In a separator chamber 8 the process of separation of the liquid phase from the gaseous phase is run, and flammable gases, hydrocarbon vapours and wax vapours are subjected to a process of separation in a separator 9, whereas hydrocarbon product vapours are subjected to a process of condensation by cooling with cold air in chamber 10 and then with cold water in chamber 11, after which the condensate is separated from the combustible gases in separator 13 and then stored in storage tank 14, while liquid waxes and solids after exiting the separator 8 are subjected to the process of secondary cracking at 380-500°C, preferably 420-470 ° C, in the reactor 12 , followed by separation in a separator 15, where liquid waxes obtained are fed to an air cooler 16, wherefrom they are recycled to melt again in the melter 3, and the hot air recovered is routed to the dryer 2, while solid particles from the separator 15 are discharged beyond the plant system.

Patent claims

1. A method for the manufacture of liquid hydrocarbons, carried out under inert gas atmosphere, where plastic waste is comminuted, concentrated, dried, a thermal cracking process is run, gas, liquid and solid phases are separated, characterised in that the plastic waste is first subjected to a process of mechanical pressing on a press 1, next it is subjected to drying in a dryer 2, after which the raw material is subjected to a melting process in a melter 3 heated by a gas burner 4 at a temperature of 120-400 ° C, preferably at 220-250°C, and the molten raw material is transferred from the melter 3 via a screw conveyor 5 directly to a tubular reactor 6 where a process of primary thermal cracking is run at 380-500°C, preferably 420-470 ° C, after which in a chamber of a separator 8 a process of separating the liquid phase from the gaseous phase is carried out, and combustible gases, hydrocarbon vapours and wax vapours are subjected to a process of separation in a separator 9 while hydrocarbon product vapours are subjected to a process of two-stage condensation by cooling with cold air in a chamber 10 and then with cold water in a chamber 11, after which the condensate is separated from the combustible gases in a separator 13 and then stored in a storage tank 14, while liquid waxes and solids after exiting the separator 8 are subjected to a secondary cracking process at 380-500°C, preferably at 420-470°C, in a reactor 12 and then separation in a separator 15 where the liquid waxes obtained are fed to an air cooler 16, wherefrom they are recycled to melt again in the melter 3, while the hot air recovered is conveyed to the dryer 2 and solids from the separator 15 are discharged beyond the plant system.

2. A plant for the manufacture of liquid hydrocarbons from plastic waste, comprising raw material feeders and molten product feeders, a reactor to carry out a cracking process, separators, condensation chambers and units for the removal of contaminants, characterised in that it is equipped with a mechanical press (1) and has a tubular screw conveyor (5) connected directly to a tubular reactor (6), and a tubular reactor (12) equipped with ceramic insulated electric band heaters (7) with resistance heating element temperature up to 1100°C, preferably 750-900°C, whereas situated between the two reactors is a separation chamber (8) to separate the liquid and the gaseous phases.