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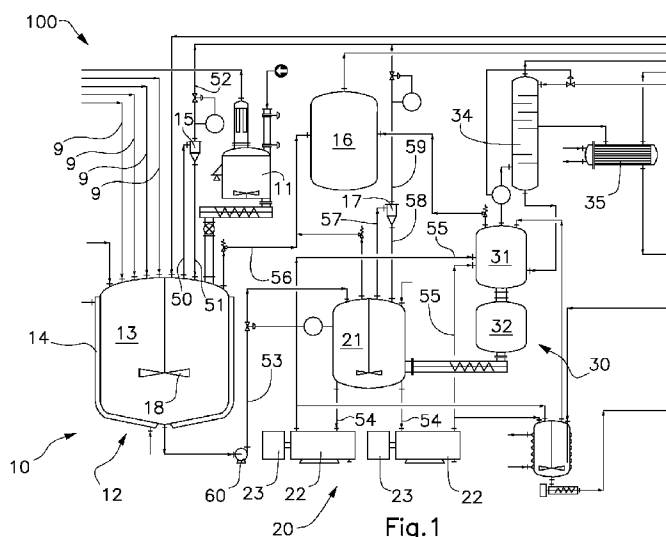
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(54) Title: APPARATUS FOR TREATING WASTE MATERIALS



(57) Abstract: The apparatus for treating waste materials comprises a system for loading an operating fluid, waste materials to be treated, at least one catalysing additive substance and at least one neutralizing additive substance. The mixture of said operating fluid, waste materials and additive substances is heated in a preheating device in order to cause the evaporation of the water contained in the present solid/liquid waste; the water vapour formed is then separated from the residual mixture of the reagents. The mixture is then treated in a reaction unit through conversion of kinetic energy into thermal energy, triggering reactions of catalytic molecular restructuring of the waste materials. The conveyed operating fluid is separated from the water produced in the reaction and recycled. The mixture deriving from the catalytic molecular restructuring, which separates from the operating fluid, is treated to obtain synthetic combustibles from it.

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Description

Title of Invention: APPARATUS FOR TREATING WASTE MATERIALS

Technical Field

Technical Field

The present invention relates to an apparatus for treating waste materials of various typologies, such as urban solid waste and similar.

Background Art

Background Art

It is known that the waste disposal represents a serious issue for the contemporary society. To solve at least partly this problem, various processes have been proposed, suitable to operate the treating of waste materials such as urban solid waste, scrap oils, refinery scraps, plastic materials, refining sludge, animal dejections, digested and biological masses. In particular, at present, some processes are known, which allow to synthesize, starting from these waste materials, fuel products of the type for instance of diesel oil or petrol. These processes provide for feeding the waste to a treatment plant in which they are suitably treated in order to obtain the formation of the desired fuel.

Patent application BO2007A000770 illustrates, in particular, a method for treating waste materials, which provides for initially introducing in a loading system a measured amount of an operating fluid and for subsequently introducing in said measured amount of operating fluid the waste materials to treat in inert atmosphere, at least one catalysing substance and at least one neutralising additive substance. The mixture of said operating fluid, waste materials and additive substances is heated through conversion of kinetic energy into thermal energy, triggering catalytic molecular restructuring reactions of the waste materials. The operating fluid transported by the water vapour is separated from the water present in the solid waste and from the water produced during the reaction, and recycled. The mixture deriving of the catalytic molecular restructuring reactions, which separates from the operating fluid, is treated to obtain synthetic combustibles from it.

The described method allows to operate in effective way the treatment through catalytic molecular restructuring of waste materials, such as in particular urban solid waste, scrap oils, plastic materials and similar, and also agricultural production waste and purification sludge of city waters. Furthermore, the method allows to obtain from this treatment a synthetic combustible conformed to the required specifications, without requiring the continual restoration of the fluidifying substances, in particular of the operating fluid used to fluidize the materials to treat.

Nonetheless, the described method requires to always keep the moisture content of the solid waste to treat, under control. In fact, it has been observed that the water, if present in excessive amount, creates harmful changes to the catalytic restructuring process, which takes place in the plant. More in detail, the water present in the waste evaporates during the reaction processes; this evaporation takes place subtracting heat to the mass of reagents present in the reactor, determining the lowering of the temperature. This temperature drop can cause the slowing-down or the interruption of the catalytic molecular restructuring reactions. In this case, it is necessary to interrupt the process and bring the reagents back to the required temperature for the correct progress of the reactions, with energy consumption.

The described problem is, at present, solved performing a preventive drying treatment of the solid waste materials, before the input in the plant. This drying treatment has the purpose of lowering the moisture content of the waste within compatible values with the correct development of the process. Clearly, the need to perform a pretreatment on the waste in entrance is financially onerous, it slows down the waste disposal. Practically, the use of facilities and manpower to perform the pretreatment of the waste remarkably affects the working costs.

Disclosure of Invention

Disclosure

The aim of the present invention is to overcome the cited drawback by devising an apparatus, which allows to operate in optimum way the treatment of waste materials, avoiding the need to perform the pretreatment of the solid waste in order to reduce the moisture content.

Within this scope, it is a further aim of the claimed invention to reduce the thermal loss and to improve the energy efficiency of processes of known type for the treatment of the waste materials through catalytic molecular restructuring.

Another aim of the present invention is to provide an apparatus for the treatment of waste materials of simple conception, versatile use and of certainly reliable functioning, and also to automatically handle the controls and measurements using electronic means also with remote control.

The cited aims are reached, according to the claimed invention, by the apparatus for the treatment through catalytic molecular restructuring of waste materials according to claim 1.

Description of Drawings

Description details of the invention will be further evident in the illustrations of preferred embodiments of the apparatus that realises the method for the treatment of waste materials according to the invention, illustrated in the guideline drawings

attached, wherein:

Fig. 1 illustrates a schematic representation of part of the claimed apparatus for treating waste materials.

Best Mode

With reference to such figures, 100 refers to the apparatus for treating waste materials through catalytic molecular restructuring for producing synthetic fuel.

The apparatus 100 provides for a fixed structure, not represented, preferably developed on different levels, equipped with a loading system 10 suitable to allow loading waste materials, and other substances involved, in a reactor unit 20.

The loading system 10 comprises in known way a first tank for the containment of an operating fluid, a second tank for the containment of a catalysing substance, a third tank for the containment of a neutralising substance and a fourth tank for the containment of waste oil to treat, not represented. According to the present invention, the above-mentioned tanks are connected through suitable pipes 9 to a preheating device 12.

The preheating device 12 comprises a preheating tank 13 and a heat exchanger device 14. The heat exchanger 14 wraps the external surface of the tank 13 and releases heat to this last one through warm oil circulation. This allows to operate the preheating of the reagents contained inside the tank 13 up to a temperature of about 150° C, as better illustrated below.

Alternatively, it is possible to provide for the exchanger device 14 to be realised through an external appliance. The tank 13 comprises, in its inner part, a mechanical agitator 18. The tank 13 has, in its upper part, a duct 50 for the evacuation of the water vapour, connected with a cyclone separator 15, suitable to separate the vapour stream coming out from the tank 13 from the liquids and solids dragged with the gaseous stream. The lower part of the cyclone 15 is connected with the tank 13 through the duct 51, to allow the recycling of the solid materials and of the liquids separated from the gaseous stream. The upper part of the cyclone 15 is connected through the duct 52 to a suitable condenser device, not illustrated.

The loading system 10 also comprises an insertion unit 11 of the solid material to treat, of known type, placed in connection with the tank 13. The insertion unit 11 of the solids has a mechanical unit suitably protected, served by a feeding member of known type for the insertion of the solid waste in the tank 13. The insertion unit 11 is suitable to insert the solid waste keeping the environment stable through controlled insertion of nitrogen and operating the loading of the solids through a system comprising one or more alternate opening valves. The insertion unit 11 is suitable to be controlled in order to automatically operate from a remote position equipped with PLC, suitably arranged to control the apparatus, not illustrated in the drawing for the sake of

simplicity.

The reactor unit 20 comprises a reaction tank 21, where the stream of substances coming from the tanks of the loading system 10, is piped. The tank 21 is equipped with suitable control and safety means, for the stabilization through nitrogen, and it is placed in connection with the tank 13 through the duct 53, which provides a suitable pumping means 60.

The tank 21 has, in its upper part, a duct 57 for the evacuation of the water vapour, connected with a cyclone separator 17, suitable to separate the vapour stream coming out from the tank 21 from the liquids and solids transported in suspension. The cyclone 17 is connected in the lower part with the tank 21 through the duct 58, and in the upper part through the duct 59 to a suitable condenser device, not illustrated, analogously to cyclone 15.

The reactor unit 20 also comprises one or more reactor members 22 of the centrifugal type, each complete with its own mover 23, a cooling system of the swivelling-support mechanical means, suitable control means of temperature and pressure inside each reactor. In the case illustrated in fig. 1, the reactor unit 20 comprises a first and a second centrifugal reactor 22 connected through respective ducts 54 to the lower part of the reaction tank 21. Preferably the centrifugal reactors 22 are controlled by inverted control devices.

The centrifugal reactors 22 also comprise a mechanical stirrer, operated in rotary motion by the mover 23, which generates a counter-current stream with respect to the motion of the fluid in entrance. This causes the conversion of part of the kinetic energy of the feeding flow into thermal energy and, as consequence, a corresponding increase of the fluid temperature, which allows the trigger of the catalytic molecular restructuring reactions.

This is obtained, in known way, through an asynchronous motor connected with the centrifugal reactor and controlled by an electronic converter that, through a complex vectorial algorithm, allows accelerations from zero to the maximum speed in less than 100 ms and decelerations in less than 80 ms.

The preheating tank 13 is also connected in the upper part, through a safety valve and a discharge pipe 56, to a discharge tank 16 also said 'blow-down', in which, through a further discharge duct, the waste gaseous substance, coming from the safety valve of a separator vessel 31, is suitable to further flow into.

Downstream of the reactor unit 20 a treatment system 30 is arranged, consisting of modules suitable to operate the separation of the final products from the reaction products. The treating system 30, of known type, provides for a separator vessel 31 connected in entrance with the centrifugal reactors 22 through respective inlet ducts 55. The separator vessel 31 is connected, in the lower part, with a recuperation vessel

32 of the liquid substances and in the upper part to a distillation column 34. The recuperation vessel 32 is connected in exit with the reaction tank 21 for the recycling of the liquid substances and, among these, mainly the diathermal oil.

At a substantially central height of the distillation column 34 a lateral outlet is provided for extracting the fluid fraction, which is the desired combustible liquid and which runs through the same distillation column 34. The fluid collected is suitable to be cooled through an exchanger device 35, preferably water-operated, before flowing out into a second separator vessel, not illustrated, preferably a vertical centrifuge, for the mechanical separation water-hydrocarbons. The water coming out from the above-mentioned second mechanical separator flows towards a water-collection tank, while the combustible liquid is suitable to flow out to intermediate storage tanks, in which it is possible to operate the control and verification of the qualitative features.

From the intermediate storage tanks the combustible liquid is suitable to be piped to a central tank through suitable pumping means to feed user means, for instance for generating electric power.

At the top of the distillation column 34, instead, the collection of distilled vapours is provided, that is the light fraction of the fluid which runs through the same distillation column 34. The distilled vapours are suitable to be piped into a condenser device of known type preferably water-cooled, where their condensation is carried out. The liquid condensed in the above-mentioned condenser device is gathered in a decanter tank where the static separation of the water and of the light hydrocarbons in the liquid is carried out. From the decanter tank two separated streams of liquid flow out: one of water towards the water-collection tank and one of light hydrocarbons towards a suitable collection tank. From the water-collection tank the water can be piped through suitable pumping means to purification processes, for instance membrane processes, for a following use. On the other hand, from the collection tank of the light hydrocarbons a liquid flow is suitable to be further collected, as backflow at the head of the column 34.

The treatment system 30 also comprises further devices of known type for the treatment and storage of the process products and fluids, in particular according to the scheme outlined in patent application BO2007A000770.

The functioning of the apparatus that realises the method for treating waste materials through catalytic molecular restructuring is as follows.

In a starting phase, the operating fluid, preferably diathermal oil, is inserted in the preheating tank 13 according to controlled inflow amounts and modalities, for instance in an amount of about 1800 kg at room temperature. Simultaneously, the reactor unit 20 is operated, for instance bringing the centrifugal reactors 22 at an initial speed of 450 rpm, then accelerating them to 1000 rpm and finally up to 1400-1500 rpm.

At this point, waste mineral oil is inserted in the preheating tank 13, preferably without chlorine and diluents, together with the chosen catalysing substance, according to a predetermined mixing percentage. Simultaneously, the waste materials to treat are inserted in the tank 13, both at liquid and solid state, preferably in amounts such as to guarantee the correct reaching of the reaction and production conditions of the combustible liquid, for instance 15-20 kg each minute, continuously.

The solid materials are inserted after eliminating metals, stones, sand, glass and ground materials in a dimension not bigger than 0-3 mm.

It is important to consider that the materials to treat must be inserted in absence of air, being careful that the atmosphere is stabilized. With this purpose, the solid materials are inserted by the the insertion unit 16 in absence of air, thanks to the valve system with alternate opening and to the controlled insertion of nitrogen.

The liquid waste, on the other hand, are inserted in the tank 13 with the aid of a pumping member operating under-head, protected and controlled by a suitable automatic stream-adjustment member.

At the same time, the circulation of hot oil is operated inside the heat exchanger 14. The oil circulating is heated by the waste fumes emitted by motors used for producing electric power. In this way, an effective energy recovery is carried out, limiting at the same time the thermal losses of the plant. The preheating allows to bring the reagents contained inside the tank 13 at a temperature of at least 150° C, determining with this the evaporation of the water contained in them. The water vapour produced in consequence of the preheating is captured by the outlet duct 50, placed at the top of the tank 13, and reaches the cyclone 15, where the solids and liquids dragged by the vapour current are separated through gravity and are recycled in the tank 13 through the duct 51. The vapour coming out from the upper end of the cyclone 15 is sent to a condenser, where the separation of the water in liquid state from the residual incondensable gases, which are recycled in the tank 13, takes place.

The temperature of the mixture inside the centrifugal reactors continues, in the meanwhile, to increase, up to the operating temperature. By controlling the angular velocity of the shaft of centrifugal reactors it is possible to maintain this temperature constant within a relatively small interval, for instance of 2°C.

Once the substances have come out from the treating unit 30, they undergo automatic sample control checks to detect the pH measure. In practice, samples of the mixture are constantly collected in order to verify that in the initial phase of the process the pH does not get close to neutral values, in correspondence of which the activity of the catalysing substance would decrease.

Furthermore, the volume of each treated substance is kept under control, and also the total volume of the mixture inside the tank 13, so that all these values are kept as stable

as possible. Furthermore, devices are provided for controlling the pressure inside the tank 13, which operate its monitoring and stabilisation.

After the insertion in the reactor unit 20, the temperature of the waste material mixture, of the catalysing substance and of the neutralising substance stabilises at around 350° C at a pressure of about 0.5 ÷ 1 bar. The catalysing substance in particular triggers, inside the reactor unit, the chemical reactions that modify the molecules of the materials inserted. These reactions produce gases/vapours of hydrocarbons and water vapour and they develop heat.

From the reactor unit 20 the gas and liquid mixture produced, flows to the separator device 31, inside which an updraft originates, thanks to the low pressure there present, towards the distillation column 34, where the distillation process takes place. In this phase of the process the volume and pressure of the mixture inside the separator vessel 31 are constantly controlled.

In the distillation column 34 initially takes place the separation of the heaviest fractions of the vapours present, extracted in the central area of the column 34, while the lighter fractions come out from the upper part of the column 34 and are inserted through a transport duct in a condenser, where the passage to liquid state takes place. The incondensable gases are suctioned, through respective ducts, by fans and/or vacuum pumps, which maintain the whole circuit in depression, and subsequently inserted in atmosphere after passing through suitable filters, or treated and used with energetic purposes. The product in liquid phase is instead collected at the bottom of the condenser device and discharged in the decanter tank, which generates two liquid currents, one of water that is conveyed towards the collection tank and one of light products, which are in their turn reintroduced at the head of column 34. From the lateral collection of the distillation column 34 the combustible liquid is extracted, which, after being cooled in the exchanger device 35, is then conveyed according to the known method in the second separator vessel for separating oil from the water, to be then collected in the intermediate-storage tanks, where the quality controls and the collection, through pumps, for the following use, are performed.

The collection, control and recycle devices placed downstream of the distillation column 34, allow to obtain an adequate production of synthetic fuel and at the same time to separate the water present in the same fuel, according to the known scheme described in patent application number BO2007A000770. In particular, most of the water is separated at its onset during the process while the remaining amount is separated at the end of the process, according to the known method.

The apparatus claimed by the invention therefore reaches the aim to optimally operate the treatment of waste materials, avoiding the need to operate the pretreatment of solid waste in order to reduce the moisture content. In fact, the separation of the

water contained in the waste takes place through evaporation inside the preheating device 12.

Furthermore, the apparatus allows to reduce the thermal loss and to improve the energetic efficiency of the processes of known type; in fact, the thermal energy needed to operate the preheating is obtained cooling the waste fumes, which are thus adequately emitted in the atmosphere at a lower temperature; furthermore, the preheating allows to reduce the energy consumption of the process, in particular it allows to reduce the electric energy consumption of the agitators inside the reactors 22.

The invention is also a valid and strategic alternative to the heat, pyrolysis or gasification waste-treatment system, allowing the recovery of combustible raw material having diversified and mobile use (electric power and auto-traction), likewise contributing to decrease the atmospheric pollution both during the process, and through the production of particulates (PM 10) low-emission fuel and to fossil fuel energy supply through turning to renewable energy sources.

Materials adopted for the actual realisation of the invention, as well as their shapes and sizes, can be various, depending on the requirements.

Where technical features mentioned in any claims are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

- im 1] Apparatus for treating waste materials through catalytic restructuring , comprising a loading system (10) for the introduction of a determined amount of operating fluid, fresh or salvage, of waste materials to treat in inert atmosphere, of at least one catalysing substance selected among possible catalysing substances according to the materials to treat, and of at least one neutralizing substance; a reactor unit (20) to operate the heating and the mixing of the mixture of said operating fluid, waste material to treat and additives, through the conversion at least partial of kinetic energy of said mixture into thermal energy, in order to trigger reactions of catalytic molecular restructuring of said waste materials to treat; a treatment system (30) comprising recuperation means of said operating fluid from said heated mixture to operate the recirculation of the same operating fluid in said loading system (10), and separation means of the water produced by said reactions of catalytic molecular restructuring; means (34) to treat the mixture of vapours deriving from the separation of said operating fluid, to obtain from it synthetic combustible products **characterized in that** said loading system (10) comprises a preheating device (12) of the mixture of said operating fluid fresh or salvage, waste material to treat and additives, arranged upstream of said reactor unit (20) and suitable to heat said mixture up to a temperature sufficient to cause the evaporation of the water contained therein.
- im 2] Apparatus according to claim 1, **characterized in that** said preheating device (12) comprises a preheating tank (13) suitable to receive said operating fluid, catalysing substance, neutralising substance, waste materials to treat.
- im 3] Apparatus according to claim 2, **characterized in that** said preheating device (12) comprises a heat exchanger device (14), which wraps the external surface of said preheating tank (13).
- im 4] Apparatus according to claim 2, **characterized in that** said preheating device (12) comprises a heat exchanger device (14) external to said preheating tank (13).
- im 5] Apparatus according to claims 3 or 4, **characterized in that** said heating exchanger device (14) is suitable to give thermal energy to said preheating tank (13) through the circulation of oil previously heated by the fumes emitted by the same apparatus (100) and by its accessory

members.

.im 6] Apparatus according to claim 1, **characterized in that** said preheating device (12) comprises a duct (50) for extracting the water vapour produced during the functioning of the same preheating device (12), connected to the upper part of said preheating tank (13), suitable to allow the removal of the water separated through evaporation from the waste to treat contained in the mixture of reagents.

.im 7] Apparatus according to claim 6, **characterized in that** said preheating device (12) comprises a cyclone separator (15), connected to said extraction duct (50), suitable to separate the residual solids and liquids dragged by the water-vapour flow coming out from said tank (13); a duct (51) suitable to allow the recirculation of solids and liquids separated at the bottom of the cyclone separator (15) to said tank (13); a duct (52) suitable to allow sending the vapour separated in the upper part of said cyclone separator (15) to a condenser.

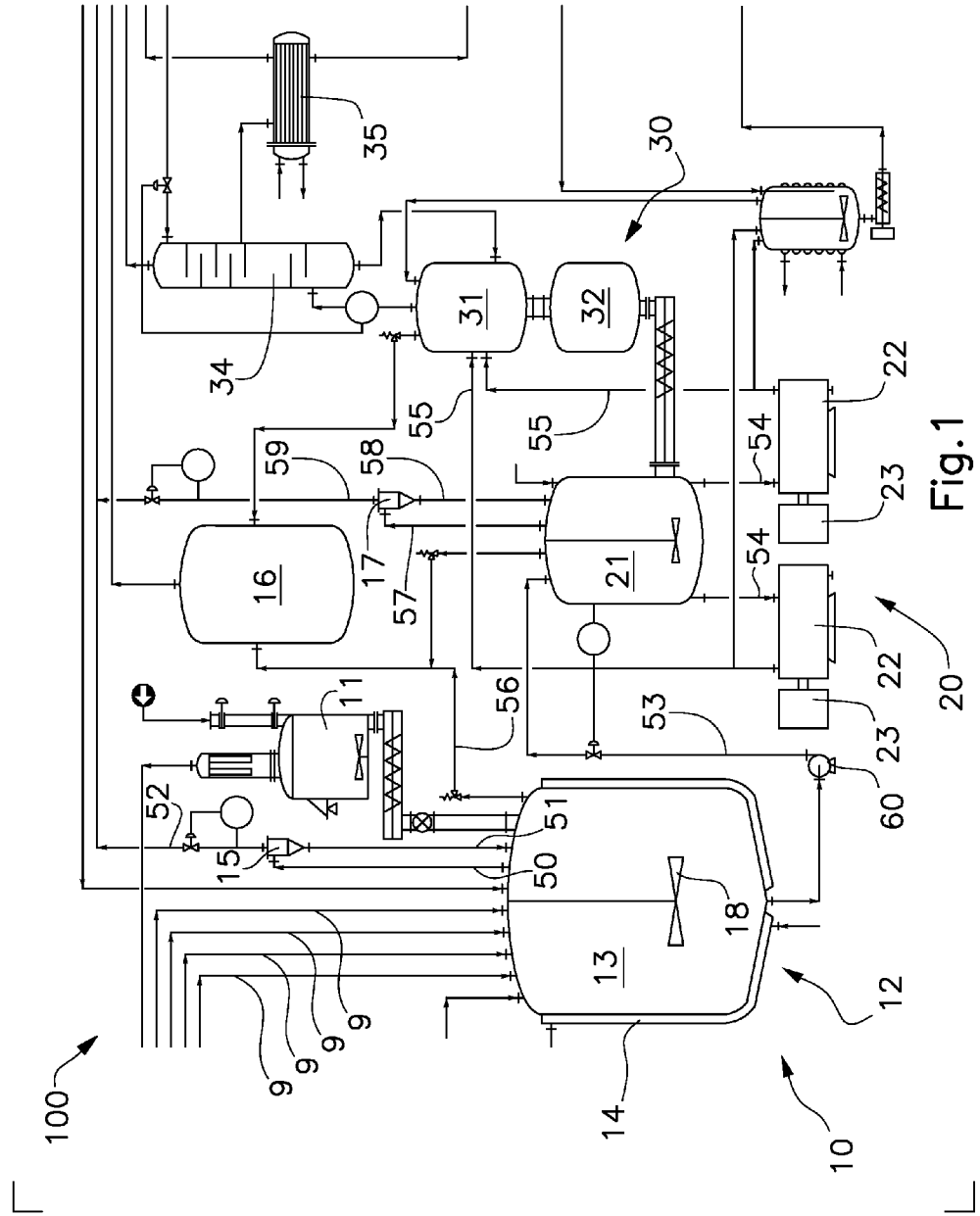


Fig.1