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(54) Titre : PROCEDE ET DISPOSITIF PERMETTANT D'ENLEVER LES PRODUITS DE RECUPERATION ET LES DECHETS

(54) Title: METHOD AND DEVICE FOR REMOVING RECOVERABLE WASTE PRODUCTS AND NON-RECOVERABLE WASTE PRODUCTS

(57) Abrégé/Abstract:
The invention relates to a method and to a device used in the field of waste management for utilizing recoverable waste products as efficiently as possible. The aim of the invention is to reduce the environmental impact of such a method to a minimum. According to the inventive method, the recoverable waste products and the non-recoverable waste products are introduced from one side into a substantially vertical stationary container and are transported in a continuous and discontinuous manner to the other side of the container. The amount of energy added is 60 to 80 % in the front zone and 20 to 40 % in the other zones. The invention further relates to a device that consists of a tubular stationary container with a shaft that is provided with devices and that extends through the center of the container.

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(54) **Title:** METHOD AND DEVICE FOR REMOVING RECOVERABLE WASTE PRODUCTS AND NON-RECOVERABLE WASTE PRODUCTS

(54) **Bezeichnung:** VERFAHREN UND VORRICHTUNG ZUM BESEITIGEN VON ABPRODUKTEN UND ABFALLSTOFFEN

(57) **Abstract:** The invention relates to a method and to a device used in the field of waste management for utilizing recoverable waste products as efficiently as possible. The aim of the invention is to reduce the environmental impact of such a method to a minimum. According to the inventive method, the recoverable waste products and the non-recoverable waste products are introduced from one side into a substantially vertical stationary container and are transported in a continuous and discontinuous manner to the other side of the container. The amount of energy added is 60 to 80 % in the front zone and 20 to 40 % in the other zones. The invention further relates to a device that consists of a tubular stationary container with a shaft that is provided with devices and that extends through the center of the container.

(57) **Zusammenfassung:** Die Erfindung bezieht sich auf das Gebiet der Abfallwirtschaft und betrifft ein Verfahren und eine Vorrichtung, die Abprodukte einer möglichst umfassenden Verwertung zuführen. Die Aufgabe der Erfindung besteht darin, eine möglichst geringe Umweltbelastung zu erhalten. Gelöst wird die Aufgabe durch ein Verfahren, bei dem die Abprodukte und Abfallstoffe in einen im wesentlichen waagerechten feststehenden Behälter von einer Seite eingebracht und in diesem kontinuierlich und diskontinuierlich zur anderen Seite des Behälters transportiert werden, und der Energieeintrag im vorderen Bereich 60 - 80 % und in den anderen Bereichen 20 - 40 % beträgt. Die Aufgabe wird weiterhin gelöst durch eine Vorrichtung, bestehend aus einem rohrförmigen feststehenden Behälter mit einer mittig durch den Behälter geführten Welle, an der sich Vorrichtungen befinden.

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Method and Device for Removing Recoverable Waste Products and Non-recoverable Waste Products

Technical Field

[0001] The invention relates to the fields of the paper industry, waste management and mechanical engineering and concerns a method and device for removing recoverable waste products and non-recoverable waste products, in particular non-recoverable waste products that occur in the paper industry and are to be utilized as efficiently as possible.

Prior Art

[0002] In the processing of recovered paper in the recycling process, residual matter remains after the elutriation of the mechanical desludging. This residual substances can contain, in varying amounts, concentration and type, clumped paper, cardboard remnants, plastic pieces, wood residues, metal parts, and more besides. As a whole, these residual substances are called rejects. After exiting the elutriation process and, if necessary, after intermediate deposition during which a gravimetric dewatering can occur, these rejects are, in general, deposited at a hazardous waste landfill.

[0003] At this point, these rejects contain an average of 50% water, which can occur as surface water and also as water absorbed in the paper and wood portion.

[0004] Various methods and devices are already known or have been described which include the utilization and, in particular, the thermal treatment of waste, residual substances and rejects.

[0005] A method for the thermal recovery of non-recoverable waste products is known from DE 41 39 512 A1. In this case, the non-recoverable waste products are household refuse, industrial waste containing plastics, paint residue, scrap tires, shredder light material from the recycling of scrap cars, or waste contaminated with oils. According to this method, these non-recoverable waste products are subjected without costly pretreatments to a combination of known processing stages, such as pyrolysis, crushing, classification, gasification and gas cleaning. This method is intended on the one hand to produce a clean gas suitable for versatile material and energy uses, and on the other to yield elutriation-proof, useable or easy to dump purely mineral, solid residue, while at the same time ruling out toxic impact on the environment.

[0006] Furthermore, according to DE 44 41 423 a method and device are known that are used to extract useable gas from waste by means of pyrolysis. With this method, the crushed waste is loaded in a pyrolysis drum sealed gas-tight, in which the pyrolysis gas is produced and the pyrolysis residue is separated. The pyrolysis gas is split into a cracked gas in a gas transformer with the addition of air and in the presence of a red-hot coke bed. The heat necessary for pyrolysis is transferred by a gas in direct contact with the material to be pyrolyzed. A partial stream of this gas is the cracked gas leaving the gas transformer.

[0007] A method for utilizing a starting material is also known from DE 43 34 544. With this method the starting material of polymer or other packing material with or without residual content that can be carbonized or not or pyrolyzed or not, is loaded in a reaction chamber. In this reaction chamber the components that can be carbonized are carbonized and the components that can be pyrolyzed are pyrolyzed, the gases produced being used as energy sources for a firing and the residual substances being taken out for further treatment.

[0008] According to DE 42 09 549 a method is known for the thermal treatment of residual substances, e.g. for the separation and recovery of metal compounds with organic content by means of a combination of pyrolysis and gasification. According to this method, the residual substances are separated in a gas and a solid phase and decomposed by means of pyrolysis at 300 to 700° C. Existing, usable products are separated from the solid phase and the remaining materials, together with the gas phase, are gasified to fuel gas with oxygen-enriched air or oxygen at temperatures > 1300° C.

[0009] Furthermore, a method is known from DE 36 32 105 for removing fissile contaminants from a pyrolysis gas. Accordingly, the pyrolysis gas, which was produced by the pyrolysis of a material containing carbon and/or hydrocarbon, is fed into a reaction chamber together with a gas heated in a plasma generator, and there the contaminants are split off so that the gas can now be supplied directly to the consumer.

[0010] According to DE 38 26 520 A1, a method is also known for the pyrolysis of sewage sludge in an externally heated, fixed reactor with an internally located transport apparatus, in which the pyrolysis, as a controllable process separate in terms of time and location, is carried out in several stages of drying, heating to decomposition temperature, pyrolysis in several temperature ranges and recovery of the pyrolysis residue as fuel.

[0011] The first stage here is dewatering the sewage sludge, the second stage is heating the dried product to 200 - 250° C, the third stage is the thermal decomposition of the sewage sludge to pyrolysis gases and a carbonaceous residue at 251 to 700° C, preferably at 300 - 500° C, and the fourth stage is the combustion of the pyrolysis gases produced and the application of the hot gas to heat the reactor in separate heating zones according to stages 1, 2 and 3.

[0012] Furthermore, a method and a device are known from DE 34 17 620 that are used to produce thermal energy that can be converted into mechanical energy from the incineration of wet waste. The invention assumes that the moisture in wet waste must be removed before it can be incinerated. A heat source for drying the waste here can be the steam that vaporizes from the wet waste, or the other heat source is the flue gas from the incineration plant. The device for implementing this invention comprises a waste drying apparatus with a feed screw, a continually agitating dryer, a second feed screw, a closed and insulated conveyor, an air supply chamber, an air supply plant with a blower and three air preheaters and a thermal energy supply plant for the dryer with a pressurizing apparatus and a supply unit.

[0013] A device for treating materials containing aluminum is furthermore known from DE 42 37 161 A1. This device comprises an indirectly heated rotary kiln with a conveyor arranged inside a gas-tight revolving cylinder, two sluices and a feed hopper and a wire shaking apparatus. The conveyor inside the gas-tight revolving cylinder is a conveyor screw that is used to circulate the product treated.

[0014] Furthermore, a plant is known from DE 195 28 018 A1 for the thermal treatment of materials with organic components, in which a revolving cylinder is arranged essentially concentrically around a shaft and connected to it, inside a housing that can be filled with hot gas.

[0015] According to DE 43 37 421 A1 a multistage, high-temperature incineration of waste products with inert components and a device for carrying out this process are known. In a first stage at first an hypostoichiometric incineration and in the second stage a further incineration is carried out in a closed chamber.

[0016] Maintaining high safety standards is disadvantageous with all of these methods and devices, since the processing stages applied, in particular pyrolysis and gasification, have to be carried out in part with the exclusion of air and at high temperatures.

Representation of the Invention

[0017] The object of the invention is achieve as completely as possible the removal of recoverable waste products and non-recoverable waste products used, using a device that is simpler to use and easier to regulate, while reducing the environmental impact to a minimum.

[0018] The solution according to the invention makes it possible to reclaim recoverable waste products and non-recoverable waste products almost completely in an environmentally friendly way, thereby producing energy that can be used in part for maintaining the process according to the invention. However, it can also be used for other energy-intensive processes.

[0019] The operating principle of the device according to the invention, using the method according to the invention, is as follows.

[0020] Recoverable and non-recoverable waste products from the most varied fields, e.g. from the paper industry (rejects) or from the leather industry, or household waste or hazardous waste are brought in. These products and materials are very inhomogeneous, made up of the most varied inorganic and organic materials, and often compacted together or compressed.
For this reason it is necessary to separate these products and materials. This can be carried out by devices known per se in the form of shredders, rippers or choppers.

[0021] After separating the products and materials, a selection is carried out. This selection focuses in particular on separating metallic from nonmetallic materials. All metallic materials can be fed to another reclamation.

[0022] The recoverable and non- recoverable waste products thus processed are then conveyed to a device for preheating and/or drying.

[0023] The separated and selected and, if necessary, preheated and/or dried material is fed into the tubular container on one of its sides via a feed opening.

[0024] A shaft extends through the middle of the fixed container, which can be cooled or insulated. Devices are located on this shaft for transporting and loosening and mixing the material in the container. By means of the devices on the shaft, the material in the container is transported continuously or discontinuously in the direction of the discharge opening.
The devices on the shaft are advantageously paddles featuring pitched surfaces. These paddles are likewise advantageously attached to the shaft by form-closed keyed joints. This means they

can be easily exchanged.

[0025] The shaft is advantageously embodied in tubular form and located on each face of the container on the outside.

[0026] In the lower area, grates are arranged in the container over its entire length, on which the material is deposited and transported forwards in the direction of the discharge opening. These grates render possible the input of energy through the inflow of heated air from below. While the material is in the container it is charged with energy and thereby pyrolyzed and gasified. The energy input takes place in the start-up process through the direct insertion and impingement of the material with heated air and after the onset of gasification by the partial combustion of the gases produced. The energy input is thereby qualitatively divided. Between 60 and 80% of the energy input is applied to the material in approx. the first quarter of the container. The remaining 20 to 40% of the energy is applied in the remaining three quarters of the container. The energy input takes place via heated air directly on the material.

[0027] At the start of the process a kind of hot bed of red-hot, thermally decomposed recoverable and non-recoverable waste products is produced in this area of the container through the supply of energy, which bed is repeatedly fed by the subsequently delivered, preheated material. A maximum temperature of 600 - 700°C is thereby achieved in the container. This hot bed is likewise transported further in the direction of the discharge opening and subsequently discharged through the sluice-like discharge opening. These solid decomposition products are of a coke-like nature.

[0028] The burning heat in this hot bed is maintained by the subsequent supply of material to be decomposed and by the addition of oxygen or air. A device for the regulated addition of air or oxygen for thermal decomposition is located under the hot bed, advantageously over the entire length of the area.

[0029] Through the controlled and regulated feeding of air or oxygen into the area of the thermal decomposition, a controllable thermal decomposition is achieved that can be regulated very precisely in terms of temperature control by means of the amount of air or oxygen added. The more air or oxygen is added, the higher the temperature in the area of the thermal decomposition of the container.

[0030] According to the invention, thermal decomposition is a controlled process between pyrolysis and incineration of the supplied material.

[0031] However, according to the invention a complete incineration of the supplied material does not occur, since air or oxygen is always added to the process only in hypostoichiometric amounts and the oxygen released in any case is combusted by the open flame arranged in the area.

[0032] It is thereby possible to have to conduct the process under not absolutely gas-tight conditions, which leads to a considerably more cost-effective device. The safety requirements are thereby no longer as high, either.

[0033] After the start of the process, thermal decomposition occurs with the release of energy.

[0034] In the area of the thermal decomposition in the container, regulable temperatures of up to 900 °C are produced and maintained. Advantageously, temperatures are set between 400 and 800 °C.

[0035] In addition to the solid decomposition products comprising mainly carbon, a crude gas with a temperature of 700 - 800 ° C is also produced with thermal decomposition. These are extracted from the container through the discharge opening as an exhaust gas-solids mixture and fed through ducts to a device for cracking the long-chain hydrocarbons and/or a device for the gasification of the solids. In this way the exhaust gases and solids from the container are processed for energy recovery.

[0036] An ignition source is advantageously installed in the tubular container in the area of the discharge opening. This ignition source can be a burner with an open flame or a spiral-wound filament. They are used to burn up any oxygen possibly still existing before the discharge of the exhaust gas-solids mixture from the container.

[0037] Furthermore, a pressure release opening is advantageously installed in the upper area of the tubular container in the area of the discharge opening. This opens when an excess pressure is reached in the tubular container, which, however, does not occur in carrying out the method according to the invention. In the case of breakdowns or damage, the possible occurrence of such an excess pressure in the tubular container can thus be reduced. This pressure release opening can be embodied as a flap or as a weighted safety valve.

Best Way of Implementing the Invention

[0038] The invention is described in greater detail below on the basis of an exemplary embodiment.

[0039] A cylindrical, fixed container with the dimensions: length 8000 mm, interior diameter 1600 mm, features a feed opening in the upper left area, through which opening the preheated material is transported into the container. The container further features a burner opening in the lower left part. A shaft with paddles extends through the center of the container inside over the entire length of the container. This tubular shaft with paddles is powered by a motor that is installed outside the container.

[0040] An inlet for heated air is arranged in the lower area of the container over its entire length. The discharge opening serves to draw off the entire exhaust gas-solids mixture arriving at the end of the container.

[0041] Recoverable and non-recoverable waste products from the paper industry are used which feature the following composition.

Paper and cardboard remnants, clumped, 1.0 to 3.0 cm edge length,

Wood pieces, mechanically broken up, partially fibrous surface, 0.5 to 5 cm edge length,

PE foil and plastic remnants, partially in clumps, up to 10 cm^2,

Rubber pieces, as strips and cords, wound, 0.5 to 3.0 cm,

Fabric remnants, fiberized as pieces, 1 cm^2 to 5 cm^2,

Ferrous metal, as wire pieces, sheet-metal strips and in crushed form shredded, 0.5 to 3 mm edge length or diameter,

Aluminum foil, as pieces or crushed to 2 cm diameter crushed,

Tin plate, beverage cans, crushed.

The gross weight of these products and materials amounts to approx. 0.35 kg/dm^3.

The water content amounts to approx. 40%.

[0042] These products and materials are separated by spiked rollers. The flow rate is 5 t/h. Subsequently, the separated material is treated with a magnet and the selected metal parts removed. Afterwards the material is transported via a conveyor system to a drying tower, where it is heated to approx. 80 °C and the water is removed. The length of time in the drying tower

is approx. 1.5 h.

[0043] Afterwards the dried material is continuously conveyed into the container via conveyer belts and the feed opening, which is embodied as a stuffing screw with a gate valve in the upper left part of the container. In the container, the material is moved by the shaft with paddles in the direction of the discharge opening with a rotational speed of 5 - 7 revolutions/min. The remaining moisture is thus removed.

[0044] An inlet for heated air is located in the lower area of the feed opening under the grates in the container. A burner is positioned in the feed segment which heats the arriving air to the necessary temperature of 600 °C. By the direct impingement of the heated air on the intake material in the first quarter, a hot bed is produced that is fed by the following material and the heat is maintained by the heated air (3.2 m^3/h) and by the beginning partial combustion of the gases produced. The fed material is thermally decomposed and the solid decomposition products in the form of 95 - 98% crystalline carbon, so-called pyrolysis coke, are discharged through the discharge opening together with the exhaust gas and conveyed to a further energy recovery process.

[0045] After the start of the process, temperatures of approx. 700 °C prevail in the area of thermal decomposition. To start the process, the temperature is produced by the inflow of heated air. Afterwards the energy continues to be fed through heated air and through the starting partial combustion of the gases produced. The heated air flows from below through the grate to the material and maintains the necessary temperature in the hotbed up to the discharge opening.

[0046] The exhaust gas-solids mixture produced is conveyed after the container via ducts to a device for cracking the long-chain hydrocarbons and from there transferred to a device for the gasification of the solids. The materials thus subjected to a further energy recovery process can be used as heating gas for other thermal processes. The residual solid has 90% mineral components and can be disposed of as ash.

Claims

1. Method for removing recoverable waste products and non-recoverable waste products, with which the recoverable waste products and non-recoverable waste products are fed into in an essentially horizontally fixed container as material from one side, and in it continuously and discontinuously transported to the other side of the container, with 60 - 80% of the energy input being carried out on the material in the area of the side of the inflow of the material, and the remaining 20 - 40% of the energy being transferred to the material in the other areas of the container, on the other side of the container the entire exhaust gas-solids mixture is discharged from the container and subsequently the exhaust gases and the solids are subjected to an energy recovery process.

2. Method according to claim 1, in which the inserted materials feature a residual moisture of 10%.

3. Method according to claim 1, in which the material is transported continuously at a speed of 18 m/h to the discharge opening.

4. Method according to claim 1, in which an energy input on the material of 70% is carried out in the first quarter of the container.

5. Method according to claim 1, in which in each further quarter of the container an energy input of 10% each is carried out.

6. Method according to claim 1, in which the energy input in the first quarter is carried out by a burner.

7. Method according to claim 1, in which the energy input in the further quarters of the container is carried out by heated air.

8. Method according to claim 1, in which the energy input is carried out at least in the first quarter directly on the material.

9. Method according to claim 1, in which a maximum temperature of 600 -700 °C is implemented in the container to start the process.

10. Method according to claim 1, in which the discharged exhaust gas-solids mixture is fed into a device for cracking the long-chain hydrocarbons after the container.

11. Method according to claim 1, in which after the container the discharged exhaust gas-solids mixture or after the cracking of the long-chain hydrocarbons, the exhaust gas-solids mixture is conveyed to a device for the gasification of the energy components.

12. Method according to claim 1, in which the gasification is carried out with hypostoichiometric air supply.

13. Method according to claim 1, in which the gasification process is regulated via the partial combustion process.

14. Method according to claim 1, in which steam is added to the gasification process.

15. Device for removing recoverable waste products and non-recoverable waste products, comprising a tubular container with a feed opening for the recoverable and non-recoverable waste products as material on one side and with a discharge opening for the exhaust gas-solids mixture on the other side, a shaft arranged centrally through the container on which devices are located and a device for cracking hydrocarbons and/or a device for the gasification of the solids from the container, that are arranged after the discharge opening of the container.

16. Device according to claim 15, in which the tubular container is made of sheet metal in

a double-walled construction.

17. Device according to claim 15, in which the feed opening is arranged as a stuffing screw with a gate valve in the upper front area of the container.

18. Device according to claim 15, in which a burner is arranged in the lower front area of the container.

19. Device according to claim 15, in which the shaft is constructed in tubular form.

20. Device according to claim 15, in which devices to transport the material are installed on the shaft.

21. Device according to claim 20, in which the devices are paddles.

22. Device according to claim 20, in which the paddles feature pitched surfaces.

23. Device according to claim 15, in which the devices are attached to the shaft with keyed joints.

24. Device according to claim 15, in which the shaft is located outside the container.

25. Device according to claim 15, in which grates to collect the material are arranged over the entire length of the container in the lower area.

26. Device according to claim 15, in which a blade-like device is arranged at the discharge opening of the container for discharging the exhaust gas-solids mixture.

27. Device according to claim 15, in which a device for cracking the long-chain hydrocarbons and a device for the gasification of the exhaust gas-solids mixture are arranged after the

container.

28. Device according to claim 27, in which the cracking and the gasification are carried out in one device.

29. Device according to claim 15, in which the tubular container features an ignition source in the area of the discharge opening.

30. Device according to claim 29, in which the ignition source is a burner with an open flame or a spiral-wound filament.

31. Device according to claim 15, in which the tubular container features a pressure release opening in the upper part in the area of the discharge opening.

32. Device according to claim 31, in which the pressure release opening is a flap or a weighted safety valve.

Translator's Note

The terms "Abprodukte" and "Abfallstoffe" are translated in the abstract as "recoverable waste products" and "non-recoverable waste products." Available dictionaries provide instead translations such as "waste materials" without the qualifying adjectives. On the assumption that these are specialized terms preferred by the client, they have been used throughout.