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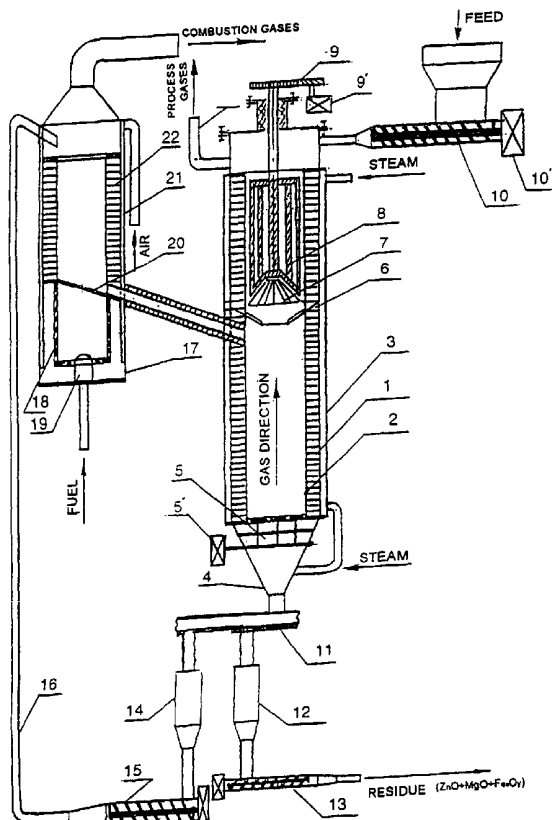
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(54) Title: AN APPARATUS AND PROCESS FOR RECOVERY OF OIL FROM USED TYRES OR WASTES OF ELASTOMERIC PRODUCTS



(57) Abstract: An apparatus and process for recovery of oil from used tyres or wastes of elastomeric products is disclosed. The apparatus comprises a gas generator having a cylindrical housing with an inlet means for charging starting material and an outlet means for process gases; the generator heating means; the internal surface of the gas generator being covered with a flame-resistant material, and the outer surface thereof being enclosed with an air jacket (3). The gas generator with its conical shape lower portion (bottom) (4) of the gas generator is separated from the inside space thereof by means of a partitions (5) connected to a motor (5') by means of a camshaft. The inside space of the gas generator is divided into two portions by a partition (6) above which a fixed partition (7) provided with cuts is disposed. In the upper portion of the generator, a tubular mixer (8) is provided which is connected to a motor (9) by a gearing (9), and is connected to a heating furnace by an inclined conduit.

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AN APPARATUS AND PROCESS FOR RECOVERY OF OIL FROM USED TYRES OR WASTES OF ELASTOMERIC PRODUCTS

Field of the Invention

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The present invention refers to the field of organic chemistry, and, more particularly, to the method and device for obtaining hydrocarbons and other products by pyrolysis of the organic raw materials, in particular, used tyres and elastomeric products.

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Background Art

In the given art, a method for reclaiming carbon black from scrap rubber material is known, which is disclosed in the United States patent specification US 5037628, including the following steps. The scrap rubber material is first pyrolyzed to produce a char material
15 that contains a mixture of agglomerated or cluster particles which consist of agglomerations of finer carbon black particles and unitary grit like particles. The agglomerated particles are then selectively de-agglomerated by agitation of the char material into the finite component particles of carbon black. These finite component particles are then separated from the unitary particles to obtain a final carbon black which
20 is comparable to commercial grade carbon blacks.

Another patent specification US4074979 discloses a thermal decomposition apparatus according which waste material heated in the bottom of a thermal decomposition furnace is vaporized to create gas flow upwardly within the furnace. Cooling means located to have the upwardly flowing gas pass thereacross operates to control the temperature of the gas
25 leaving the furnace through the upper end thereof so that gaseous product having a boiling point above the boiling point induced by the cooling means will condense and fall within the furnace onto tray means located below the cooling means and adapted to receive therein condensed liquid from the cooling means. The tray means include orifice means for enabling upwardly flowing gas to come into contact with the liquid received in the tray
30 means, and downflow tubes for causing liquid within the tray means to flow downwardly to the bottom of the furnace into contact with heating means. Gas flowing upwardly from the heating means passes through the orifice means and into contact with the liquid in the tray means. By adjustment of the temperature of the cooling means above the tray means,

exit gas flow is controlled to prevent clogging of the exhaust portions of the apparatus by solidification of the decomposition product.

In the United States patent US4235676 an apparatus for obtaining hydrocarbons from rubber tyres and from industrial and residential waste. In this apparatus, an elongated
5 tube is maintained at a temperature of about 1100.degree. F. throughout its length. Organic waste material such as shredded rubber automobile tyres or industrial plastic waste or residential trash which preferably has metal and inorganic matter removed therefrom, is moved through the tube at a uniform rate of speed in the absence of air and/or oxygen, with the material being churned or tumbled as by means of a screw conveyor. The vapors and
10 gases which are produced and/or liberated within the tube are quickly removed therefrom by means of a vacuum of from about four inches to about six inches of mercury, with the vapors being condensed and the gases separated therefrom. The char or residue which is a black, powdery, carbon-type material is also recovered.

A process for economically recovering carbon black, oil and fuel gas from vehicle
15 tyres is disclosed in the patent US467443, for either whole tyres or physically fragmented tyres. The tyres are washed to remove dirt and road film. The clean tyres are dried and preheated with super-heat steam. The hot tyres are pyrolyzed to partially devolatilize a major portion of the hydrocarbons and produce a char that can be separated from the steel and fiber glass. The char is subsequently pyrolyzed with microwaves that elevate the tyre
20 temperature and devolatilize the remaining hydrocarbons from the char as gas. The hot gases are cooled and partially condensed. The uncondensed gas is used as fuel. The condensed oil is sent to storage. The solid residue from the tyre pyrolysis is char, fiberglass and steel. The char is mechanically separated from the glass and steel. The char is milled to break down agglomerates and subsequently pelletized and bagged. The steel and glass are
25 discarded as trash.

Process for conveying old rubber tyres into oil and a useful residue is described in the patent US5095040 wherein old rubber tyres are physically shredded and a sized fraction of the shreds is fed into a heated rotating stainless steel tube in which the temperature is carefully controlled so that the shreds are converted to a char and a No. 4 oil
30 product both of which are separately recovered.

A Process for recovering carbon black and hydrocarbons from used tyres is described in the patent US4250158. The invention is a process for economically recovering carbon black, tar, oil and fuel gas from used tyres. Used tyres are physically sliced and

fragmented. The fragments are pyrolyzed in an oxygen-limited, hydrocarbon vapor at subatmospheric pressure while being refluxed with process tar condensate. Vapor phase products of the pyrolysis are fractionated into tar, oil and fuel gas. The fuel gas can be compressed and burnt to provide process heat. Solid phase pyrolysis products are stripped
5 of trash and milled to carbon black in an air swept roller mill. Carbon black is mechanically separated from the effluent air stream of the roller mill and formed into pellets that are dried in a series multi-stage fluid bed dryer.

The united states patent US4983278 discloses a two step retorting process for pyrolyzing a solid feed selected from the group consisting of oil shale, tar sand, waste
10 motor oil, and scrap tyres to recover valuable products therefrom comprising retorting a mixture of the solid feed in heavy oil at a relatively low temperature, recycling the oil formed back to the first step, and completing the pyrolysis of the residue formed at a higher temperature in the absence of product oil recycling. Apparatus is provided including a means for feeding and soaking the solid feed, a HSPR, an IFBC, and means for handling
15 product liquid and gas.

Still another US patent US4284616 discloses a process for economically recovering carbon black, oil and fuel gas from used tyres. Used tyres are physically fragmented. The fragments are pyrolyzed at slightly subatmospheric pressure in a reactor while process char is being recycled to increase heat transfer and avoid coke on heat
20 transfer surfaces. Entrained char is separated from the vapor phase products of the pyrolysis, and the vapor phase products of the pyrolysis are then fractionated into oil and fuel gas. A preferred embodiment condenses reactor vapors in two stages at two temperature levels to separate dust from an oil-dust mixture, without water in the first stage and light oil in the second stage. The fuel gas can be compressed and burnt to provide
25 process heat. The entrained char dust and some heavy oil is returned to the reactor. Solid phase pyrolysis products are stripped of trash and milled to carbon black. Carbon black is mechanically separated from the effluent air stream of the mill and formed into pellets with added water and dried.

Known also are the technologies concerning the methods for processing
30 household and industrial wastes and apparatuses for performing such methods, which are described in the following patents of Russia: RU 93004738; RU 95122647; RU 97100849; and RU 98101334.

In the given art of technology, a reactor for recovering oil (hydrocarbons) by reacting together the used shredded tyres and petroleum products is known. The reactor is equipped with the first inlet means for receiving shredded tyres; second inlet means for receiving petroleum products; and heating means for heating the inside of the reactor to a temperature sufficient to cause a reaction between the shredded tyres and the petroleum product to produce tyre oil; a separating means for separating unreacted components of the shredded tyress from the petroleum product; discharge means for discharging the petroleum product from the reactor; removal means for removing the unreacted components from the reactor, which compreses a substantially horizontal first conduit means affixed to the reactor; a substantially vertical second conduit means connected to the first conduit means; a first screw auger means, having a portion located within the reactor and the remaning portion within the first conduit means, for moving the unreacted components from the reactor through the first conduit to the second conduit, a first motor means being connected to the first screw auger means for driving the first screw auger means, and a second screw auger means being located within the second conduit means for preventing binding of the unreacted components in the reactor, also being connected to the motor means for driving it.

The reactor cemprises also a pair of screens located within the chamber means at a predetermined angle with the vertical, and bottom element connecting to said screens to facilitate the movement of the unreacted components down the screens while the petroleum products pass through the screens.

A method for obtaining oil by reacting tyres with petroleum products which is described in the partenent specification US 5423950 comprises the steps of introducing shredded tyres and oil into the reactor; heating the inside of the reactor to a temperature sufficient to cause a reaction between the shredded tyres and the oil to produce oil, separating unreacted components of the shredded tyres from the reactor and discharging the tyre oil from the reactor, removing the unreacted components from the reactor by using a first screw auger means in a substantially horizontal first conduit means to move the unreacted components from the reactor through the first conduit means and through a substantially vertical second conduit means connected to the first conduit means and containing a second screw auger means.

According to the above described invention, the heat exchange is performed by means of the reactor wall, which substantially decreases the intensity of the process.

Separation of the reaction volume from the atmosphere by means of valves at an elevated temperature is not reliable, the post-pyrolysis remaining products of the starting material come into the direct contact with combusted gases thereby preventing the capability of producing the pure synthesis gas that could be utilized in wide range of industry areas. In addition, along with the combusted gases and reduction gases existing in the atmosphere, 5 impurities obtained from the gas are exhausted into the atmosphere, polluting thereby the environment, and the big quantity of sulphur is remained in coke, being also undesirable in the view of environment protection.

Known also in the art is the method of carbonaceous pyrolysis which comprises the 10 steps of: forming a mixture of the solid feed with heavy product oil; heating the mixture, in a first retorting step, to a first temperature at substantially atmospheric pressure to form light oil, heavy oil, and solid residue; recovering the heavy oil from the residue and recycling the heavy oil to the first retorting step; treating the residue, in a second retorting step in a horizontal screw pyrolysis reactor, at a second temperature at substantially 15 atmospheric pressure, the second temperature being higher than the first temperature, the second retorting step completing pyrolysis of the residue and forming solid residue, product liquid and product gas; and separating the solid residue from the product liquid and product gas and combusting the solid residue in a fluidized bed to form combusted solid residue and flue gas; wherein the hot flue gas downstream of the heavy oil heating step is 20 used to heat air for the combustion step, and the pyrolysis is conducted at the first temperature range of about 400-500° F, and at the second temperature range of about 500-800° F (US 4983278).

The above described invention does not provide for the pyrolysis of any product other than the raw material, which, naturally, causes production of carbon as product 25 requiring specific treatment in addition. The process is carried out at a low temperature allowing for fractioning of heavy hydrocarbons alone and not allowing the process of "deep cracking" to be performed. Removal of the result solid products after the pyrolysis from the reaction zone is conducted by means of screws without performing any cooling step (at the reaction temperature) which causes significant losses of liquid. Use of such 30 reactors is limited in such a technological process where there is need of synthesis of other hydrocarbons apart from the primary products of pyrolysis.

Known also is a method and apparatus for recovering energy of waste classification incineration which is disclosed in the international application published under the

document number WO 9853251. The method and apparatus allows to effectively recovery oil, gas and remainders to use again by a series of processing, such as classify, incineration and recovery. In addition, the method and apparatus can self-sufficiently feedback electric power and heating power needed by the apparatus and successfully reduce the opportunity
5 of seconded pollution taken by the waste processing.

Another international application WO 068338 describes condensation and recovery process of oil from pyrolysis of material containing hydrocarbons such as shredded vehicle tyres. In this process a pair of sequentially positional packed towers to recover at least 95% of the oil contained in the pyrolysis gases is utilized. The first packed
10 tower operates above the dew point of the water vapor in the pyrolysis gases to ensure that no water is condensed and obtain a primary oil fraction having oil with a high flash point of about 60° C or greater and a primary vapor fraction containing additional oils, fuel gases and water vapor. The primary vapor fraction is fed to the second packed tower which operates below the dew point of the water vapor to condense the water and oil having a
15 low flash point of 34° C or below, and provide a secondary vapor fraction containing valuable fuel gases.

Particular attention should be drawn to a known apparatus for the pyrolysis of waste products, which is disclosed in the United States patent US 4084521 and which is comprised of a reactor vessel having an entrance end for receiving the starting material,
20 and a delivery end; a driven feed for driving waste products in the form of cuttings between the entrance and delivery ends; a heating device arranged coaxially around the reactor vessel for heating the waste material cuttings; a charging hopper connected airtightly to the reactor vessel at its entrance end; airtight closures of the hopper; a delivery chamber connecting with the reactor vessel at its delivery end receiving the decomposed
25 products of the waste products; means for keeping the delivery chamber airtightly closed; a delivery closure separating the delivery chamber from the reactor tube means for beassing the delivery closure to its closed position, and a blower, the suction side of which is connected to the delivery chamber to remove gaseous products and maintain both the delivery chamber and reactor vessel at sub-atmospheric pressure.

30 A method for the pyrolysis of waste products which can be carried out by means of the above described apparatus comprises the steps of: disintegrating the waste products into cuttings; drying the cuttings and driving the dried cuttings subsequently through the reactor vessel; heating the cutting as they are being driven from the entrance end to the

delivery end of the reactor vessel up to the temperature sufficient for the decomposition of the cuttings, reactor vessel being maintained at a subatmospheric pressure and, further, airtight and substantially free of oxygen; damming the cutting at the delivery end such that the entire reactor becomes filled with the cuttings being kept compressed at a predetermined dynamic pressure; and passing the decomposition gases and residue of undecomposed cuttings into the delivery chamber where the gases and residue are separately removed, while the delivery chamber is maintained at subatmospheric pressure and substantially oxygen free by the exclusion of air.

The present invention has for its objective to simplify the engineering process and decrease the amount of the heat-transfer medium.

Summary of the Invention

The present invention provides an apparatus for recovery of oil (hydrocarbons) from used tyres and wastes of elastomeric products, which comprises: a cylindrical housing; means for feeding the cut starting material to a gas generator; heating means for heating the gas generator with the starting material contained therein; a feed hopper airtightly connected to the gas generator entrance end; a partition separating the inside portions of the reactor, wherein the internal surface of the gas generator cylindrical housing is covered with the flame-resistant material, and the outer surface of the housing is enclosed by a steam jacket, the cylindrical bottom thereof being separated by a partition formed by the parallel members arranged in a plane perpendicular to the axis of the gas generator, which is oscillable vertically with respect to the axis of the gas generator; and being connected via a vibroseparator to an intermediate hopper connected via a camshaft with a motor having a reduction gear, the internal space of the gas generator being divided by a fixed conical partition into two portions, another fixed partition being disposed over the conical partition, the latter two partitions being provided with cuts parallel to the generating line, the conical surface of which is raised by about 3-5 mm; a mixer is mounted in the upper portion of the gas generator inside space, connected to the motor having the reduction gear, the conical bottom of the gas generator being connected to the vibroseparator connected with the intermediate hoppers, one of the intermediate hoppers being connected to a screw feeder for unloading the waste products, and the another one being connected to a screw feeder for feeding the heat - transfer mediums connected via a

pipeline to a cylindrical furnace for heating the heat - transfer mediums, the upper portion of the furnace internal surface being covered by a flame-resistant material, and the outer surface being provided with air jackets. In the conical cover thereof an outlet for combusted gases is provided. The lower portion of the furnace is a combustion chamber provided with a flame tube and an atomizer and the heating furnace is connected by means of an inclined tube with the gas generator the top of which is provided with an outlet for process gases.

The present invention provides also a method for recovery of oil (hydrocarbons) from used tyres and wastes of elastomeric products, which comprises the steps of disintegrating the waste products into cuttings; heating the cuttings up to the temperature sufficient for the decomposition thereof, wherein the heating step of the cuttings is performed by feeding the heat released by the heat-transfer medium in the heating furnace to the lower portion of the gas generator; and the step of pyrolysis of the starting material located above the partition separating the gas generator starts with production of hydrocarbon vapor and coke, releasing of process gases from the outlet for the hydrocarbon vapors and transferring of the coke to the space under the partition, the starting material is then subject to the gasification and further mixing with the coke heat-transfer medium to improve the heat contact between them, the inorganic components contained in the starting material being separated by means of the screw feeder into the hopper, and the heat-transfer medium accumulated in the intermediate hopper being fed to the upper space of the heating furnace.

Brief Description of the Drawings

Fig. 1 shows diagram of the gas generator according to the present invention;
Fig. 2 shows flow diagram of the engineering process.

Detailed Description of the Preferred Embodiment of the Invention

The gas generator 1 is a cylindrical housing the internal surface of which is covered by a flame-resistant layer (brick) 2, the outer surface of which is enclosed by a vapor jacket 3, the bottom of which has the shape of the cone and is separated from the internal space of the generator by means of a partition 5 consisting of several members parallel to one

another and arranged in the plane which is perpendicular to the axis of the gas generator, and oscillable vertically along the axis, and heaving a contact with a reduction gear motor 5' by means of a camshaft.

The internal space of the gas generator is divided into two portions by means of a fixed conical partition 6 above which another fixed partition 7 is disposed. The partitions 6 and 7 are provided with cuts parallel to the generator line. The cuts have walls raised by about 3-5 mm. In the upper portion of the gas generator, a tubular (hollow) mixer 8 is mounted which is connected with a reduction gear motor 9' by means of a gearing 9.

For feeding the starting material to the gas generator, a screw feeder 10 connected with a reduction gear motor 10' is provided. The conical bottom 4 of the gas generator is connected to a vibrosepartor 11 being with its one end connected to intermediate hoppers 12, 13. The intermediate hopper 12 is connected to a waste separating feeder 14, and the intermediate hopper 13 is connected to a screw feeder 15 for feeding the heat-transfer medium. The screw feeder 15 is connected with a tubular furnace 17 for heating the heat-transfer medium by means of a pipeline 16.

The internal surface of the heating furnace upper portion is covered with a flame-resistant layer 18, and the outer surface thereof is provided with an air jacket 19. The conical roof of the heating furnace 17 is provided with an outlet for combusted gases. The lower portion of the heating furnace 17 is a combustion chamber 20 with a flame tube 21 and an atomizer 22.

The heating furnace 17 is connected with the gas generator having an outlet tube 24 for process gases by means of an inclined tube 23.

In operation of the gas generator: the under-partition 6 space of the gas generator 1 and heating furnace 17 is filled with the heat-transfer medium, e.g. Al_2O_3 , by means of the intermediate hopper 13, and the heat-transfer medium starts to circulate. Then the combustion chamber 20 sets to operate by feeding the fuel into the atomizer 22 and the air into the jacket 19, resulting in ignition of the combustion chamber and starting the heating of the heat-transfer medium up to the temperature of 1000°C . By means of the screw feeder 10, the starting material is fed to the gas generator 1, and, simultaneously, the vapor is entered into the vapor jacket 2 in the upper portion of which, i.e. in the space above the partition 6, pyrolysis process starts resulting in production of hydrocarbons vapor and coke. The production vapor of the hydrocarbons is let through the outlet tube 24 for process gases, and the coke is transported into the under-partition 6 space of the gas

generator wherein the coke is subject to the gasification by the influence of water vapor and conversion thereof, accordingly, into hydrogen (H₂) and carbon oxid (CO). The partition 5 starts 10 to oscilate by means of the reduction gear motor 5' by the frequency of about 0.1-0.3 Hz.

5 As a result of the oscilation the heat-transfer medium and coke are remixed thereby increasing the heat exchange between them. After the gasification step of the coke, the inorganic components contained in the starting material are separated from the heat-tranfer medium by means of the vibroseparator 11 and they are accumulated in the intermediate hopper 13 and, subsequently, fed to the upper space of the heating furnace by means of the
10 screw feeder 15.

The starting material – waste of the rubber of the like products, for the purposes of washing out of mechanical impurities, is subject to the washing just before the treatment process with circulating water. The impurities (grime, crushed stone and the like) accumulate in the settler and are discharged from time to time. The washed material is fed
15 to the cutting tool cutting it in 30-50 mm size peaces.

The cutting step is performed without any preliminary drying process which prevents its overheating and releasing of the volatiles in the course of cutting.

The washed and cut starting material is initially subject to the chemical treatment in the gas generator where it is sequently thermally treated in the pyrolysis and gasification
20 zones and is entyrelly converted into the process gas by acting the water vapor and carbon oxid thereon. The gas generator works on the principle of so called “thermophore-process“, the heat necessary for performing the chemical reactions is entered by means of the preliminarly heated heat-transfer medium. The first stage of the thermal treatment by use of the gasification product gases (hydrogen, carbon oxide and little amount of other
25 admixture gases) is the decomposition pyrolysis performed at the temperature of about 500-900°C. This time the starting material is subject to weathering and the volatile compounds are released therefrom in the form of hydrocarbon vapor. Simultaneously, the thermal cracking caused by basically hydrogen and water vapor takes also place. The resulting solid residue-coke from the weathering of the starting material is subject to the
30 gasification by acting the water vapor thereon at the second stage of the thermal treatment and so called “water-gas” substance i.e. mixture of the hydrogen and carbon oxide is produced.

The process gas obtained from the gas generator is the mixture of hydrogen (H₂), carbon oxide (CO), carbon dioxide (CO₂), sulfur-containing gases (H₂S₁, COS, CS₂, etc), Sodium oxides (N_xO_y), methane (CH₄), hydrocarbon vapors and excessive (unreacted) steam, which is fed to the system for sulfur removal and processing.

5 Apart from the process gas obtained after gasification step, mineral residue is also obtained from the starting material with the amount of about 2-5% by the weight of the starting material. It is a zinc oxide (ZnO), magnesia (MgO) and ferroxides (FexOy), contained in the starting material-rubber for various purposes. They are separated from the gas generator and is manufactured to obtain ready products for use as raw materials in
10 metallurgy.

The part of the gas coming out of the gas generator is cooled together with the combustion products produced in the furnace for heating the heat-transfer medium to be mixed together in a steam utilizer. The cooled combustion gases comprising the products free from the sulfur (CO₂, H₂O, N_xO_y) are exhausted into the atmosphere, and the process
15 gas is mixed with its basic part so as to produce a mixture having temperature of about 300°C and, subsequently, to feed the mixture to the sulfur removal system.

Removal of the sulfur is conducted in two stages: in the first stage, all compounds of the sulfur are subject to hydrogenation in an adiabatic manner in a special reactor to produce hydrogen sulfide, and at the second stage, the hydrogen sulfide is absorbed by
20 means of zinc oxide and nickelic oxide also in special adiabatic reactors. The process gas coming out of the absorbing reactors is substantially free from sulfur as its remaining amount does not exceed 10⁻³%. Regeneration of the absorbing reactors is performed by heated air or steam (at 550°C). The processing of the sulfur is carried out in a special system being operated on synthesized principle of basic plinciples used in conventional
25 "concat" (company under the name "lurg") and "modop" (company under the name "mobile") processes which enable to obtain the sulfur coming into the atmosphere in an amount not exceeding 10⁻⁴% and to minimizo the power consumption. The products being obtained are the elementary sulfur and sulfur acid, both being ready products. After removing the sulfur, the process gas is fed either to a conversion system or a separating
30 column, or to both of them in parts. The valuable products are isolated therefrom in the separation column, e.g. petroleum and diesel fuel, and the remaining products after the separation is fed to the conversion system wherein the components of the process gas are converted into the synthesis gas at the temperature of about 800-900°C by means of steam

onto the special catalyst. The conversion step is performed in a single stage on the recirculation principle, in the course of which the liquid products isolated in the separator are returned back to the conversion reactor. The later reactor, like the gas generator, works by the principle of thermophore-process. The heat of the combusted gases is utilized in the
5 utilizer. The converted gases (free from the liquid produces) are compressed by means of a compressor up to the pressure of about 16-20 atmosphere after cooling in the separator and, subsequently, is cooled in a condenser wherein fraction of hydrocarbon C₃-C (liquid gas) is separated therefrom, the fraction being either manufactured as ready product or returned back to the conversion system.

10 The synthesis gas obtained as a result of the conversion is subject to purification from carbon oxide in an absorption system for removing carbon dioxide (CO₂). The absorption system consists of absorption and desorption columns and heat transfer device by means of absorption using ethanol amine. The removed CO₂ at this stage of processing is fed to the processing system. Purified synthesis gas is divided into two parts, the first
15 part the amount of which depends on the amount of hydrogen in the synthesis gas and the purpose of the synthesis gas being fed to the carbon oxide (CO) conversion system. The conversion system of CO consists of two transfer device, conversion reactor and separator. The conversion reactor operates in an adiabatic manner, and the conversion process is carried out in standard conditions on "ferrum-chromium" catalyst.

20 The converted synthesis gas becomes free from carbon dioxide in a removal system of CO₂ which is similar to the above described one and is an independent system (absorption is carried out using ethanol amine). The liberated CO₂ from this system is fed to the CO₂ processing system wherefrom the obtained synthesis gas is mixed with its basic portion. As a result of the mixing the synthesis gas is obtained wherein the concentrations
25 of carbon oxide (CO) and hydrogen (H₂) is determined by the conditions of further synthesis process. The concentration of impurities therein does not exceed 1% by amount.

The obtained synthesis gas can be used for manufacture of methane, methol alcohol, petrol, hydrogen and other products producable by the standard engineering processes using CO₂ and H₂.

30 In the system of processing of carbon dioxide, preparation of the pure CO₂ (by charging into cylinders) ready products or soda ash takes place. In case of preparation of the aoda ash, the engineering process runs according to the "ammonia" method and necessary raw material is common, sodium salt (along with CO₂). The described method

for processing the carbon dioxide allows to utilize CO₂ in a big amount so that there remains capability to isolate it from the combustion gases.

The described engineering process is an independent process in view of power consumption. Feeding of external fuel is not necessary except in starting regime after which the engineering process runs on the heat developed by its liquid or gaseous fuel. Meantime, the product used as fuel is the product obtained after passing through the sulfur removal system; therefore the combustion products do not contain sulfur compounds and do not affect the atmosphere accordingly.

The total yield of the engineering process is 70% by weight of the organic starting material. This basic indicator enables it to differ substantially from the similar processes (e.g. processes proposed by the company "Coalite"). Moreover, the running principle of the engineering process allows to produce any chemical product (not only fuel) produced by the synthesis performed on the basis of carbon dioxide (CO₂) and hydrogen (H₂). This fact provides it with particular flexibility as it is possible to change to production of that product (by only altering the process regimes) which would have maximum demand in the market. In this point of view, it should be particularly mentioned the possibility of production of methyl alcohol (methanol CH₃OH). The main purpose of the engineering process is to process used automobile tyres. This latter field of applicability makes it especially promising technology as the reutilization of used tyres is one of the most important issues in view of current state of the environment.

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What is claimed is:

1. An apparatus for recovery of oil (hydrocabons) from used tyres or wastes of elastomeric products, comprising:

- 5 a gas generator having a cylindrical housing provided with an inlet means and outlet means;
- a feeding means for feeding cuttings of starting material to said gas generator;
- a heating means for heating said gas generator and the starting material contained therein;
- 10 a charging means for feeding the starting material, said charging means being airtightly connected with said inlet means;
- a partition for dividing the inside space of said reactor;
- characterised in chat
- the internal surface of said cylindrical housing of said gas generator is covered with a flame-resistant material;
- 15 the outer surface of said cylinrical housing is enclosed in a steam jacket;
- the bottom of said gas generator, having a conical shape, is separated by a partition oscillable vertically with respect to the axis of said gas generator;
- said partition being formed by several members arranged in parallel with one another in the plane vertical to the axis of said gas generator;
- 20 said conical shape bottom of said gas generator being connected with an intermediate hopper through a vibroseparator means;
- said intermediate hopper being connected with a motor means;
- the space inside said gas generator is divided into two portions by a first fixed conical partition;
- 25 a second fixed partition being located above said first conical partition;
- said first and second partitions are provided with cuts in parallel to the generator line;
- said cuts of said first and second partitions having a conical surface raised by about 3-5 mm;
- 30 a tubular mixer is mounted in the upper portion of said gas generator;
- said mixer being connected with a motor means;
- said mixer having a conical bottom connected to said vibroseparator connected with said intermediate hopper;

one of said intermediate hoppers being connected with a screw feeder for discharging the residual products;
said another intermediate hopper being connected with a screw feeder for feeding the heat-transfer medium;
5 said screw feeder for feeding the heat-transfer medium, being connected through a pipeline with a cylindrical furnace for heating the heat-transfer medium;
upper portion of the internal surface of said cylindrical furnace being covered with a flame-resistant material, and outer surface of said furnace being enclosed by air jacket;
10 an outlet means for combustion air is provided in the conical cover of said furnace;
the lower portion of said furnace being a combustion chamber provided with a flame tube and atomizer;
said heating furnace being connected with said gas generator through an inclined conduit means;
15 an outlet means for process gases is provided in the upper portion of said gas generator;

2. A process for recovery of oil (hydrocarbons) from used tyres or wastes of elastomeric products, comprising the step of:
20 disintegrating the starting material;
heating the cuttings of said disintegrated starting material up to the temperature sufficient for its decomposition,
characterized in that
said heating step of cuttings of said disintegrated material is performed by feeding the heat
25 released by the heat-transfer medium in a heating furnace to the lower portion of a gas generator;
the starting material contained in the upper space above the partition dividing the gas generator is subject to pyrolysis step resulting in production of hydrocarbon vapor and coke;
30 the hydrocarbon vapors being come out of the outlet for process gases;
the coke is fed to the lower space under said partition and is gasificated therein;
the coke further being remixed with the heat-transfer medium to improve the heat exchange between them;

the inorganic components comprised in the starting material being isolated by means of a separator into an intermediate hopper through a screw feeder;
heat-transfer medium existing in said intermediate hopper being fed to the upper space of said heating furnace.

5

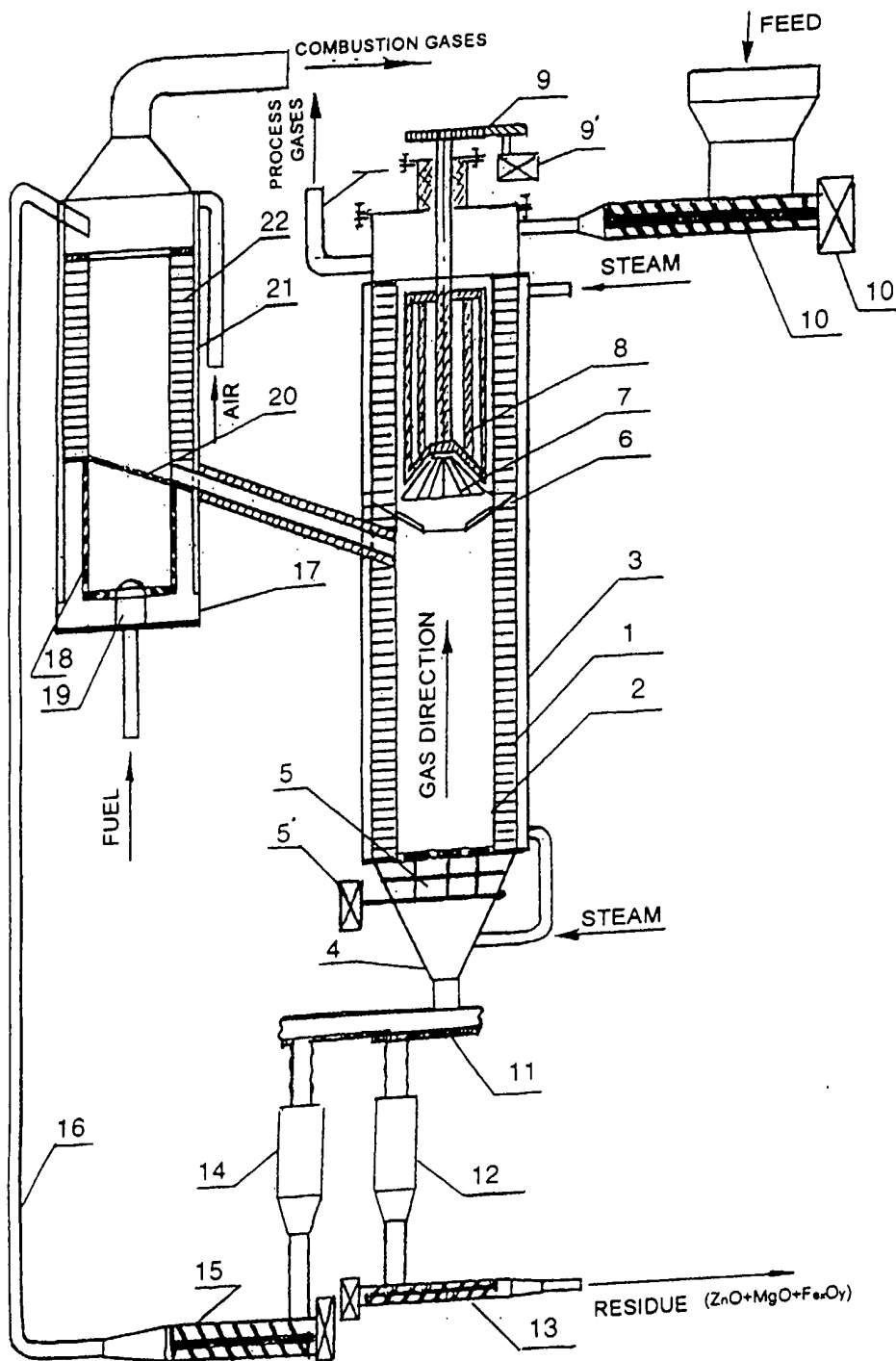


Fig. 1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GE 01/00001

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10G1/10 C10B53/00 C10B51/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C10B C10J C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 225 392 A (TAYLOR LELAND T) 30 September 1980 (1980-09-30) ---	
A	US 4 588 477 A (HABIB IKRAM W) 13 May 1986 (1986-05-13) ---	
A	US 5 423 950 A (AVETISIAN VAHAN ET AL) 13 June 1995 (1995-06-13) -----	

Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents :

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- *E* earlier document but published on or after the international filing date
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- * & * document member of the same patent family

Date of the actual completion of the international search 4 April 2002	Date of mailing of the international search report 12/04/2002
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Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer De Herdt, O
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GE 01/00001

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4225392	A	30-09-1980	NONE	
US 4588477	A	13-05-1986	NONE	
US 5423950	A	13-06-1995	DE 69414980 D1	14-01-1999
			DE 69414980 T2	22-04-1999
			EP 0652275 A1	10-05-1995
			JP 7179861 A	18-07-1995