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(54) Title: METHOD AND GAS GENERATOR FOR GASIFICATION OF A SOLID FUEL WITH THE LOW CALORIFIC VALUE, PARTICULARLY OF A BIOMASS WITH THE WIDE SPECTRUM OF HUMIDITY

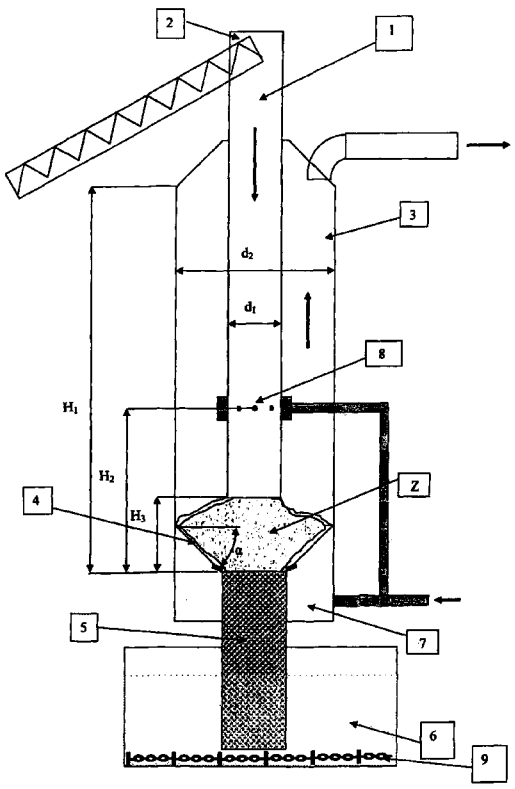

Fig. 1.

(57) Abstract: The method and the gas generator for gasification of the solid fuel with the low calorific value, particularly of the biomass with the wide spectrum of humidity is characterized in this that there is made prior assessment of fuel reactivity and humidity using the known methods and then fuel is introduced through the top inlet into the gasification chamber (1) which is located inside of the external chamber (3) in an inside of which there is axially built-in the slot grate (4) in the form of a truncated cone of the angle (α) of an inclination of the wall in relation to the plane ranging from 20° to 80° and the lower part of the external chamber (3) constitutes the air box (7). Under the grate (4) there is located the chamber of ash receiving (5). Moreover, gasifying medium nozzles (8) are located on the surface of the pipe wall of the pyrolysis chamber on the height (h2) from the lower edge of the slot grate (4).

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Method and Gas Generator for Gasification of a Solid Fuel with the Low Calorific Value, particularly of a Biomass with the Wide Spectrum of Humidity

The subject-matter of the invention is a method and a gas generator for gasification of a solid fuel with the low calorific value, particularly of a biomass with the wide spectrum of humidity used in modern heat engineering employing chipboard wastes, wood pieces, community waste, brown coal as fuel.

The gas generators with a solid bed known from the use divide into countercurrent and cocurrent gas generators. Countercurrent gas generators are characterized by the opposite directions of the biomass and the gas flow. Hot gas from the oxidation, pyrolysis and gasification zone ensures good dryness of the biomass, ensuring relatively high efficiency of the gas generator since the biomass fragmentation requirements are low and gas being used to dry the biomass inside the gas generator is cooled inside the gas generator before exiting. A disadvantage of countercurrent gasification method and the gas generators employing it is the significant amount of tars floated by the outlet gas stream.

There are known the cocurrent gas generators of US group BECHTEL in cooperation with an Indian company ASET and of the company WAMSLER used in the industry. Cocurrent gas generators are characterized by the same directions of the biomass and the gases flow in the lower part of the gas generator. The biomass after drying in cocurrent flow goes to the pyrolysis sphere and subsequently to the oxidation sphere. Gas produced in the pyrolysis process has a temperature of 1000°C and is mixed with gas produced in the gasification sphere. Due to high outlet gas temperature of 300-400°C, the efficiency of cocurrent gas generators is low. They are also characterized by a tendency to generate slag.

There is, moreover, known from the Polish patent specification 201871, a method and a gas generator for gasification of a solid fuel with the low calorific value, including a preliminary fuel degasser inside the gasification chamber, the lower part of which is located inside the hot air box placed in the chamber funnel under the skew grate. The lower pipe intake of the preliminary degasser is connected with a fuel feeder and the top outlet of the preliminary degasser is located below the air inlet supplying the heater equipped chamber. An inconvenience of the solution described in the Polish patent specification no. 201871, is the necessity of using pumping pressure for loading a chamber gasifying with fuel.

A gist of the method for gasification of fuel with the low calorific value, particularly the biomass with the wide spectrum of humidity is that after the preliminary analysis of fuel reactivity and humidity using the known methods, fuel is introduced through the top inlet into the pyrolysis chamber, located centrically in the external chamber, in

which fuel is subjected to drying and pyrolysis under the influence of heat supplied through the wall of the pyrolysis chamber. Subsequently, a residue of the pyrolysis process in the form of the solid bed, collected in the lower part of the gas generator in the space above the slot grate, which height is controlled and maintained on a level dependent on humidity and reactivity of fuel, is gasified by means of gasifying medium feeded under the slot grate. When using fuel of humidity greater than 30%, if the height of the solid bed is lower than the distance between the end of the pyrolysis chamber and the lower edge of the slot grate and when using fuel of humidity lower than 20%, gasifying medium is feeded through gasifying medium nozzles, located in the pipe wall of the pyrolysis chamber on the height determined on the basis of fuel reactivity measurement. Subsequently, an additional stream of gasifying medium is feeded through the slots of a grate into the residue in the form of a bed, located between the slot grate and the pyrolysis chamber outlet, burning the remaining coal element. Moreover, when using fuel of humidity within a range of 20%-30%, gasifying medium is feeded both through gasifying medium nozzles, located in the pipe wall of the pyrolysis chamber and under the slot grate, in the amount proportional to the fuel humidity and the pyrolysis process speed.

The gist of the gas generator for gasification of the solid fuel with the low calorific value, particularly of the biomass with the wide spectrum of humidity relies on this that the pyrolysis chamber, preferably in the form of a vertical pipe with a top fuel inlet is placed centrically in the external chamber, preferably in the form of the vertical pipe. Inside the said chamber, below the end of the pyrolysis

chamber pipe, there is axially built-in the slot grate in the form of a truncated cone with an angle of inclination of the wall in relation to the plane ranging from 20° to 80°. The lower part of the external chamber is the air box. Moreover, gasifying medium nozzles are placed in the wall of the pyrolysis chamber, whereby the height on which gasifying medium nozzles are situated, their number and the total area of the nozzle openings is dependent on the type and granulation of fuel and is established using the separate methods, preferably by experimentation.

An advantage of the method for gasification of the solid fuel, particularly of the biomass characterized by a large dispersion of the contents of humidity is its ability to gasify the biomass in a single process and in a single gas generator, after prior fuel reactivity and humidity assessment, on the basis of which the conditions of gasification are selected, dependent on whether the fuel humidity exceeds 30%, is lower than 20% or is in 20%-30% range. An advantage of the gas generator according to the invention is the supply of two gasifying media on different steps of the pyrolysis process and feeding of fuel to the top pyrolysis chamber inlet which greatly facilitates the loading of the pyrolysis chamber and prevents malfunctions.

The invention is embodied in an Example of realization on a drawing, on which Fig. 1 presents schematically the gas generator for gasification of the biomass of humidity contents within a range of 5-40% and Fig.2 presents an elongated cross-section of the lower part of the gas generator, showing the structure of the slot grate.

At the beginning of the gasification process according to the invention, reactivity and humidity of the biomass is

assessed, the biomass is subsequently charged from the fuel tank by means of a feeder not shown on the drawing, to the inside pipe of the pyrolysis chamber 1 through the top inlet 2, where it is subject to drying and pyrolysis under the influence of heat supplied through the wall of the pylorysis chamber 1. The solid pyrolisys reaction residue creates a bed Z accumulated in the lower part of the gas generator, above the slot grate 4. The height of the bed Z is controlled during the process and maintained at a level dependent on humidity and reactivity of the biomass.

When using a high humidity biomass, above 30%, it has been stated experimentally that the best results are achieved when the height of the bed Z is lower than the distance h3 between the end of the pyrolysis pipe 1 and the bottom edge of the slot grate 4 and gasifying medium is feeded under the slot grate 4. Steam travels from the pyrolysis chamber pipe 1 to the space between the walls of the pyrolysis chamber 1 and the external chamber 3 without flowing through the bed Z, to prevent an endotermic reaction of steam with a coal element included in the bed material Z, which could be the cause of disadvantageous bed temperature drop and slowing of the gasification process which results in stopping the gasification and pyrolysis process. Low placement of the bottom pyrolysis chamber pipe outlet 1 above the slot grate 4 ensures direction of the pyrolysis gas to the high temperature zone 800°-1400°C above the slot grate 4 and prevents the creation of secondary tars. The produced flammable high temperature gas, e.g. 800°C flows through the space between the pyrolysis chamber pipe wall 1 and the external chamber pipe wall 3 transferring heat to the

pyrolysis chamber 1 and as a final product it is collected with a stub pipe 10 in the upper part of the gas generator.

In case of using the biomass of humidity lower than 20%, the biomass after chamber loading through the upper inlet 2 fills the interior of the pyrolysis chamber pipe 1 and the process for gasification of the biomass relies according to the invention on feeding gasifying medium to an inside of the pyrolysis chamber pipe and through an arrangement of gasifying medium nozzles 8, located on the pipe wall of the pyrolysis chamber 1 on the height h2. The biomass bed in the pyrolysis chamber pipe 1, in the part situated above gasifying medium nozzles 8 is heated by heat of a combustible gas produced in the pyrolysis and gasification process what ensures drying and the pyrolysis of the biomass. In a zone of gasifying medium nozzles 8 on the height h2 of the pyrolysis chamber 1 proceeds burning of the tarry products of the pyrolysis with carbon dioxide and water release, as well as heat emission of a reaction. The solid residue after pyrolysis undergoes gasification as a result of the reaction with carbon dioxide and water inside the pyrolysis chamber pipe 1 below gasifying medium nozzles. The solid residue after the reaction of gasification comprising mainly the inorganic compounds forms the bed of slag Z between the slot grate 4 and the pyrolysis chamber pipe outlet 1. An additional stream is supplied to the bed of slag Z according to the invention, e.g., of air through the slots 11 of the slot grate 4 ensuring burning of the remaining coal element.

In case of using the biomass of humidity within a range of 20%-30%, gasifying medium is feeded both through gasifying medium nozzles 8, located on the pipe wall of the pyrolysis chamber and on the height h2, counted from the lower edge of

the slot grate 4 and under the slot grate 4 what ensures maintenance of the minimal temperature on the grate 4, e.g, 800°C. During the process there is measured the temperature on the slot grate 4 and in case of establishment of the temperature drop below 800°C increases a quantity of gasifying medium feeded under the slot grate 4 what ensures an appropriate process speed. Gasifying medium is air or a mixture of air and steam, possibly a mixture of oxygen and steam in an amount of 0,2-0,4 of the quantity indispensable for total burning of fuel.

The gas generator consists of the cylindrical pyrolysis chamber 1 in the form of a pipe into which from a top through the upper inlet 2 there is in a continuous manner introduced fuel collected from the fuel tank by means of the feeder not shown on the drawing. According to the invention, the pyrolysis chamber 1 in the form of the pipe is located concentrically inside the pipe constituting cylindrical external chamber 3. In an inside of the external chamber pipe 3, below the end of the pyrolysis pipe 1 there is axially built-in the slot grate 4 with the conical slots 11 as it is shown on Fig. 2. There has been experimentally established according to the invention that advantageous is low distance between the end of the pyrolysis pipe 1 and the upper edge of the slot grate 4 amounting to from 100 mm to 300 mm, e.g. 200 mm, what ensures easy flow of the gaseous products of the pyrolysis from an inside of the pyrolysis pipe and to an inside of the external chamber pipe 3. According to the invention, the slot grate 4 possesses a form of a truncated cone directed downwardly of the angle α of an inclination of the wall in relation to the plane ranging from 20° to 80°, e.g. 45°, what ensures an increase of the reaction speed

between the material of the bed Z and gasifying medium and makes easier ash flow. Location of the slots 11 of the slot grate 4 in the plane of the wall of a cone ensures direction of a stream of gasifying medium parallel in direction to an axis of the gas generator. Under the slot grate 4, there is located the cylindrical chamber of ash receiving 5 installed in such a manner that the lower edge of the slot grate 4 is connected with the upper edge of the cylindrical chamber of ash receiving 5. The lower part of the chamber of ash receiving 5 is installed in the water seal tank 6 in a distance of 50 mm to 200 mm, e.g. 100 mm from a bottom of the tank. Ash from the water seal tank 6 is removed mechanically, e.g. by means of a scraper conveyor 9. The lower part of the external chamber 3 below the slot grate 4 constitutes the air box 7. The pyrolysis chamber pipe 1 is equipped with an arrangement of 4-30 of gasifying medium nozzles 8 located on the height h2 from the lower edge of the slot grate 4. The said height is selected experimentally in dependence on reactivity of fuel. E.g. for fuel in the form of the deciduous trees chips of medium size of a grain to 30 mm, the height h2 amounts to 200 mm, the number of the nozzles amounts to 16, the total surface of the nozzles amounts to 6079 mm2. The total number of the nozzles of gasifying medium 8 and the surface of the nozzles openings is selected in dependence on the type and granulation of fuel ensuring an effective penetration of the bed.

Claims

1. The method for gasification of the solid fuel with the low calorific value, particularly of the biomass with the wide spectrum of humidity using a preliminary gasification in the pyrolysis chamber externally heated by means of gas produced in the gasification process wherein gasifying medium is passed cocurrently or countercurrently through the biomass, characterized in that there is made prior assessment of reactivity and humidity of the solid fuel using the known methods then fuel is introduced through the upper inlet (2) into the pyrolysis chamber (1), located vertically centrically in the external chamber (3) wherein fuel is subject to drying and pyrolysis under an influence of heat supplied through the wall of the pyrolysis chamber and subsequently a residue of the pyrolysis process in the form of the solid bed (Z) collected in the lower part of the gas generator in the space above the slot grate (4), which height is maintained on a level dependent on humidity and reactivity of fuel, is gasified by means of gasifying medium feeded under the slot grate (4), when using fuel of humidity greater than 30%, if the height of the solid bed (Z) is lower than the distance (h3) between the end of the pyrolysis chamber and the lower edge of the slot grate (4) and when using the

solid fuel of humidity lower than 20%, gasifying medium is feeded through gasifying medium nozzles (8), located in the wall of the pyrolysis chamber (1) on the height (h2) of the chamber, determined on the basis of fuel reactivity measurement and subsequently, an additional stream of gasifying medium is feeded through the slots (11) of the slot grate (4) into the residue in the form of the bed (Z), located between the slot grate (4) and the pyrolysis chamber outlet (1), burning the remaining coal element, moreover, when using the solid fuel of humidity within a range from 20% to 30%, gasifying medium is feeded both through gasifying medium nozzles (8), located on the wall of the pyrolysis chamber (1) and under the slot grate (4), in the amount proportional to the fuel humidity and the controlled pyrolysis process speed.

2. The gas generator for gasification of the solid fuel with the low calorific value, particularly of the biomass with the wide spectrum of humidity comprising a fuel feeder, the pyrolysis chamber with the slot grate, a preliminary degasser of fuel, the lower air box, characterized in that the pyrolysis chamber (1), preferably in the form of the vertical pipe with the upper fuel inlet (2) is located centrically in the external chamber (3), preferably in the form of the vertical pipe, the lower part of which, constitutes the air box (7) in an inside of which, below the end of the pyrolysis chamber pipe (1), there is axially built-in the slot grate (4) in the form of a truncated cone of an inclination of the wall in relation to the plane under the angle (α) ranging from 20° to 80° under which there is situated a chamber of ash receiving (5), the lower part of which, is installed in a water seal tank (6), moreover,

gasifying medium nozzles (8) are located in the pipe wall of the pyrolysis chamber (1) located on the height (h2) from the lower edge of the slot grate (4) whereby the number of gasifying medium nozzles (8) and the total area of the nozzle openings (8) and the height (h2), on which they are located, depends on the type and granulation of fuel and is established using the separate methods, preferably by experimentation.

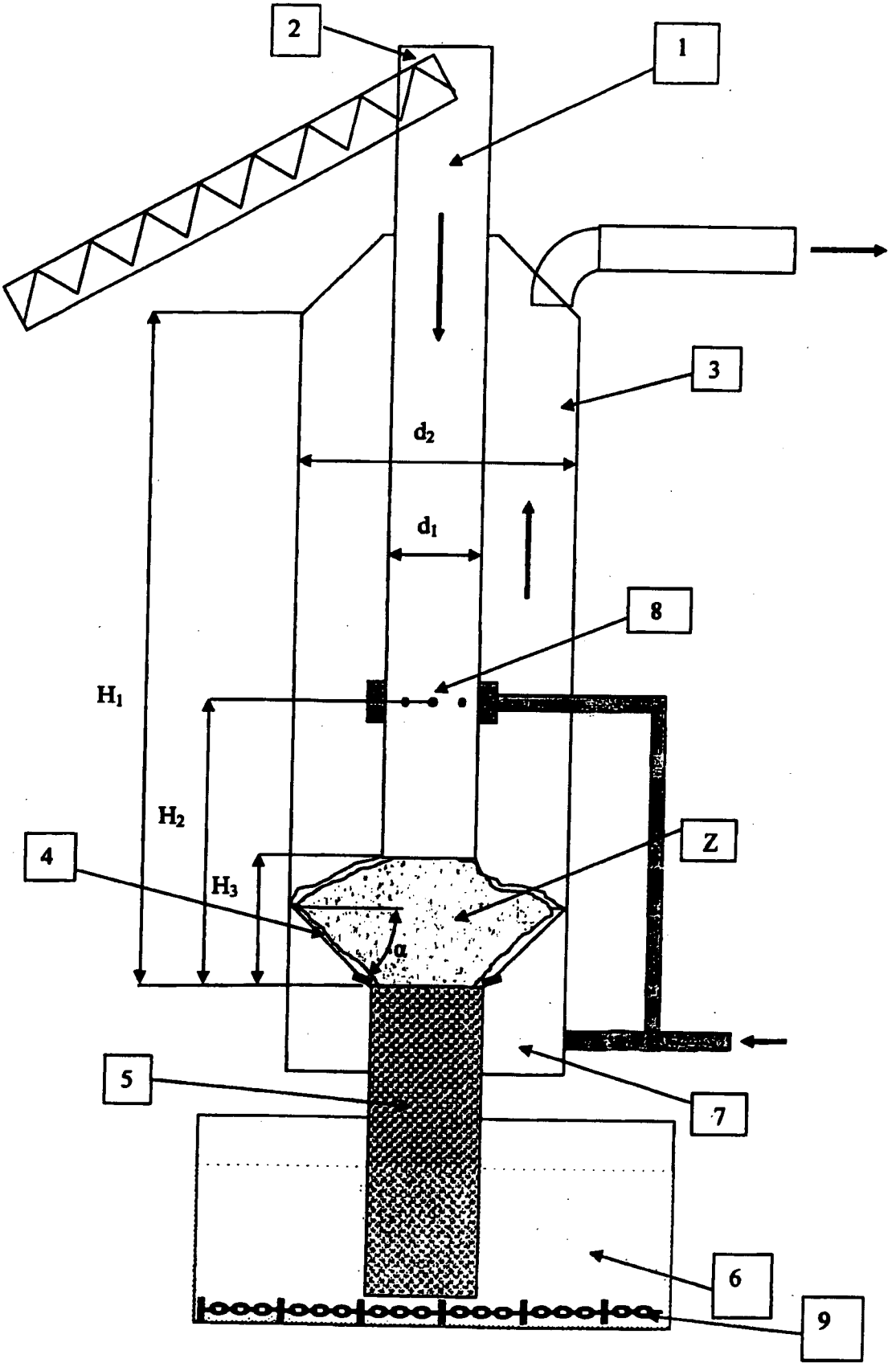

Fig. 1.

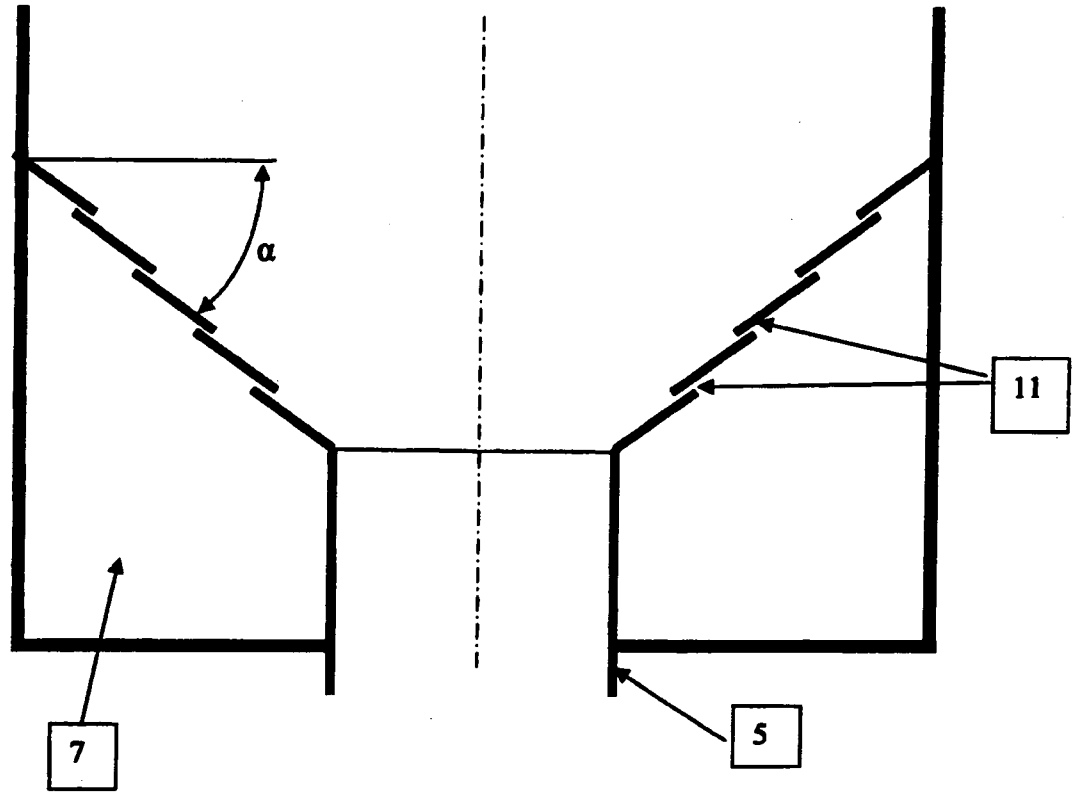

Fig 2.