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(54) Method for gasifying organic material and device applied thereby

(57) Method for gasifying organic material in a reactor (2) in which particles (26) are provided, made of a material with a large thermal capacity, characterised in that this method consists of gasifying the organic material by means of heating in a gasification chamber (17) in the reactor (2); of letting a gas flow through the reactor (2), from an inlet (7) to an outlet (8); of letting the particles (26) circulate through the reactor (2), in counterflow with the above-mentioned gas; and of collecting the gasified organic material at the above-mentioned outlet (8).

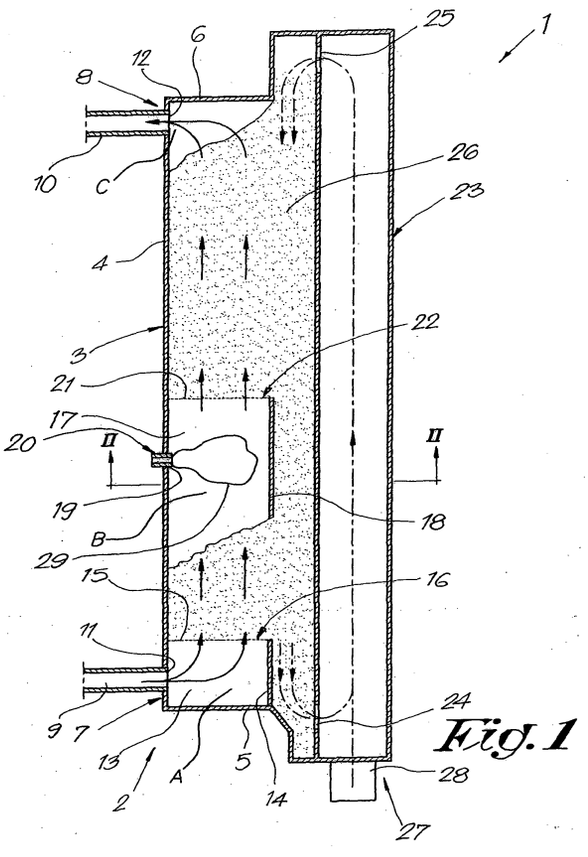

Fig. 1

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Description

[0001] The present invention concerns a method for gasifying organic material, more particularly for gasifying organic material in a liquid or solid state, such as for example heavy fuel oil, vegetable oils, glycerol, bitumen, but also wood, straw, plastic and the like.

[0002] Methods for what is called thermal gasifying of organic material are already known, whereby the organic material is supplied into a device and is transformed into gas under the influence of heat.

[0003] A disadvantage of such a known method for gasifying organic material is that the obtained gas leaves the device at a high gas temperature, such that a large part of the heat energy from the device is lost, so that relatively much new energy always has to be supplied into the device in order to maintain a sufficiently high temperature.

[0004] Working at a low temperature is not possible either, as tar compounds may be created in that case as a result of the polymerization of different products in the gasified organic material.

[0005] The present invention aims to remedy the above-mentioned and other disadvantages.

[0006] To this end, the invention concerns a method' for gasifying organic material in a reactor in which particles are provided, made of a material having a large thermal capacity, whereby this method consists of gasifying the organic material by means of heating in a gasification chamber in the reactor; of letting a gas flow through the reactor, from an inlet to an outlet; of letting the particles circulate through the reactor, in counterflow with the above-mentioned gas; and of collecting the gasified organic material at the above-mentioned outlet.

[0007] An advantage of the method according to the invention is that, by letting a heat-carrying material circulate through the reactor, a large part of the heat in the gasified organic material can be given to the heat-carrying material, before the gasified organic material leaves the reactor, as a result of which this heat stays in the reactor and as a result of which, as a consequence, less energy will have to be consumed in order to maintain the temperature in the reactor at level.

[0008] The present invention also concerns a device which can be applied for gasifying organic material and which mainly consists of a reactor with an inlet for gas and an outlet for the gasified organic material, which reactor is filled with particles made of a material having a large thermal capacity, whereby the reactor is equipped with a circulation circuit for the above-mentioned particles, in counterflow in relation to the above-mentioned gas, more particularly in the direction of the above-mentioned outlet to the inlet and whereby, between the inlet and the outlet, a gasification chamber is provided in the reactor.

[0009] In order to better explain the characteristics of the present invention, the following preferred embodiment of a method and a device according to the invention for gasifying organic material is given as an example only without being limitative in any way, with reference to the accompanying drawings, in which:

figure 1 schematically represents a section of a device according to the invention;
figure 2 represents a section according to line II-II in figure 1;
figure 3 is a graph representing the temperature profile in the reactor.

[0010] Figures 1 and 2 represent a device 1 according to the invention which mainly consists of a reactor 2.

[0011] Said reactor 2 in this case consists of a vertical housing 3 which is formed of a cylindrical jacket 4 sealed on both ends, preferably in an air-tight manner, by a bottom 5 on the one hand and a cover plate 6 on the other hand.

[0012] The reactor is provided with an inlet 7 and an outlet 8, which are each formed of a pipe, 9 and 10 respectively, which are each connected to the reactor 2 at an opposite far end of the device 1 through openings 11-12 in the housing 3 of the reactor 2.

[0013] At the height of the inlet 7, a compartment 13 is provided in the reactor 2 which is limited by a side wall 14 which partly coincides with the jacket 4 of the reactor 2, more particularly at the place of the inlet 7 itself and through a plate 15 with perforations 16, which plate 15 rests on the above-mentioned side wall 14.

[0014] In the reactor 2 is further provided a gasification chamber 17 which is limited by a vertical side wall 18 which partly coincides with the above-mentioned housing 3, whereby a passage 19 is provided in the housing 3 through which an injection pipe 20 opens in the gasification chamber 17. The gasification chamber 17 is limited at the top side by a second plate 21 with perforations 22.

[0015] Against the reactor 2 is placed a pipe 23, which is connected via two openings 24-25 on both its far ends to the bottom side and the top side of the reactor 2 respectively.

[0016] The reactor 2 according to the invention is filled with particles 26 of a material which is preferably heat-resistant and has a high thermal capacity, such as ceramics, gravel, aluminium oxide or the like, whereby the dimensions of the particles 26 are at least somewhat larger than the cross section of the above-mentioned perforations 16 and 22, and whereby the particles 26 may have any shape whatsoever.

[0017] In the pipe 23 is provided a means of transport 27 which is schematically represented by means of a dashed line in figure 1, which makes it possible to move the above-mentioned particles 26 through the above-mentioned pipe 23 from the lower opening 24 to the top opening 25, in order to form a circulation circuit whereby the particles 26 are continuously circulated through the reactor 2.

[0018] As a means of transport 27 can be used known

means, such as for example a bucket elevator, a conveyor belt or the like, whereby the means of transport 27 for the drive is provided with a motor 28.

[0019] A method according to the invention for gasifying organic material 29 is simple and as follows.

[0020] The organic material 29 to be gasified is provided in the gasification chamber 17 via the injection pipe 20. At this position in the reactor 2 the temperature is for example 1570° Kelvin (K), whereby the organic material to be gasified is cracked in order to form gases.

[0021] The formed gases ascend through the perforations 22 in the above-mentioned second plate 21 and subsequently between the particles 26 in the reactor 2 towards the outlet 8.

[0022] It is clear that, as the gases ascend, the temperature of these gases will drop as the gases come closer to the outlet 8 of the reactor 2, since the gases near the outlet 8 come into contact with relatively cold particles 26 which are supplied from the pipe 23 at the top of the reactor 2 and which circulate through the reactor 2 in counterflow with the gases.

[0023] In order to maintain the temperature in the reactor 2, the organic material 29 to be gasified is partially burnt; to this end, oxygen is provided in the reactor 2 in the shape of air, vapour or the like.

[0024] The air or the like is supplied in this case at ambient temperature, at the bottom of the reactor 2 via the inlet 7, and ascends in the reactor 2 to the gasification chamber 17, where the oxygen is consumed to partially burn the organic material 29.

[0025] While the air or the like ascends, it is heated by the relatively hot particles 26 that drop via the gasification chamber 17 through the reactor 2, as a result of which air or the like is heated up to a relatively high temperature before reaching the gasification chamber 17.

[0026] When heating up the air or the like, the particles 26 will preferably give the thermal energy, which was stored above the gasification chamber 17, entirely to the air, after which the particles 26 can be carried up to the top of the reactor 2, where they are heated again by the gasified organic material.

[0027] By adjusting the circulation flow of the particles 26, the flow of the organic material to be gasified, the amount of oxygen and the flow and/or the temperature of the air or the like, a stationary heat profile, as represented in figure 3, can be obtained while the reactor 2 is working, whereby organic material 29 can be gasified in an efficient manner. The use of large particles 26 results in smaller load losses over the reactor 2, such that a larger flow of air and gases can be used than when using smaller particles 26.

[0028] Figure 3 is a curve I which represents the above-mentioned stationary temperature profile in the reactor 2, whereby the point A represents the temperature at the inlet 7; point B represents the temperature at the gasification chamber 17; and point C represents the temperature at the outlet 8 of the reactor 2.

[0029] The lower part of the curve I shows how the temperature in the reactor 2 rises from the inlet 7 to the gasification chamber 17, which corresponds to the heating of the air or the like.

[0030] The top part of the curve I shows how the temperature in the reactor 2 drops from the gasification chamber 17 towards the outlet 8, which corresponds to the absorption of the thermal energy from the formed gas by the particles 26.

[0031] The difference between the temperature in position A and the temperature in position C, indicated by AX, is a measure for the loss of thermal energy in the reactor 2, to the exception of heat losses via the housing 3 of the reactor 2 or via the pipe 23, which loss AX, when applying a method according to the invention, is smaller than when applying a known method for gasifying organic material.

[0032] Of course, it is possible to add a catalyst to the particles 26 which makes it possibly to crack certain organic bonds, such as tar, ammonia or the like, in a catalytic manner. Examples of such catalysts are dolomite or limestone in what is called a calcined form, nickeliferous or ferriferous catalysts and charcoal.

[0033] An advantage of such catalysts is that, in the gasified organic material at the outlet 8 of the reactor 2, the amount of for example ammonia can be restricted, as a result of which the gasified organic material can be used in a combustion engine without giving rise to the formation of for example large amounts of nitrogen oxides which are formed during the combustion of ammonia and which are harmful to mankind and the environment.

[0034] When using for example nickeliferous catalysts, it is known to also mix a capture material among the particles 26, which capture material makes it possible to absorb possible chlorine or sulphurous fumes, which may extend the life of the used nickeliferous catalyst considerably, as chlorine and sulphur are poisonous to such catalysts.

[0035] The used capture material should in that case be regularly removed from the particles 26 and be replaced by new or regenerated capture material, since it becomes saturated with sulphur or chlorine after a while and thus loses its operating function.

[0036] It should be noted that the above-described device according to the invention can also be made with several gasification chambers 17, which are either or not provided with a separate inlet 7 for oxygen and/or with a separate recirculation circuit.

[0037] Also the orientation of the reactor 2 can be altered. It must not necessarily be positioned vertically, but it can also be placed slantingly or even horizontally, whereby extra facilities will have to be provided in the latter case in order to obtain a good flow of air, gas and particles.

[0038] Further, it should be noted that the temperature in the reactor 2 must not necessarily be maintained by a partial combustion of the organic material to be gasified. Naturally, it is also possible to provide other heat

sources to this end for heating the organic material in the gasification chamber. Thus, for example, heat can be generated in an electric manner by means of for example induction, or in a physical manner, by means of for example friction.

[0039] In the latter two cases, it is preferred that no oxygen is supplied to the reactor, but an inert gas, such as nitrogen gas or the like, in order to avoid a partial combustion of the organic material to be gasified.

[0040] The present in invention is by no means limited to the above-described embodiment represented in the accompanying drawings; on the contrary, such a method and device according to the invention for gasifying organic material can be made in all sorts of variants while still remaining within the scope of the invention.

Claims

1. Method for gasifying organic material in a reactor (2) in which particles (26) are provided, made of a material with a large thermal capacity, **characterised in that** this method consists of gasifying the organic material by means of heating in a gasification chamber (17) in the reactor (2); of letting a gas flow through the reactor (2), from an inlet (7) to an outlet (8); of letting the particles (26) circulate through the reactor (2), in counterflow with the above-mentioned gas; and of collecting the gasified organic material at the above-mentioned outlet (8).

2. Method according to claim 1, **characterised in that** a gas is supplied to the device (1) on one far end of the reactor (2), whereas the gasified organic material is collected on the opposite far end, and **in that** the organic material to be gasified is supplied to the reactor (2) between both far ends.

3. Method according to claim 1, **characterised in that** particles (26) are discharged on one far end of the reactor (2) and **in that** these particles (26) are then brought back into the reactor (2) on the other far end of the reactor (2).

4. Method according to claim 2, **characterised in that** the above-mentioned gas comprises oxygen in order to realise a partial combustion of the organic material (29) to be gasified in order to maintain a desired temperature in the reactor (2).

5. Method according to any one of the preceding claims, **characterised in that** the temperature profile in the reactor (2) is kept practically constant.

6. Method according to claim 5, **characterised in that** the temperature in the reactor (2) is adjusted by the gas flow through the reactor (2).

7. Method according to claim 5, **characterised in that** the temperature in the reactor (2) is adjusted by the circulation speed of the above-mentioned particles (26).

8. Method according to claims 4 and 5, **characterised in that** the temperature in the reactor (2) is adjusted on the basis of an amount of gas which is supplied to the reactor (2).

9. Method according to claim 1, **characterised in that** a catalyst is added to the particles (26) which makes it possible to crack organic material in a catalytic manner.

10. Method according to claim 9, **characterised in that** a capture material is added to the particles (26) which protects the used catalyst against catalyst poisons.

11. Device which can be applied for gasifying organic material by means of a method according to any one of the preceding claims, which device (1) mainly consists of a reactor (2) with an inlet (7) for gas and an outlet (8) for the gasified organic material, which reactor (2) is filled with particles (26) made of a material having a large thermal capacity, **characterised in that** the reactor (2) is equipped with a circulation circuit for the above-mentioned particles (26) in counterflow with regard to the above-mentioned gas, more particularly in the direction of the above-mentioned outlet (8) towards the inlet (7), and **in that**, between the inlet (7) and the outlet (8), a gasification chamber (17) is provided in the reactor (2).

12. Device according to claim 11, **characterised in that** the inlet (7) and the outlet (8) are situated on opposite far ends of the reactor (2).

13. Device according to claim 11, **characterised in that** the circulation circuit is mainly formed of a reactor (2) and a pipe (23) which is connected, via two openings (24-25) on both its far ends, to both far ends of the reactor (2), and **in that** a means of transport (27) is provided in the pipe (23) which makes it possible to move the above-mentioned particles (26) through the pipe (23).

14. Device according to claim 13, **characterised in that** the means of transport (27) is made in the shape of what is called a bucket elevator.

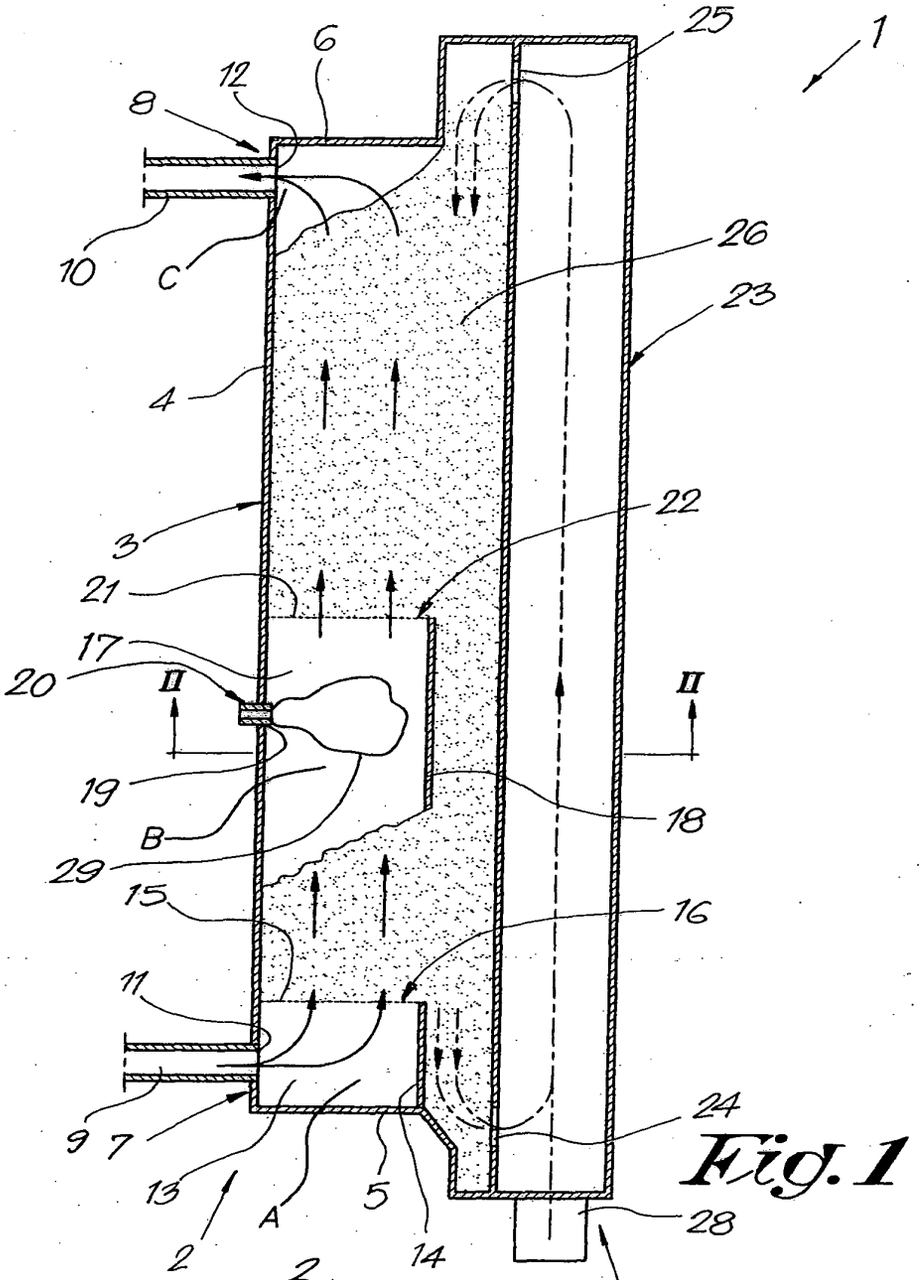
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Fig. 1

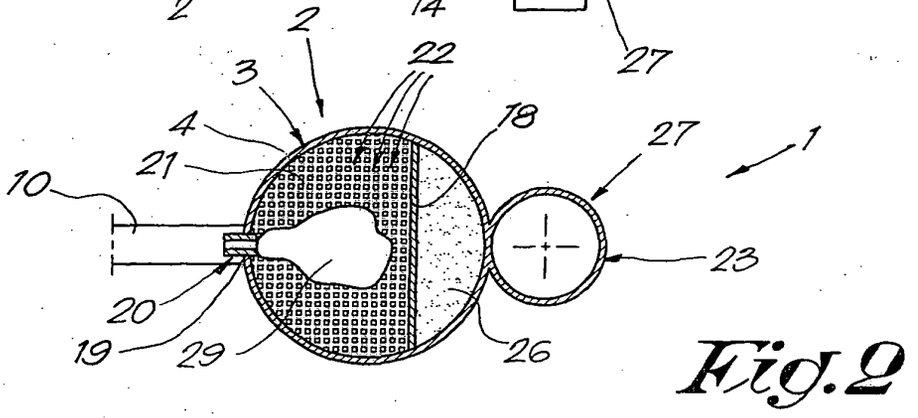
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Fig. 2

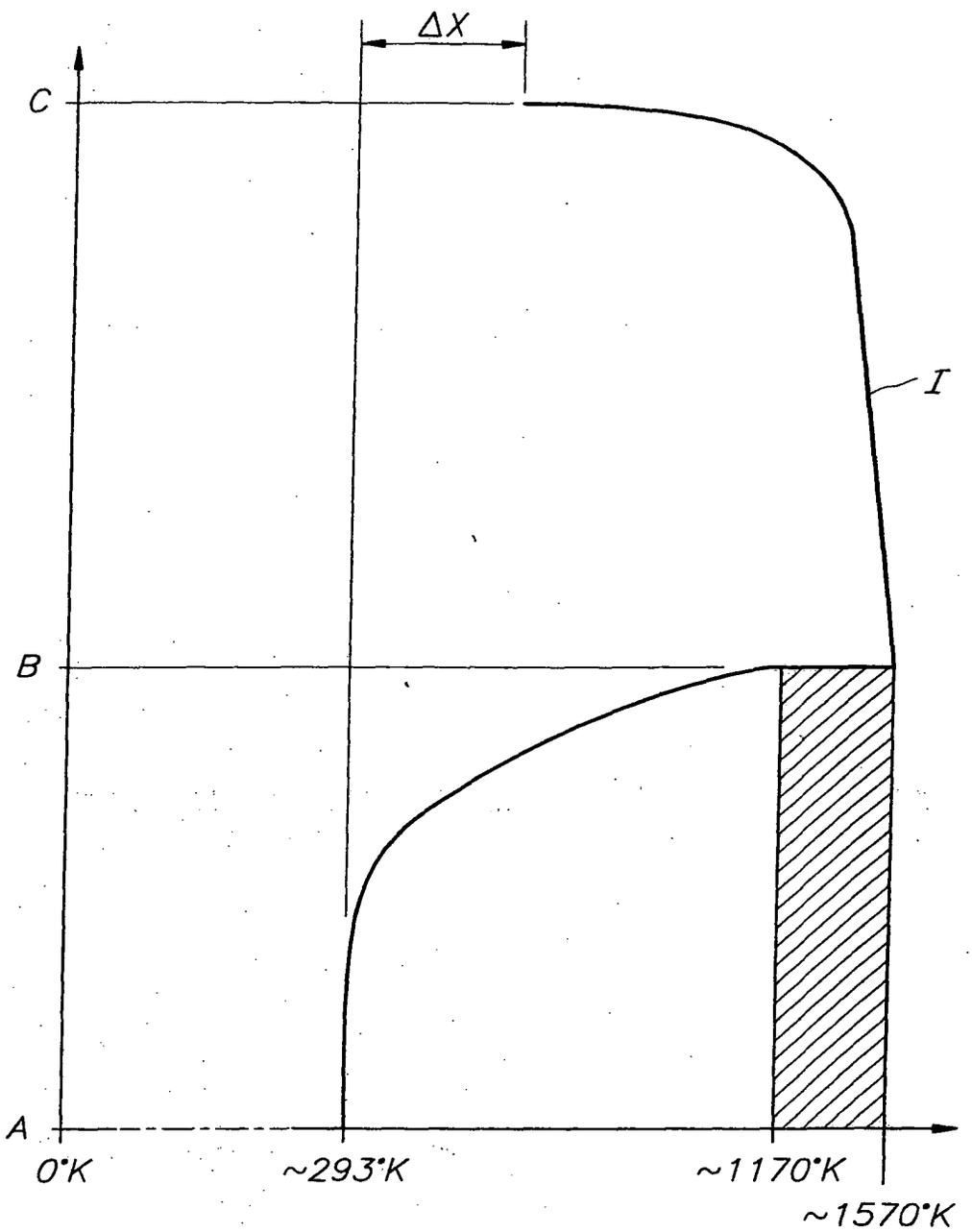

Fig.3

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EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5254

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

C01B
C10J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 June 2005	Lapeyrere, J

CATEGORY OF CITED DOCUMENTS

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