

Martin GmbH für Umwelt-
und Energietechnik

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**PROCESS AND DEVICE FOR PRODUCING AND
UTILIZING GAS FROM WASTE MATERIALS**

The invention pertains to a process and a device for producing and utilizing gas from waste materials, in which the waste materials are transported along a grate in a furnace and combustion air is added.

From patent DE 42 20 265 C1 a process of this type is known in which the waste materials pass sequentially through a drying zone, a carbonizing zone, a reduction zone and an oxidation zone, in order to achieve combustion and coking toward the end of the grate. In this process large proportions of slag are formed, which must be broken up by crushing rollers of correspondingly large dimensions. The energy needed for the gasification process is conveyed to the waste material through convection and radiation by the combustion which occurs at the end of the grate, via the combustion air which is introduced for the most part above the grate. This requires an especially strong combustion process at the end of the grate, with the corresponding formation of coke and slag.

The task of the invention is to achieve a stable gasification process at lower temperatures, and thereby a good burnout of residual material, while avoiding pyrolysis coke in the slag and avoiding formation of large quantities of slag.

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This problem is solved in the invention, starting from a process of the type explained at the beginning, by having an arrangement of undergrate forced-draft chambers, at least in the longitudinal direction of the grate, charged with combustion air; by the fact that the waste materials are ignited in the charging area of the grate with superstoichiometric introduction of oxygen; and that in the direction of the slag removal the combustion is limited to a substoichiometric level, which is required for gasification of the combustible components as well as for a device with the characteristics in Claim 12.

In this process the energy needed for gasification is not introduced from outside through excessively vigorous combustion at the end of the firing grate, and hence through heating of the combustion air and through radiant energy from the roof area which has been heated up by this incineration; instead this gasification energy comes from the incineration of the waste materials, which are continuously ignited in the charging area of the grate under superstoichiometric conditions and then continue to be incinerated under substoichiometric conditions. As a result there is always an adequate supply of energy available, making possible a stable combustion process which leads to good ash burnout and to avoidance of pyrolysis coke in the left-over residue. Since the necessary energy comes from the fuel as a result of its ignition, and does not need to be transferred to the waste materials from outside, this yields a greater degree of efficiency, with the result that it is no longer necessary to burn so much of the waste material to generate energy for the gasification process, so that a larger quantity of usable gas can be created.

These beneficial effects are still further enhanced, under a refinement of the invention, by adding oxygen to the gasification air at a substoichiometric level after the waste materials are ignited.

The advantage of this measure is that the quantity of gasification air, and hence the quantity of nitrogen which functions as ballast, can be reduced very significantly, which leads to a number of benefits. One of the benefits is that as a result of the smaller quantity of gasification air the flow speed through the bed of the fuel mass is lowered, which leads to a noticeable reduction in the flow of airborne dust. An additional substantial advantage is that lowering the proportion of nitrogen reduces the formation of nitrogen oxides. There continues to be a relatively large measure of energy available for the gasification, since it is no longer necessary to heat up so much nitrogen, which is present in the gasification air only as ballast.

The gasification is preferably carried out in such a way that the gasification temperature of the substances to be gasified is 600 to 850°C, and the air ratio needed to achieve substoichiometric gasification is 0.4 to 0.8.

The gases which are produced can be used in a great variety of ways. Preferably, provision is made to use the created gases by burning exclusively the combustible components which come from the first furnace in a second furnace which is connected to the first either directly or by a gas extraction system. This procedure depends primarily upon the oxygen content and the calorific value of the gases coming from the first furnace.

If the oxygen content of the waste gases coming from the first furnace is not sufficiently high, in order to achieve complete combustion it is beneficial to add combustion air in the form of ambient air to the waste gas coming from the first furnace.

On the other hand, if the calorific value of these gases is not sufficient to enable the necessary incineration at a higher temperature, then in a refinement of the invention a higher-grade combustible gas can be added to the combustible components in the second furnace, in accordance with their calorific value, along with the combustion air.

To achieve higher combustion temperatures in the second furnace than is possible with ambient air, there is benefit in mixing oxygen with the combustion air for the second furnace and/or to the higher-grade combustible gas, in a refinement of the invention. The introduction of oxygen in addition to the combustion air has the advantage that the quantity of combustion air which needs to be added can be kept down, which allows the quantity of waste gas from the second furnace to be reduced.

If there is sufficient oxygen present in the waste gas coming from the second furnace, and if the calorific value is also sufficiently high, waste gas which is taken from the waste gas stream after cooling in a waste heat recovery system can be introduced for mixing and burning the gases in order to regulate the combustion in the second furnace. This procedure has the advantage that any gases which may still be combustible when they leave the second furnace are burned in addition; and furthermore the quantity of waste gas is lower compared to the procedure in which a higher-grade combustible gas is added.

The incineration in the second furnace is carried out by selecting from the measures described above, preferably in such a way that in the second furnace the air ratio is 1.1 to 1.8. The combustion temperature of the gases in the second furnace is 950 to 1250°C.

The device for carrying out the process is characterized by the fact that in a furnace which comprises a fuel charging system, a grate with undergrate forced draft chambers subdivided in the longitudinal direction and possibly also in the transverse direction, and a slag removal system, the forced draft chambers have lines for the introduction of oxygen. This makes it possible to regulate the gasification with a fine touch, and furthermore with smaller quantities of waste gas compared to the exclusive use of ambient air for the gasification process.

If utilization of the generated gases by burning is planned, then the invention provides for connection of a second furnace with the first furnace, either directly or through a waste gas flue. This prevents any significant cooling of the combustible gases which arise in the first furnace, and consequently the combustion in the second furnace can be carried out at a relatively low excess air ratio, in many cases even without additional sources of energy, at such high temperatures that all of the organic components in the combustible gas can be broken down without promoting the formation of nitrogen oxides, since the temperature in the second furnace is kept at a level which is lower than a critical temperature limit at which greater quantities of nitrogen oxides begin to be formed.

In order to be able to carry out the advantageous refinements of the process, advanced implementations of the device provide for the second furnace to be equipped with at least one line for the introduction of combustion air, at least one line for the introduction of a higher-grade combustible gas, or at least one line for the introduction of recirculated waste gas. These three measures can optionally be provided individually or in combination, depending upon the type of implementation.

The invention is explained in additional detail below on the basis of a sample implementation shown in the drawing, the only figure of which is a schematic representation of a furnace with a second furnace connected to it.

As can be seen from the drawing, the device for carrying out the process comprises in its essentials a furnace which is identified in its entirety as 1, as used heretofore for waste incineration, in combination with a second furnace 2 functioning as an afterburner chamber, followed by a heat exchanger 3. The other requisite devices, especially for cleaning the waste gases, are not shown in this drawing, since they are part of the current technology of furnaces and are superfluous to an explanation of the invention.

The first furnace 1 comprises a charging funnel 4 with adjacent charging chute 5, by means of which the waste materials which are to be burned are conveyed to a firing grate 6; the waste materials on the firing grate 6 are designated as 7. Beneath the firing grate 6 there are individual forced draft chambers 8a to 8e, through which air is introduced from a supply line 9 through lines 9a to 9e. The air passes through the grate 6 into the combustion chamber 10. Through the forced draft chambers 8a and 8b combustion air is supplied, possibly mixed with oxygen, in order to ignite the waste materials in a superstoichiometric atmosphere. After this initial phase of ignition air is conveyed to the grate through the forced draft chambers 8c to 8e as gasification air, preferably mixed with oxygen, with the quantity of gasification air and the quantity of oxygen adjusted so that the gasification takes place substoichiometrically with an air ratio of $\lambda = 0.4$ to 0.8. Oxygen is conveyed to the individual forced draft chambers through the lines 11a to 11e,

which are fed from a common line 11 and merge into the lines 9a to 9e. To regulate the respective quantities, both the lines 9a to 9e and the lines 11a to 11e are fitted with valves, which are not shown. Thus the additional introduction of oxygen leads not only to an increase in the proportion of oxygen in the supplied air, but at the same time also to a reduction in the proportion of nitrogen. The gasification is carried out in such a way that temperatures between 600 and 850°C occur. The resulting combustible gas is conducted, with practically no loss of heat, by means of a waste gas flue 12 leading from the furnace, to the second furnace 2, which takes the form of an afterburner chamber. The slag which arises in the gasification process leaves the furnace by a slag removal system 13.

In the second furnace 2 the excess air ratio is adjusted to between 1.1 and 1.8, preferably at 1.2, by introducing combustion air through a line 14. The resulting temperatures are in the range of 950 to 1250°C. If the gas to be burned, coming from the first furnace 1, has too low a calorific value, an additional line 15 is provided for the introduction of high-grade combustible gas, such as natural gas. Both the line 14 for combustion air and the line 15 for higher-grade gas can have lines 16 and 17 connecting to them for additional oxygen. An additional line 18 can be provided in order to introduce recirculated waste gas into the second furnace 2; this recirculated waste gas is cooled to a temperature below 300°C after having passed through the heat exchanger 3. This recirculated waste gas is thoroughly mixed with the combustible gas in the second furnace 2, avoiding the introduction of too much combustion air, which would be needed to create turbulence and which would increase the quantity of waste gas and also the temperature which occurs in the second furnace. At the same time any combustible components which are still

present in this waste gas can be burned. The gases coming from the heat exchanger 3 are conducted through a line 19 to an exhaust gas cleaning system, which is not shown because it is not part of the invention and is generally known.



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Patent claims

1. Process for creating and utilizing gas from waste materials, in which the waste materials are conveyed along a grate in a furnace and combustion air is applied, **characterized by the fact** that undergrate forced draft chambers at least in the longitudinal direction of the grate have combustion air applied to them in such a way that the waste materials in the charging area of the grate are ignited while oxygen is supplied at a superstoichiometric level, and by the fact that in the direction of slag removal the combustion is limited to a substoichiometric level, which is necessary for gasification of the combustible components.
2. Process as in Claim 1, **characterized by the fact** that after ignition of the waste materials oxygen at a substoichiometric level is mixed into the gasification air.
3. Process as in Claim 1 or 2, **characterized by the fact** that the gasification temperature of the waste materials to be gasified is 600 to 850°C.
4. Process as in one of the claims 1 to 3, **characterized by the fact** that the air ratio to achieve substoichiometric gasification is 0.4 to 0.8.

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5. Process as in one of the claims 1 to 4, characterized by the fact that in utilizing the resulting gases in a second furnace, which is connected to the first furnace either directly or via an exhaust gas flue, exclusively the combustible components which come from the first furnace are burned.
6. Process as in one of the claims 1 to 5, characterized by the fact that combustion air in the form of ambient air is added to the exhaust gas coming from the first furnace.
7. Process as in one of the claims 1 to 6, characterized by the fact that in the second furnace a higher-grade combustible gas is added to the volatile components in accordance with the calorific value of the latter.
8. Process as in claim 7, characterized by the fact that oxygen is mixed into the combustion air for the second furnace and/or into the higher-grade combustible gas.
9. Process as in one of the claims 1 to 8, characterized by the fact that in the second furnace recirculated exhaust gas which is removed from the exhaust gas stream after cooling down in a heat recovery system is introduced to mix and burn out the gases.
10. Process as in claims 5 to 9, characterized by the fact that the air ratio in the second furnace is 1.1 to 1.8.
11. Process as in one of the claims 5 to 10, characterized by the fact that the combustion temperature in the second furnace is 950 to 1250°C.



12. Device for carrying out the process according to one of the claims 1 to 11, characterized by the fact that in the case of a furnace (1) comprising a fuel charging system (4, 5), a grate (6) with undergrate forced draft chambers which are subdivided in the longitudinal and possibly also in the transverse direction (8a to 8e), and a slag removal system (13), the undergrate forced draft chambers (8a to 8e) have lines (11a to 11e) for introducing oxygen.

13. Device as in claim 12, characterized by the fact that a second furnace (2) is connected with the first furnace (1) either directly or through an exhaust gas flue (12).

14. Device as in claim 12 or 13, characterized by the fact that the second furnace (2) has at least one line (14) for supplying combustion air.

15. Device as in one of the claims 12 to 14, characterized by the fact that the second furnace (2) has at least one line (15) for introducing a higher-grade combustible gas.

16. Device as in claim 14, characterized by the fact that a line (16) for introducing oxygen is connected into the line (14) for the combustion air.

17. Device as in Claim 15, characterized by the fact that a line (17) for introducing oxygen is connected into the line (15) for a higher-grade combustible gas.

18. Device as in one of the claims 12 to 17, characterized by the fact that the second furnace (2) has at least one line (18) for introducing recirculated waste gas.