

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 750 161 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

02.09.1998 Bulletin 1998/36

(51) Int Cl.⁶: **F23G 5/027**, F23G 5/50

(21) Application number: **96109716.9**

(22) Date of filing: **18.06.1996**

(54) Method and plant for production and combustion of a combustible product

Verfahren und Vorrichtung für die Herstellung und Verbrennung eines brennbaren Mischprodukts

Méthode et dispositif pour la manufacture et la combustion d'un produit composé combustible

(84) Designated Contracting States:
AT DE DK GB IE IT SE

(30) Priority: **21.06.1995 DK 70895**

(43) Date of publication of application:
27.12.1996 Bulletin 1996/52

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Description

TECHNICAL FIELD

The present invention relates to a method and plant of the kind set forth in claims 1 and 6 respectively.

BACKGROUND ART

The combustion of combustible organic material, such as e.g. bio-mass comprising i.a. straw, hay, grass and wood, occurs normally by means of combustion systems, such as e.g. plants with combustion grates, fluid-bed plants or plants with cyclone combustion. In special cases, individually adapted systems like powdered plants or systems for the combustion of whole bales of straw are used.

The use of plants with combustion grates is limited by the fact that in high-capacity plants, it is difficult to adapt the size of the grates to the requisite boiler equipment, also because it is difficult to control an even layer of fuel and a good distribution of air, this being a necessary prerequisite for achieving good combustion. For this reason, plants comprising combustion grates are normally limited to a maximum fuel input corresponding to approximately 200 MW.

Fluid-bed plants can be used for types of fuel having a low reactivity, i.e. slow-burning fuels, and also for greater inputs of fuel, but with types of fuel with a high reactivity, i.e. fast-burning fuels like e.g. straw and other annual crops, it is necessary to use a supplementary fuel like e.g. coal for stabilizing the process of combustion.

Plants with cyclone combustion are used in those cases, in which a high turnover rate is desired in combination with small physical dimensions. The disadvantage with these plants is that cyclone combustion produces high combustion temperatures, and for the majority of organic material types this means that the slag is produced in liquid form. This causes the fertilizer value of the slag to be "encapsulated", for which reason it can no longer be utilized. This means that the slag product will have to be deposited, this being undesired, partly because of the increased costs, partly because the fertilizer value is lost as just mentioned.

Powder combustion is especially known from its use in large coal-fired power-station boilers, as coal can be ground into powder with few problems beyond those caused by the formation of dust. The use of organic materials as fuels is problematic, since the comminution of bio-mass crops is difficult and requires great amounts of energy, because these crops contain tough material or material comprising long fibres. In addition to this, the water content in this type of crops is usually high, for which reason it is necessary to subject the material to a drying process before comminuting it.

Combustion plants for burning whole bales of straw are known in a number of types, in some plants, whole

bales of straw are burned "in one go", whilst in other plants, the bale of straw burns from one end and is gradually pushed forward during the combustion process. In these types of plants, problems can arise with regard to maintaining the continuous and uniform combustion process, because it is difficult to provide bales of straw that are uniform and homogeneous with regard to the calorific value.

It is a common feature for the combustion plants referred to above that they all use air for combustion that is cold or preheated to a maximum of 350°C. In the mechanical plants, this is due to the necessity of cooling the structural parts of the plants, while in the fluid-bed plants it is primarily a question of maintaining the combustion temperature sufficiently low to avoid sand and ash with low melting points coalescing or fusing.

From US-A-5,279,234 it is known to provide a plant for the production and combustion of a combustible product being converted from a combustible organic material in the plant, which comprises an infeed zone, a reaction zone and a combustion zone, and in which the combustible organic material is advanced continuously through the infeed zone and fed into the reaction zone, in which, in a reaction chamber adapted for the purpose, it is converted using a gaseous reaction medium which is supplied in a controlled condition with regard to quantity, speed and temperature, to a combustible product comprising pyrolysis gas, without molten slag being formed, and the pyrolysis gas is made to enter the combustion zone in which air for the combustion is supplied. In this system a great part of the calorific content in the combustible organic material is lost in the reaction chamber by the pyrolysis of the charcoal part of the material and only pyrolysis gas is fed to the combustion chamber.

Thus, the use of each of these previously known combustion systems is associated with both advantages and disadvantages depending on the combustible organic material being used, but these systems have that in common, that they are difficult to use for burning great quantities of organic material.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide a method of the kind referred to above for use in the continuous production and combustion of great quantities of combustible organic materials, with which it is possible to achieve very high conversion rates with difficult materials, e.g. such having a high water content, and according to the present invention, this object is achieved by proceeding in the manner set forth in claim 1.

In this manner, it is possible to convert a combustible organic material into a combustible composite product consisting of gas, tar and powder-like charcoal and having a very high calorific value and a very high reactivity, and which will burn with a strongly radiating flame,

thus being well suited for use in association with a conventional boiler plant.

The invention also relates to a plant for carrying out the method according to the invention. This plant is of the kind set forth in the preamble of claim 6, and according to the invention, it also exhibits the features set forth in the characterizing clause of this claim 6.

Advantageous embodiments of the method and the plant, the effect of which - beyond what is obvious - will be evident from the following detailed part of the present description, are set forth in claims 2-5 and 7-9, respectively. S 7-9

BRIEF DESCRIPTION OF THE DRAWING

In the following detailed part of the present description, the invention will be explained in more detail with reference to the drawing, showing diagrammatically an embodiment of a plant that can be used for carrying out the method according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The plant for conversion and combustion of the combustible organic material comprises various zones placed immediately in sequence in the direction of advancement of the material, and the plant comprises mainly an infeed zone I, a reaction zone II and a combustion zone III. Thus, the combustion device may e.g. be connected to a conventional boiler plant so as to replace or supplement the conventional furnace equipment.

The infeed zone I comprises an infeed system 1 adapted to convey the combustible organic material continuously to the reaction zone II. The infeed system as such may e.g. consist of one or a number of worms or hydraulic systems with reciprocating pistons. Thus, the material is advanced by the infeed system 1 via an infeed channel 2 that may have various cross-sectional shapes. An adjustable obstruction 3 is placed in the infeed channel 2 so as to make it possible to achieve a suitable compacting and partial retaining of the material having been introduced, thus making it possible to establish and maintain a counter-pressure making the material sufficiently impervious to prevent gas and product of combustion from penetrating back into the infeed system 1.

The reaction zone II may be constructed with a reaction chamber 4 consisting of an inner part with through openings 8, preferably in the form of small air nozzles, i.e. having a small cross-sectional area. The through openings 8 are connected to supply ducts 7, e.g. via an air-distribution jacket 9, and accordingly, the gaseous reaction medium enters the reaction chamber 4 via the supply duct 7, the air-distribution jacket 9 and the through openings 8. The supply of reaction medium may be achieved by using commonly known air supply devices, for which reason these devices will not be de-

scribed here. In addition, the reaction chamber 4 consists of an outer part, e.g. comprising an insulating layer 6. The reaction chamber 4 may have any imaginable cross-sectional shape, such as square or oval, but it is preferred that the reaction chamber 4 is a substantially cylindrical device with a length/diameter ratio of at least 1, preferably at least 3-4, to provide sufficient space for an optimum number of through openings 8 for the gaseous reaction mediums.

In this connection it may be mentioned that the gaseous reaction medium being used may e.g. comprise atmospheric air, oxygen, flue gases as well as mixtures thereof, and that the medium must be preheated to a temperature of more than 500°C, preferably between 650 and 900°C. And at the same time - in order to provide a composite product with maximum reactivity - the gaseous reaction medium contains oxygen in a proportion corresponding to a maximum of 25% of the stoichiometric quantity used in connection with a complete combustion, preferably in a proportion of between 15 and 25%.

In order to achieve that the air and the heat are distributed as evenly and as uniformly as possible, it is preferred that the gaseous reaction medium is supplied to the inside of the reaction chamber through the highest possible number of openings. Thus, it is the combination of a small quantity of oxygen, a high velocity and high temperature for the reaction medium, as well as a relatively great length and small diameter of the reaction chamber, that makes it possible to convert large quantities of combustible organic material. At the same time, the small proportion of oxygen contained in the reaction medium enables the reaction temperature to be controlled in such a manner that the formation of molten slag is avoided, thus making it possible to use the slag as a fertilizer.

The converted combustible composite product contains approximately 50% gas and tar as well as approximately 50% powder-like charcoal when leaving the reaction zone II and entering the combustion zone III. The conversion per se is achieved without the use of mechanical means. The internal temperature of the product lies above the ignition temperature of the product, but it is sufficiently low to avoid the formation of molten slag, and the combustible composite product being formed enters the combustion zone, in which the air for combustion is supplied in a controlled manner in order to avoid high combustion temperatures and to prevent or minimize the formation of nitrogen oxides (NO_x).

The combustion zone III comprises an air processor 5 through which the necessary air for combustion may be supplied. The air processor 5 must be of a type that is able to supply the air for combustion in steps, so as to prevent or minimize the formation of nitrogen oxides.

In this embodiment of the combustion zone III, it constitutes a final part of the reaction zone II, but it might just as well be an independent unit downstream of the reaction zone II.

LIST OF PARTS

- I infeed zone
- II reaction zone
- III combustion zone

- 1 infeed system
- 2 infeed channel
- 3 adjustable obstruction
- 4 reaction chamber
- 5 air processor
- 6 insulating layer
- 7 supply ducts
- 8 through openings
- 9 air-distribution jacket

Claims

1. Method for the production and combustion of a combustible product being converted from a combustible organic material in a plant comprising an infeed zone (I), a reaction zone (II) and a combustion zone (III), said plant being capable e.g. of being connected to a conventional boiler plant, wherein
 - a) the combustible organic material is advanced continuously through the infeed zone (I) and fed into the reaction zone (II), in which, in a reaction chamber (4) adapted for the purpose, it is converted using a gaseous reaction medium which is supplied in a controlled condition with regard to quantity, speed and temperature, to a composite combustible product comprising pyrolysis gas, tar and powder-like charcoal and having an internal temperature above the ignition temperature of the product, without molten slag being formed,
 - b) the combustible product formed is made to enter the combustion zone (III), in which the air for combustion is supplied in a manner which avoids high combustion temperatures in order to prevent or minimize the formation of nitrogen oxides,
 - c) that the gaseous reaction medium is supplied to the reaction chamber (4) via a large number of through openings (8) in an inner part of the reaction chamber to achieve that the medium is distributed as evenly as possible,
 - d) that the gaseous reaction medium being used contains a small quantity of oxygen, in a proportion corresponding to a maximum of 25% of the stoichiometric proportion used in connection with a complete combustion, and
 - e) that the gaseous medium being used is preheated to a high temperature, of more than 500°C.

2. Method according to claim 1, **characterized in** that the converted combustible composite product contains approximately 50% gas, especially pyrolysis gas, and tar as well as approx. 50% powder-like charcoal, and that the conversion takes place without the use of mechanical means.
3. Method according to claims 1-2, **characterized in** that the gaseous reaction medium being used may e.g. comprise atmospheric air, oxygen, flue gases as well as mixtures thereof.
4. Method according to claims 1-3, **characterized in** that the gaseous reaction media being used contain oxygen in a proportion corresponding to between 15 and 25% of the stoichiometric proportion used in connection with a complete combustion.
5. Method according to claims 1-4, **characterized in** that the gaseous reaction medium being used is preheated to a temperature of between 650 and 900°C.
6. Plant for use in the production and combustion of a combustible composite product being converted from a combustible organic material in a combustion device comprising an infeed zone (I), a reaction zone (II) and a combustion zone (III), said plant e.g. being capable of being connected to a conventional boiler plant, and in which the various zones are placed in immediate succession in the direction of advancement of the material, wherein the infeed zone (I) comprises an infeed system (1) adapted to convey the material continuously to the reaction zone (II) via an infeed channel (2), **characterized in**
 - a) that the reaction zone (II) comprises a reaction chamber (4) comprising an inner part with a large number of through openings (8), the latter being connected to supply ducts (7) for the gaseous reaction medium, e.g. via an air distribution jacket (9) such that the reaction medium is distributed as evenly as possible, and an inner part e.g. containing an insulating layer (6),
 - b) that the reaction chamber (4) is a substantially cylindrical device with a length/diameter ratio of at least 1, preferably at least 3-4, so as to accommodate an optimum number of through openings (8) for the gaseous reaction medium, and
 - c) that the combustion zone (III) comprises an air processor (5) through which the necessary air for combustion is supplied, in a manner to prevent or minimize the formation of nitrogen oxides.
7. Plant according to claim 6, **characterized in** that the air processor (5) is adapted to supply the air for

combustion in steps, so as to prevent or minimize the formation of nitrogen oxides.

8. Plant according to claims 6-7, **characterized by** an adjustable obstruction (3) being placed in the infeed channel (2) making it possible to make the material more compact and hence maintain a counter-pressure making the material more dense and preventing gas and products of combustion to penetrate back into the infeed system (1).
9. Plant according to claims 6-8, **characterized in** that the combustion zone (III) constitutes a final part of the reaction zone (II).

Patentansprüche

1. Verfahren zur Herstellung und Verbrennung eines brennbaren Produkts, das aus einem brennbaren organischen Material umgewandelt wird, in einer Anlage, umfassend eine Beschickungszone (I), eine Reaktionszone (II) und eine Verbrennungszone (III), wobei die Anlage z.B. geeignet ist, an eine herkömmliche Kesselanlage angeschlossen zu werden, und wobei

a) das brennbare organische Material kontinuierlich durch die Beschickungszone (I) vorwärts befördert wird und der Reaktionszone (II) zugeführt wird, in der es in einer Reaktionskammer (4), die diesem Zweck angepaßt ist, unter Verwendung eines gasförmigen Reaktionsmediums, welches hinsichtlich Menge, Geschwindigkeit und Temperatur unter kontrollierten Bedingungen zugeleitet wird, in ein brennbares Verbundprodukt (Mischprodukt), welches Pyrolysegas, Teer und pulverförmige Kohle enthält, und welches eine innere Temperatur über der Entzündungstemperatur des Produkts hat, ohne daß geschmolzene Schlacke gebildet wird, umgewandelt wird;

b) das gebildete brennbare Produkt in die Verbrennungszone (III) eintreten gelassen wird, in die die Luft zur Verbrennung in einer Art und Weise zugeführt wird, die hohe Verbrennungstemperaturen vermeiden, um die Bildung von Stickstoffoxiden zu verhindern oder zu minimieren;

c) das gasförmige Reaktionsmedium in die Reaktionskammer (4) über eine große Anzahl von Durchgangsöffnungen (8) in einen inneren Teil der Reaktionskammer geleitet wird, um so zu erreichen, daß das Medium so gleichmäßig wie möglich verteilt wird;

d) das verwendete gasförmige Reaktionsmedium eine geringe Menge Sauerstoff enthält, und zwar in einem Anteil, der maximal 25% des

stöchiometrischen Anteils, der in Verbindung mit einer vollständigen Verbrennung verwendet wird, entspricht, und

e) das verwendete gasförmige Medium auf eine hohe Temperatur von mehr als 500°C vorerhitzt wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das umgewandelte brennbare Verbundprodukt etwa 50% Gas, insbesondere Pyrolysegas, und Teer wie auch etwa 50% pulverartige Kohle enthält, und daß die Umwandlung ohne Anwendung mechanischer Mittel stattfindet.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das verwendete gasförmige Reaktionsmedium z.B. atmosphärische Luft, Sauerstoff, Rauchgase wie auch Gemische derselben enthalten kann.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die verwendeten gasförmigen Reaktionsmedien Sauerstoff in einem Anteil enthalten, der zwischen 15 und 25% des stöchiometrischen Anteils ist, der in Verbindung mit einer vollständigen Verbrennung verwendet wird.

5. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das verwendete gasförmige Reaktionsmedium auf eine Temperatur zwischen 650 und 900°C vorerhitzt wird.

6. Anlage zur Verwendung bei der Herstellung und Verbrennung eines brennbaren Verbundproduktes, das aus einem brennbaren organischen Material umgewandelt wird, in einer Verbrennungsvorrichtung, umfassend eine Beschickungszone (I), eine Reaktionszone (II) und eine Verbrennungszone (III), wobei die Anlage z.B. geeignet ist, an eine herkömmliche Dampfkesselanlage angeschlossen zu werden, und die verschiedenen Zonen in ihr in unmittelbarer Aufeinanderfolge in der Beförderungsrichtung des Materials angeordnet sind, wobei die Beschickungszone (I) ein Beschickungssystem (1), das so angepaßt ist, daß das Material kontinuierlich durch einen Beschickungskanal (2) zu der Reaktionszone (II) gebracht wird, umfaßt, dadurch gekennzeichnet, daß

a) die Reaktionszone (II) eine Reaktionskammer (4), welche einen inneren Teil mit einer großen Anzahl von Durchgangsöffnungen (8) enthält, wobei die zuletzt genannten mit Zuführleitungen (7) für das gasförmige Reaktionsmedium z.B. über eine Luftverteilungs-Ummantelung (9) verbunden ist, so daß das Reaktionsmedium möglichst gleichmäßig verteilt wird, und einen inneren Teil, der z.B. eine Isolier-

rungsschicht (6) enthält, umfaßt;
 b) die Reaktionskammer (4) eine im wesentli-
 chen zylindrische Vorrichtung mit einem Länge/
 Durchmesser-Verhältnis von mindestens 1,
 vorzugsweise 3 bis 4 ist, um so eine optimale
 Anzahl von Durchgangsöffnungen (8) für das
 gasförmige Reaktionsmedium unterzubringen;
 und
 c) die Verbrennungszone (III) eine Luftverarbei-
 tungseinheit (5) umfaßt, durch die die zur Ver-
 brennung notwendige Luft in einer Weise zuge-
 führt wird, daß die Bildung von Stickstoffoxiden
 verhindert oder auf ein Minimum beschränkt
 wird.

7. Anlage nach Anspruch 6, dadurch gekennzeichnet, daß die Luftverarbeitungseinheit (5) so angepaßt ist, daß die Luft zur Verbrennung in Schritten zugeleitet wird, um so die Bildung von Stickstoffoxiden zu verhindern oder auf ein Minimum zu beschränken.

8. Anlage nach einem der Ansprüche 6 bis 7, gekennzeichnet durch ein verstellbares Hindernis (3), das im Beschickungskanal (2) angeordnet ist, und das es ermöglicht, das Material kompakter zu machen, und daher einen Gegendruck aufrechterhält, der das Material dichter macht und verhindert, daß Gas und Verbrennungsprodukte zurück in das Beschickungssystem (1) penetrieren.

9. Anlage nach einem der Ansprüche 6 bis 8, dadurch gekennzeichnet, daß die Verbrennungszone (III) einen Endteil der Reaktionszone (II) bildet.

Revendications

1. Procédé de fabrication et de combustion d'un produit combustible obtenu par transformation à partir d'un matériau combustible organique dans une installation comprenant une zone d'introduction (I), une zone de réaction (II) et une zone de combustion (III), ladite installation étant susceptible d'être reliée par exemple à une installation de chaudière conventionnelle, dans lequel

a) le matériau organique combustible est transporté en continu à travers la zone d'introduction (I) et introduit dans la zone de réaction (II), dans laquelle, dans une chambre de réaction (4) adaptée à ce but, il est transformé, en utilisant un milieu réactionnel gazeux qui est fourni en quantité, vitesse et température contrôlées, en un produit composite combustible comprenant du gaz de pyrolyse, du goudron et du charbon pulvérulent et ayant une température interne supérieure à la température d'ignition du pro-

duit, sans formation de scories fondues,

b) le produit combustible formé est introduit dans la zone de combustion (III), dans laquelle l'air pour la combustion est fourni d'une manière qui évite des températures de combustion élevées afin de prévenir ou de réduire à un minimum la formation d'oxydes d'azote,

c) le milieu réactionnel gazeux est fourni à la chambre de réaction (4) via un nombre important de trous traversants (8) dans une partie intérieure de la chambre de réaction pour obtenir une répartition aussi régulière que possible du milieu,

d) le milieu réactionnel gazeux utilisé contient une petite quantité d'oxygène en une proportion correspondant à un maximum de 25 % de la proportion stoechiométrique utilisée en relation avec une combustion complète. et

e) le milieu gazeux utilisé est préchauffé à une température élevée, de plus de 500°C.

2. Procédé selon la revendication 1, caractérisé en ce que le produit composite combustible contient environ 50% de gaz, en particulier du gaz de pyrolyse, et du goudron ainsi qu'environ 50 % de charbon pulvérulent, et en ce que la transformation a lieu sans utilisation de moyens mécaniques.

3. Procède selon les revendications 1 à 2, caractérisé en ce que le milieu réactionnel gazeux utilisé peut comprendre par exemple de l'air atmosphérique, de l'oxygène, des gaz de fumée ainsi que leurs mélanges.

4. Procédé selon les revendications 1 à 3. caractérisé en ce que les milieux réactionnels gazeux utilisés contiennent de l'oxygène en une proportion correspondant à entre 15 et 25 % de la proportion stoechiométrique utilisée en relation avec une combustion complète.

5. Procédé selon les revendications 1 à 4, caractérisé en ce que le milieu réactionnel gazeux utilisé est préchauffé à une température entre 650°C et 900°C.

6. Installation destinée à être utilisée dans la production et la combustion d'un produit composite combustible obtenu à partir d'un produit combustible organique dans un dispositif de combustion comprenant une zone d'introduction (I). une zone de réaction (II) et une zone de combustion (III), ladite installation étant susceptible d'être reliée par exemple à une installation de chaudière conventionnelle, et dans laquelle les diverses zones sont disposées en succession immédiate dans la direction de l'avancement du matériau, dans laquelle la zone d'introduction (I) comprend un système d'introduction (I)

approprié pour transporter le matériau en continu vers la zone de réaction (II) via un canal d'introduction (2), caractérisée en ce que

- a) la zone de réaction (II) comporte une chambre de réaction (4) comprenant une partie intérieure munie d'un nombre important de trous traversants (8), ces derniers étant reliés à des conduits d'alimentation (7) pour le milieu réactionnel gazeux, par exemple via une enveloppe de distribution d'air (9) pour obtenir une répartition du milieu de réaction aussi régulière que possible, et une partie intérieure contenant par exemple une couche d'isolation (6), 5 10
 - b) la chambre de réaction (4) est un dispositif sensiblement cylindrique avec un rapport longueur/ diamètre d'au moins 1, de préférence d'au moins à 4, de manière à loger un nombre optimal de trous traversants (8) pour le milieu réactionnel gazeux, et 15 20
 - c) la zone de combustion (III) comprend un dispositif de traitement de l'air (5) à travers lequel est fourni l'air nécessaire pour la combustion, de manière à empêcher ou réduire à un minimum la formation d'oxydes d'azote 25
7. Installation selon la revendication 6, caractérisé en ce que le dispositif de traitement de l'air (5) est approprié pour fournir de l'air pour une combustion par paliers, de manière à empêcher ou réduire à un minimum la formation d'oxydes d'azote. 30
8. Installation selon les revendications 6 à 7, caractérisé par une obstruction réglable (3) placée dans le canal d'introduction (2), et qui permet de rendre le matériau plus compact et de maintenir ainsi une contre-pression qui conduit à un matériau plus dense et empêche les gaz et les produits de combustion de pénétrer en retour dans le système d'introduction (1). 35 40
9. Installation selon les revendications 6 à 8, caractérisé en ce que la zone de combustion (III) constitue une partie d'extrémité de la zone de réaction (II). 45

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