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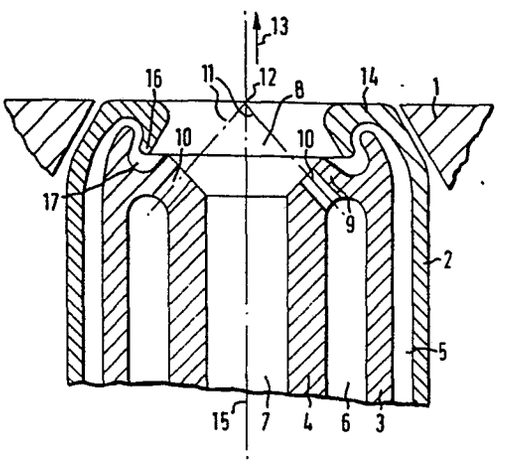
(54) Process and burner for the gasification of solid fuel and gas so prepared.

(57) Process and burner for preparing hydrogen and carbon monoxide by the partial combustion of finely divided solid fuel with oxygen-containing gas using moderator gas. The reactants are separately supplied to an empty reactor through the burner. The solid fuel is passed in a carrier gas centrally (7). The oxygen-containing gas is passed concentrically (6) around and separate from the fuel stream. The moderator gas is passed concentrically (5) around and separate from the oxygen-containing gas.



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PROCESS AND BURNER FOR THE GASIFICATION OF SOLID FUEL AND GAS SO PREPARED

The invention relates to the gasification of finely divided solid fuel.

This gasification - also known as partial combustion - is carried out by reaction of solid fuel with an oxygen-containing gas. The fuel contains as useful components mainly carbon and hydrogen, which react with the oxygen - and possibly with steam and carbon dioxide - to form carbon monoxide and hydrogen. Depending on the temperature, the formation of methane is also possible. In principle, all possible solid materials of vegetable and animal origin, such as coal, brown coal, wood pulp, etc. are suitable as fuel. The oxygen-containing gas is usually air or oxygen or a mixture thereof.

In existing coal gasification processes, coal particles are contacted with the oxygen-containing gas in a reactor in a fixed or fluidized bed at temperatures below 1000°C. The residence time of the coal particles is relatively long (certainly more than one minute). A drawback of said processes is that not all types of solid fuel can be gasified in this manner, which limits the flexibility of said processes. Highly swelling coal, for example, is unsuitable because it sinters together and clogs the reactor. In some cases the high yield of methane of said processes is a disadvantage.

An alternative process has therefore been developed in which finely divided solid fuel is passed into a reactor through a burner at a relatively high velocity and in which process the fuel reacts there in the flame with the oxygen-containing gas at temperatures above 1000°C. In the latter process the residence time of the fuel in the reactor is relatively short (usually less than 10 seconds). By this process it is possible to gasify all types of solid fuel. The methane yield is low. The process can be carried out at high pressure.

In the latter process the fuel is usually passed in a carrier gas to the reactor through the burner, while the oxygen-containing

gas is also passed to the reactor through the burner. Since the solid fuel, even if it is finely divided, is usually less reactive than liquid or gaseous fuel (it cannot be atomized by the burner) great care is bestowed on the manner in which the fuel and oxygen are mixed. When the mixing in the reactor is insufficient, zones of underheating occur in the reactor next to zones of overheating, since part of the fuel does not receive enough oxygen and an other part of the fuel receives too much oxygen. Part of the fuel is then not fully gasified and an other part is converted completely into carbon dioxide and water vapour. A drawback of locally high temperatures in the reactor is that damage is caused to the refractory lining which is usually provided therein.

In order to check the temperature in the reactor a water vapour-containing moderator gas is often supplied to the reactor. The water vapour reacts with part of the fuel, with the formation of hydrogen and carbon monoxide. The reaction in question is endothermic. The moderator gas can be supplied to the reactor through the burner or otherwise.

In order to ensure a good mixing of fuel and oxygen-containing gas it has already been proposed to have the mixing already take place in or upstream of the burner. A great disadvantage thereof is, however, that - especially when the gasification is carried out at high pressure - the design and operation of an apparatus suitable for said purpose is highly critical. The fact is that the time elapsing between the moment of mixing and the moment when the mixture enters the reactor must invariably be shorter than the combustion induction time of said mixture. This induction time decreases substantially at a rise in the gasification pressure. In view of this problem it should be borne in mind that the fuel is supplied in a carrier gas, that the fuel load of the carrier gas must be high to ensure that the carrier gas does not constitute an excessive thermal ballast and that the quantity of oxygen to be supplied is related to the quantity of fuel supplied, but that in spite of all these limiting factors it should be possible to operate the reactor at a variable production rate, that is to supply fuel

in alternately large and small quantities through one and the same burner. It will be obvious that when supplying a small quantity of fuel (carrier gas) together with a small quantity of oxygen-containing gas the velocity in the burner will be low, so that the above-mentioned induction time is reached or exceeded.

The object of the present invention is to remove these drawbacks and provide a process in which on the one hand the fuel and the oxygen-containing gas are only mixed near the end of the burner and on the other hand an intensive mixing is reached in an early stage, i.e. at the entrance of the fuel and the oxygen-containing gas into the reactor - without causing overheating of the reactor wall near the burner.

The invention therefore relates to a process for the preparation of a gas comprising hydrogen and carbon monoxide by the partial combustion of a finely divided solid fuel with an oxygen-containing gas using a moderator gas, in which said three components are each separately supplied to an empty reactor space through a burner, which process in characterized in that the solid fuel is passed in a carrier gas centrally through the burner, the oxygen-containing gas is passed through the burner concentrically around and separate from the fuel stream, and the moderator gas is passed through the burner concentrically around and separate from the oxygen-containing gas.

Now that the moderator gas surrounds the streams of fuel and oxygen-containing gas flowing out of the burner and a degree of tolerance is formed in respect of the velocity at which and the direction in which the moderator gas and the oxygen-containing gas leave the burner, on the one hand an effective mixing of fuel and oxygen-containing gas can be ensured and, on the other hand, satisfactory cooling of the reactor wall near the burner can be effected, since the moderator gas comes into contact therewith.

Moreover, the jacket of moderator gas which surrounds the streams of fuel-containing gas and oxygen-containing gas in the reactor immediately beside the burner, prevents that the hot mixture of carbon monoxide and hydrogen which has formed in the reactor

become prematurely mixed with the stream of oxygen-containing gas (whereby a considerable degree of overheating is prevented in the vicinity of the burner mouth). The formation of a hot flame front at the burner mouth is thus prevented.

In order to obtain a good mixing of fuel-containing gas and oxygen-containing gas, according to the invention it is preferably ensured that the fuel-containing carrier gas leaves the burner with an exactly axial moment and that the oxygen-containing gas leaves the burner with an axial moment and an inwardly directed radial moment. In this way, the stream of oxygen-containing gas is directed to the stream of fuel-containing carrier gas outside the burner.

In this specification by "moment" of a gas stream is meant the product of the mass throughput and velocity (in v), the mass throughput being the number of kg of mass of the relevant stream per second leaving the burner. The mass throughput is expressed in kg of mass/second and the velocity in m/sec.

A good mixing is usually obtained in practice when the ratio between the radial moment of the oxygen-containing gas and the axial moment of the fuel-containing carrier gas is between 0.2 and 1.0.

The process according to the present invention enables the use of a burner of which at the front part a wall adjoins with its front face the reactor space, said wall being cooled on the inside of the burner with the moderator gas. In this manner a satisfactory protection of the front part of the burner is obtained.

The moderator gas preferably leaves the burner with an axial moment and an inwardly directed radial moment. Consequently, it is prevented that the fuel-containing gas and the oxygen-containing gas become mixed in a premature stage with hot carbon monoxide and hydrogen and come into contact with the reactor wall near the burner, so that local overheating is prevented.

The process according to the invention can of course also be carried out by means of two or more burners debouching into the gasification reactor.

The invention also relates to a burner for carrying out the

present process. Such a burner has a central passage for fuel-containing carrier gas and concentric passages for oxygen-containing gas and moderator gas around said central passage.

According to the invention said burner has outlet openings for the oxygen-containing gas which are directed obliquely forward to one point and one or more outlet openings for the moderator gas running mainly parallel with the former openings. With a burner of this type good results are obtained.

The front part of said burner is provided with a wall having a front face normal to the burner axis, along the inside of said wall the passage for moderator gas is located, which passage changes direction at this point. In this manner a satisfactory cooling of the burner front is obtained.

The invention will be further illustrated below with reference to the appertaining drawing.

The drawing shows diagrammatically an axial cross-section of the front part of a burner according to an embodiment of the invention.

The burner is fitted in an opening of the reactor wall 1, which is shown diagrammatically and comprises an outer wall 2 and an inner double wall 3,4. Between the outer wall 2 and the outer double wall 3 is an annular space 5 for the passage of the moderator gas. Between the double walls 3 and 4 is an annular space 6 for the passage of oxygen-containing gas and within the inner double wall 4 is an axial passage 7 for carrier gas with finely divided solid fuel.

The passage 7 debouches directly into the space 8 within the burner mouth. The fronts of the double walls 3,4 are connected by a connecting wall 9. In this wall a number of bores 10 are provided, the centrelines 11 of which are located in a conical plane, the apex 12 of which lies in or even beyond the space 8 seen in the direction of flow 13. The bores 10 form the connection between the space 6 and the space 8.

The front of the outer wall 2 is provided with a front face 14 which is directed normal to the centreline 15 of the burner and

has also an inwardly directed end 16 which fits loosely in an annular slot 17 of the connecting wall 9. In this manner the space 5 extends near the burner front along the inside of the front face 14 and said space 5 nevertheless debouches into the space 8 in a direction which is substantially parallel to the bores 10.

During operation the burner injects a well-mixed stream of fuel and oxygen, surrounded by a jacket of moderator gas, into the reactor, the front part of the burner being cooled by moderator gas.

It will be obvious that numerous alterations can be made to the burner shown. For example, the number of bores 10 may be varied or replaced by an annular slit and the annular slot 17 can be replaced by separate bores.

CLAIMS

1. A process for the preparation of a gas comprising hydrogen and carbon monoxide by the partial combustion of a finely divided solid fuel with an oxygen-containing gas using a moderator gas, in which process said three components are each separately supplied to an empty reactor space through a burner, characterized in that the solid fuel is passed in a carrier gas centrally through the burner, the oxygen-containing gas is passed through the burner concentrically around and separate from the fuel stream, and the moderator gas is passed through the burner concentrically around and separate from the oxygen-containing gas.

2. A process as claimed in claim 1, characterized in that the fuel-containing carrier gas leaves the burner with an exactly axial moment and the oxygen-containing gas leaves the burner with an axial moment and an inwardly directed radial moment.

3. A process as claimed in claim 2, characterized in that the ratio between the radial moment of the oxygen-containing gas and the axial moment of the fuel-containing carrier gas is between 0.2 and 1.0.

4. A process as claimed in claims 1, 2 or 3, characterized in that use is made of a burner of which at the front part a wall adjoins with its front face the reactor space and that said wall is cooled on the inside of the burner with the moderator gas.

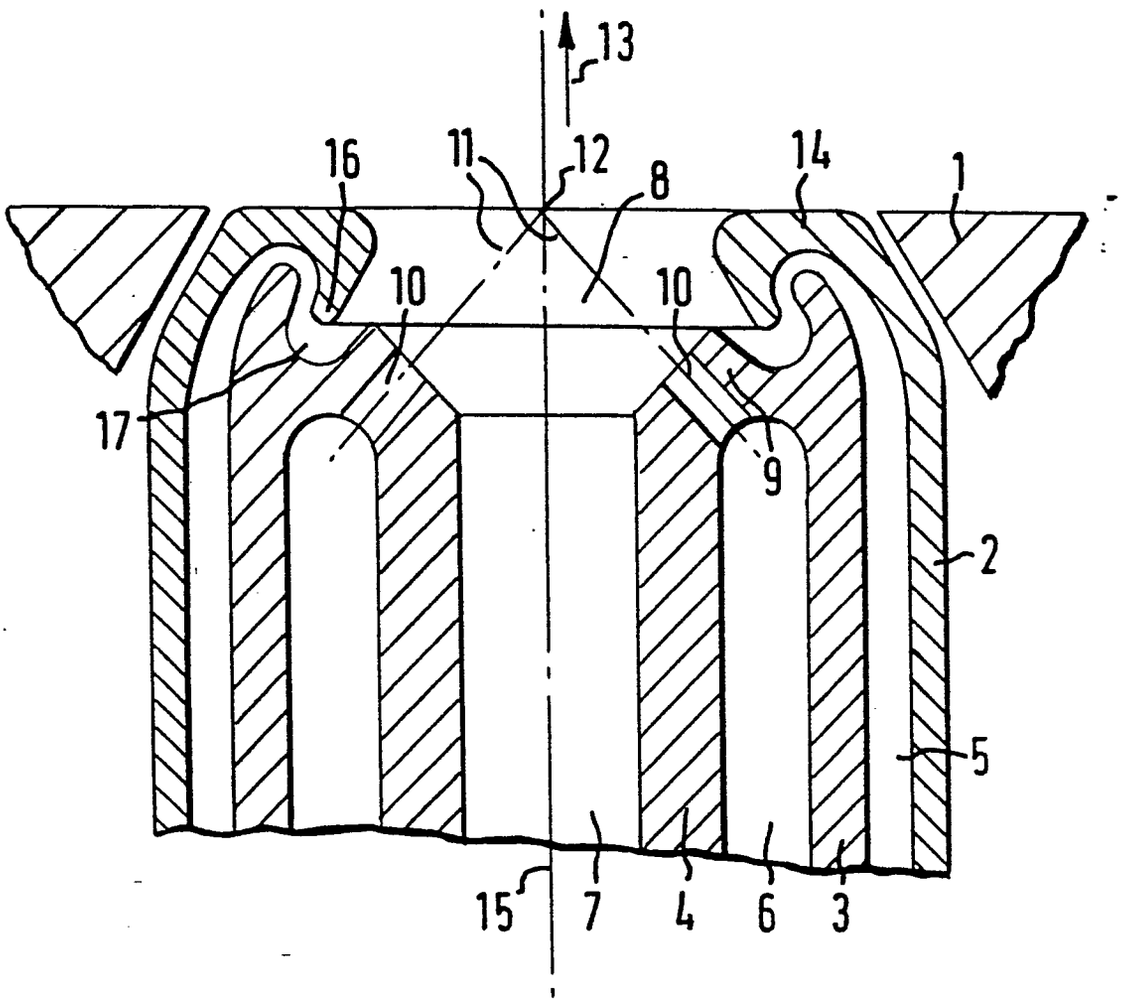
5. A process as claimed in claims 1,2, 3 or 4, characterized in that the moderator gas leaves the burner with an axial moment and an inwardly directed radial moment.

6. A burner for carrying out the process as claimed in any one of the preceding claims, characterized in that it is provided with a central passage (7) for fuel-containing carrier gas and concentric passages for oxygen-containing gas (6) and moderator gas (5) around said central passage, outlet openings (10) for the oxygen-containing gas being directed obliquely forward to one point, and one or more outlet openings (17) for the moderator gas extending mainly parallel with the former openings, and in that the burner is further provided

with a wall (2) having a front face (14) normal to the burner axis, along the inside of said wall the passage (17) for moderator gas is located, which passage changes direction at this point.

7. A burner substantially as hereinbefore described with special reference to the drawing.

8. A gas comprising hydrogen and carbon monoxide whenever prepared by the process as claimed in any one of claims 1-5.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European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80 20 0355

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 3 847 564 (MARION) * Column 8, lines 37-39; column 9, lines 40-69; column 10, lines 1-69; column 11, lines 1-69; column 12, lines 1-46 *	1,2,5, 6,7,8
	FR - A - 1 203 262 (BATAAFSCHE PETROLEUM MAATSCHAPPIJ) * Page 2, right-hand column, paragraph 2 *	1,4
A	GB - A - 911 374 (KOPPERS)	
A	FR - A - 2 286 104 (TEXACO)	
A	FR - A - 978 135 (KOPPERS)	
A	FR - A - 1 089 366 (BASF)	
A	LU - A - 35 569 (TEXACO)	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

C 10 J 3/46
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TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

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CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10-09-1980	WENDLING