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PATENT SPECIFICATION

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780,120

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International Classification :—C10b, j.

COMPLETE SPECIFICATION

Improvements in or relating to Processes for preparing Gas Mixtures containing Hydrogen and Carbon Monoxide

PATENT OFFICE

We, N. V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ, a company organised under the laws of The Netherlands, of 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to processes for preparing gas mixtures containing hydrogen and carbon monoxide.

It is known to obtain, by partial combustion of hydrocarbon material a gaseous mixture consisting mainly of hydrogen and carbon monoxide. The gas mixtures obtained, however, always contain soot, since, when there is incomplete combustion, the formation of free carbon is practically unavoidable, and this is a great drawback, for this soot usually has to be separated from the gas mixture before the latter can be used, e.g. for the purpose of synthesis.

A process has now been found for the partial combustion of gaseous, liquid or solid (e.g. asphalt) hydrocarbon material in which the resulting gas mixtures containing hydrogen and carbon monoxide contain very little soot. If desired also, the process may be applied to the partial combustion of powdered coal. The new process is particularly important for the partial combustion of high molecular hydrocarbons such as heavy oils or asphalt, since hitherto there has been heavy soot formation in the desired conversion of such products.

In a process according to the invention for preparing gas mixtures containing hydrogen and carbon monoxide by partial combustion of hydrocarbon material with oxygen-containing gas, the hydrocarbon material is atomized and injected in the form of a hollow conical jet coaxially into one end of a cylindrical or substantially cylindrical combustion chamber the length of which is less than five times the diameter, the oxygen-containing gas being introduced through an opening at the same end of the combustion chamber as the conical jet with a rotary motion about the axis such that two toroidal vortices are formed inside the combustion chamber, which causes a rapid mixing of the hydrocarbon material with the oxygen-containing gas and a rapid rate of combustion, such that the combustion time is less than 4 seconds, and the pressure in the combustion chamber being at least 3 atmospheres.

Apparatus for carrying out a process according to the invention and a specific example of its use will now be described by way of example with reference to the accompanying drawing in which, Fig. 1 is a longitudinal cross-section of the apparatus and Fig. 2 a vertical cross-section on the line II—II of Fig. 1.

As shown in Fig. 1, the apparatus comprises an atomizer holder 1 to which the hydrocarbon material is supplied at one end as indicated by the arrow 7. The hydrocarbon is atomized by a whirl chamber atomizer situated at the other end of the holder 1 and injected into the combustion chamber 2 so as to form a hollow conical jet. Although an atomizer operated by means of the fuel pressure alone is preferred, since in this way a fine atomization can be obtained in a simple manner, it is also possible to use an atomizer requiring a stream of an auxiliary atomizing fluid such as air or steam, provided a hollow conical jet is obtained. The atomizer holder 1 is mounted in the oxygen chamber 3 which is mainly cylindrical. The combustion chamber 2, also mainly cylindrical has walls of refractory material and communicates with the oxygen chamber 3 through an opening 5 which has a diameter smaller than the diameter of the chambers 2 and 3. The diameter of the oxygen chamber 3 should be 1½—2 times as great as that of the opening 5. The combustion chamber 2 is provided with an annular ridge 4 to which the shape of the oxygen chamber 3 is adapted.

The atomizer is arranged in the oxygen chamber 3 in a position such that the hollow conical jet of atomized hydrocarbon passes near

[Price 3s. 6d.]

the edge of the opening 5 on entering the combustion chamber 2. This position will depend on the apex angle of the cone which is determined by the properties of the hydrocarbon, the construction of the atomizer and the pressure with which the fuel is applied to it.

The oxygen chamber 3 is provided at its periphery with a number of tangential slots or nozzles 9 (see Fig. 2) which are placed at regular intervals around the circumference and through which oxygen-containing gas from the case 10 can flow tangentially into the oxygen chamber 3. During operation oxygen-containing gas is introduced into the case 10 at a suitable super-atmospheric pressure. Owing to the tangential component of flow on entering the oxygen chamber 3, the oxygen-containing gas flows with a rotary motion about the axis of the chamber 3 towards the opening 5, and as the diameter of the opening is smaller than that of the oxygen chamber, the speed of rotation increases considerably as the gas flows towards the opening 5.

The result is that the conical jet of fuel in passing close to the edge of the opening 5 is forcibly entrained by the stream of oxygen-containing gas also entering the combustion chamber 2 through the opening 5, and a very intimate mixing of the hydrocarbon and oxygen-containing gas occurs, which promotes both ignition and combustion in the combustion chamber 2. The wall of the combustion chamber 2 which, when the apparatus is operating, is hot, imparts heat to the hydrocarbon by radiation and thus promotes the evaporation, vaporization, ignition and combustion thereof. Moreover, the shape of the chamber 2 is such that, as shown in the drawing, toroidal vortices are formed both inside and outside the conical fuel jet which, particularly in the case of the outermost vortex situated near the ridge 4, return an already burning mixture to the place where the ignition has to occur and thus promote the ignition of the hydrocarbon entering the combustion chamber 2.

A tube 6 is also provided which surrounds the atomizer holder 1. A combustible gas can be supplied to the tube 6 through the inlet 8 and can enter the air chamber around the atomizer nozzle. It has been found that in the apparatus a combustible gas can be burnt either at the same time as a liquid hydrocarbon or separately. The gaseous fuel can be used when there is a temporary shortage of the liquid hydrocarbon.

The oxygen-containing gas supplied preferably consists either of substantially pure oxygen or air to which, if desired, additional oxygen has been added.

The amount of oxygen to be used will, of course, have to be smaller than the quantity required for a complete combustion of the hydrocarbon. When heavier hydrocarbons are used as initial material, the oxygen-containing gas used may be mixed with steam, before being passed into the reaction chamber. Usually a mixture of approximately equal parts by weight of oxygen and steam is supplied for the partial combustion of heavy products. Preferably approximately 1.25 kg of oxygen are used per kg of hydrocarbon.

The reaction is carried out at a temperature of from 1200—1500° C., and preferably from 1300—1400° C. The pressure used is at least 3 atmospheres, and is preferably higher than 10 atmospheres. The pressure used depends on the pressure at which the gas mixture formed is further processed. Thus the combustion reaction is carried out at elevated pressure if the gas mixture formed is used, for example, for an ammonia synthesis, which is carried out at a very high pressure. When the pressure is greater than 3 atmospheres, the advantage obtained is that the small amount of soot which is present in the resulting gas mixture may be very easily removed by scrubbing with water. The partial combustion lasts for less than 4 seconds. Such a short reaction time is very important for the prevention of undesired side reactions. The gas mixture formed is preferably rapidly cooled. Such a short reaction time is possible with the use of the apparatus described above since there is an intimate mixing in the reaction chamber immediately after the introduction of the reaction components, and also an immediate combustion of the reaction mixture obtained.

The specific gravity and viscosity of the heavier hydrocarbons to which the invention is particularly applicable may vary between wide limits. Thus the specific gravity may lie between approximately 0.90 and 1.05; the viscosity may vary between that of a gas oil and that of an asphalt with a penetration of 10—20 at 25° C., as determined by the Institute of Petroleum's Standard Method IP 49/56 for measuring the penetration of bitumen, which is set out at p 371—4 of "Standard Methods for testing Petroleum and its Products" (16th Edition) published by the Institute of Petroleum. Heavy products of this type are preheated before being atomized. The mixture of oxygen-containing gas and steam supplied is also preferably preheated before being fed into the combustion chamber 2.

Example

An apparatus of the design shown in Figs. I and II, the combustion chamber of which was 160 cm long and had a diameter of 40 cm, was used for the partial combustion of a high sulphur residual fuel oil with a viscosity of 3500 sec. Redwood I at 37.8° C. Preheated oxygen and super-heated steam, preheated to about 400° C., were passed into the combustion chamber under a pressure of 20 atmospheres and at a temperature of about 1300° C. For each 100 kg of oil supplied 85 cubic metres (measured at N.T.P.) of oxygen and 90 kg of steam were supplied to give 310 cubic metres

(measured at N.T.P.) of a gas mixture having approximately the following composition:—

	Vol %
H_2S	0.8
CO_2	11.8
CO	37.4
H_2	48.1
CH_4	0.6
N	1.3

and a small amount of carbon black. After a quenching with water or passage through a waste boiler the gas mixture was scrubbed with 9 m³ water. The gas mixture left the scrubber free from carbon black and containing only 0.01 vol. % of H_2S.

What we claim is:—

1. A process for preparing gas mixtures containing hydrogen and carbon monoxide by partial combustion of hydrocarbon material with oxygen-containing gas in which the hydrocarbon material is atomized and injected in the form of a hollow conical jet coaxially into one end of a cylindrical or substantially cylindrical combustion chamber the length of which is less than five times the diameter, the oxygen-containing gas being introduced through an opening at the same end of the combustion chamber as the conical jet with a rotary motion about the axis such that two toroidal vortices are formed inside the combustion chamber, which cause a rapid mixing of the hydrocarbon material with the oxygen-containing gas and a rapid rate of combustion, such that the combustion time is less than 4 seconds, and the pressure in the combustion chamber being at least 3 atmospheres.

2. A process according to Claim 1, in which the hydrocarbon material is a product having a viscosity between that of a gas oil and that of an asphalt with a penetration as determined by the Institute of Petroleum's Standard Method IP 49/56, of 10—20 at 25° C., the oxygen-containing gas being mixed with steam.

3. A process according to Claim 2 in which oxygen and steam are supplied in equal parts by weight.

4. A process according to any one of Claims 1—3 in which the oxygen-containing gas is a stream of air.

5. A process according to any one of Claims 1—4 in which the weight of oxygen supplied is 1.25 times the weight of hydrocarbon material.

6. A process according to any one of Claims 1—5, in which the combustion is carried out at a temperature of from 1200—1500° C.

7. A process for preparing gas mixtures containing hydrogen and carbon monoxide substantially as hereinbefore described with reference to the accompanying drawing, or in the example.

8. Apparatus for carrying out a process according to any one of Claims 1—7 substantially as hereinbefore described with reference to the accompanying drawing.

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PATENTS ACT, 1949

SPECIFICATION NO. 780,120

In accordance with the Decision of the Superintending Examiner, acting for the Comptroller-General, dated the sixteenth day of January, 1959, this Specification has been amended under Section 14 in the following manner:—

Page 1, line 17, *for* "always" *read* "generally".

Page 1, line 61, *after* "Fig. 1." *insert* "Such apparatus is the subject of our Patent 703,721.".

Page 3, *delete* lines 62-65.

THE PATENT OFFICE,
12th February, 1959

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(measured at N.T.P.) of a gas mixture having approximately the following composition:—

	Vol %
H_2S	0.8
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