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PATENT SPECIFICATION

Application Date: May 10, 1940. No. 8440/40. **573,923**

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Specification Accepted: Dec. 13, 1945.

3620

PROVISIONAL SPECIFICATION
No. 8440 A.D. 1940.

A Process for the Production of Gas Mixtures containing Carbon Monoxide and Hydrogen

I, MICHAEL STEINSCHLAEGER, of no nationality, formerly of Russian nationality, of 50, Portsea Hall, Connaught Square, London, W.2, do hereby declare the nature of this invention to be as follows:—

This invention relates to the production of gaseous mixtures containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch process.

In order to carry out the Fischer-Tropsch process in the most satisfactory manner the proportion of hydrogen to carbon monoxide should be between about 1.8 and 2.0 volumes of hydrogen per volume of carbon monoxide.

Gases occurring in nature or artificially produced do not have the desired composition because they are usually rich in carbon monoxide. It is therefore necessary to apply particular processes in order to obtain gases rich in hydrogen, which are then mixed with gases rich in carbon monoxide.

When coal is coked, coke and coke oven gas are obtained. Water gas, a gas rich in carbon monoxide, may be obtained from the coke, and a gas rich in hydrogen may be produced from the coke oven gas by heating it with steam. If these gases are mixed a synthesis gas is obtained containing $CO:H_2$ in the proportion of 1:2. This process has the drawback that the coke being formed during coking and gasification is never completely used up and consequently the coal consumption is too high.

It is an object of the present invention to overcome the aforesaid drawback and produce a gas mixture which can be satisfactorily utilised in the Fischer-Tropsch process in a cheap and efficient manner or to produce a gas mixture which by the mere addition of water gas will contain hydrogen and carbon monoxide in the correct proportions.

With this object in view, the process of the present invention for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1100° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a temperature between 160 and 250° C., to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 800 and 900° C. in the presence of a nickel or iron catalyst to produce a gas which on admixture with normal blue water gas is suitable for use in the Fischer-Tropsch process.

The cobalt, nickel or iron catalyst employed may, if desired, be activated with an activator such as thoria and the catalyst may be mixed with a carrier such as kieselguhr, magnesia, silica, pumice or aluminium earths.

All the gases employed in the process should be purified so that they contain not more than 0.4 gms. of total sulphur per 100 cubic metres of gas.

The following example illustrates how the process of the invention may be carried into effect.

Coke was treated with 200% of the theoretical proportion of steam required for the blue water gas reaction at a temperature of 950° C. and there was thus produced a gas having the following composition:—$CO = 36.0\%$, $H_2 = 53.0\%$, $CH_4 = 1.0\%$, $CO_2 = 7.0\%$ and $N_2 = 3.0\%$. This gas was washed with a solution

[*Price* 1/-]

containing a mixture of alkylolamine bases to remove carbon dioxide and a gas was obtained having the following composition:—$CO = 33.4\%$, $H_2 = 56.4\%$, $CH_4 = 1.0\%$, $CO_2 = 1.0\%$ and $N_2 = 8.2\%$. 1,000,000 cubic metres of this gas was mixed with 500,000 cubic metres of a coke oven gas having the following composition:—$CO = 7.0\%$, $H_2 = 54.0\%$, $C_nH_m = 3.6\%$, $CH_4 = 29.0\%$, $N_2 = 4.4\%$ and $CO = 2.0\%$. There was thus produced 1,500,000 cubic metres of a gas hereinafter referred to as Synthesis Gas I of the following composition:—$CO = 27.5\%$, $H_2 = 55.3\%$, $CH_4 = 10.4\%$, $C_nH_m = 1.2\%$ and $CO_2 + N_2 = 5.6\%$. The Synthesis Gas I was then passed over a cobalt catalyst activated with thoria and mixed with a kieselguhr carrier at a temperature of 160—220° C. and there was obtained per cubic metre of Synthesis Gas I a yield of 70 gms. of primary products and 0.5 cubic metre of residual gas hereinafter referred to as Residual Gas I. It will thus be seen that a contraction of volume of 50% took place. The Residual Gas I had the following composition:—$CO = 21.5\%$, $H_2 = 32.9\%$, $CH_4 = 32.0\%$, $C_nH_m = 2.4\%$ and $CO_2 + N_2 = 11.2\%$. The Residual Gas I was then mixed with steam in the proportion of 0.56 kgm. of steam per cubic metre of gas and the mixture heated in the presence of a nickel catalyst containing 10% by weight of magnesium oxide at a temperature of 800° C. There was thus obtained per cubic metre of Residual Gas I 2.15 cubic metres of a gas of the following composition:—$CO = 24.0\%$, $H_2 = 67.0\%$, $CH_4 = 1.0\%$ and $CO_2 + N_2 = 8.0\%$. 1,610,000 cubic metres of this gas were then mixed with 1,000,000 cubic of blue water gas and there was thus obtained 2,610,000 cubic metres of a gas hereinafter referred to as Synthesis Gas II of the following composition:—$CO = 30.5\%$, $H_2 = 61.0\%$, $CH_4 = 0.7\%$ and $CO_2 + N_2 = 7.8\%$. By subjecting this Synthesis Gas II to the Fischer-Tropsch process about 140 gms. of primary products and 0.25 cubic metre of residual gas can be obtained per cubic metre of gas.

The residual gas hereinafter referred to as Residual Gas II obtained after the Synthesis Gas II has been subjected to the Fischer-Tropsch process (the composition of the Residual Gas II was as follows:—$CO = 21.0\%$, $H_2 = 34.0\%$, $CH_4 = 14.0\%$, and $CO_2 + N_2 = 31.0\%$) may be used for heating the coke oven plant, the plant employed in treating the Residual Gas I with steam and for heating the plant employed in the sulphur purification and it is then found that the coal consumption is about 3.6 tons of coal per ton of primary products produced. The expression "primary products" does not include the oil yield in the coke oven plant.

Dated this 10th day of May, 1940.

ELKINGTON & FIFE,
Consulting Chemists & Chartered Patent Agents,
20 to 23, Holborn, London, E.C.1,
Agents for the Applicant.

PROVISIONAL SPECIFICATION

No. 8441 A.D. 1940.

A Process for the Production of Gas Mixtures containing Carbon Monoxide and Hydrogen

I, MICHAEL STEINSCHLAEGER, of no nationality, formerly of Russian nationality, of 50, Portsea Hall, Connaught Square, London, W.2, do hereby declare the nature of this invention to be as follows:—

This invention relates to the production of gaseous mixtures containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch process.

In order to carry out the Fischer-Tropsch process in the most satisfactory manner the proportion of hydrogen to carbon monoxide should be between about 1.8 and 2.0 volumes of hydrogen per volume of carbon monoxide.

Gases occurring in nature or artificially produced do not have the desired composition because they are usually rich in carbon monoxide. It is therefore necessary to apply particular processes in order to obtain gases rich in hydrogen, which are then mixed with gases rich in carbon monoxide.

When coal is coked, coke and coke oven gas are obtained. Water gas, a gas rich in carbon monoxide, may be obtained from the coke, and a gas rich in hydrogen may be produced from the coke oven gas by heating it with steam. If these gases are mixed a synthesis gas is obtained containing CO—H_2 in the proportion of 1:2. This process has the drawback that the coke being formed during coking and gasification is never completely used up and consequently the coal consumption is too high.

It is an object of the present invention to overcome the aforesaid drawback and produce a gas mixture which can be satisfactorily utilised in the Fischer-Tropsch process in a cheap and efficient manner or to produce a gas mixture which by the mere addition of water gas will contain hydrogen and carbon monoxide in the correct proportions.

With this object in view, the process of the present invention for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1000° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a temperature between 160 and 250° C., to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 1200 and 1500° C. in the absence of a catalyst to produce a gas which on admixture with normal blue water gas and a gas obtained by heating normal blue water gas with steam in the presence of a cobalt or nickel catalyst at a temperature of between 400 and 550° C. and then separating carbon dioxide is suitable for use in the Fischer-Tropsch process.

The cobalt, nickel or iron catalyst employed may, if desired, be activated with an activator such as thoria and the catalyst may be mixed with a carrier such as kieselguhr, magnesia, silica, pumice or aluminium earths.

All the gases employed in the process should be purified so that they contain not more than 0.4 gms. of total sulphur per 100 cubic metres of gas.

The following example illustrates how the processes of the invention may be carried into effect:

Coke was treated with 175% of the theoretical proportion of steam required for the blue water gas reaction at a temperature of 950° C. and there was thus produced a gas having the following composition:—$CO=36.0\%$, $H_2=53.0\%$, $CH_4=1.0\%$, $CO_2=7.0\%$ and $N_2=3.0\%$. This gas was washed with water under pressure to remove carbon dioxide and a gas was obtained having the following composition:—$CO=38.4\%$, $H_2=56.4\%$, $CH_4=1.0\%$, $CO_2=1.0\%$ and $N_2=3.2\%$. 1,000,000 cubic metres of this gas was mixed with 500,000 cubic metres of a coke oven gas having the following composition:—$CO=7.0\%$, $H_2=54.0\%$ $C_nH_m=3.6\%$, $CH_4=29.0\%$, $N_2=4.4\%$ and $CO_2=2.0\%$. There was thus produced 1,500,000 cubic metres of a gas hereinafter referred to as Synthesis Gas I of the following composition:—$CO=27.5\%$, $H_2=55.3\%$, $CH_4=10.4\%$, $C_nH_m=1.2\%$ and $CO_2+N_2=5.6\%$. The Synthesis Gas I was then passed over a cobalt catalyst activated with thoria and mixed with a kieselguhr carrier at a temperature of 160—220° C. and there was obtained per cubic metre of Synthesis Gas I a yield of 70 gms. of primary products and 0.5 cubic metre of residual gas hereinafter referred to as Residual Gas I. It will thus be seen that a contraction of volume of 50% took place. The Residual Gas I had the following composition:—$CO=21.5\%$, $H_2=32.9\%$, $CH_4=32.0\%$, $C_nH_m=2.4\%$ and $CO_2N_2=11.2\%$. The Residual Gas I was then mixed with steam in the proportion of 1.10 kgm. of steam per cubic metre of gas and the mixture heated in the absence of a catalyst at a temperature of 1250° C. There was thus obtained a gas of the following composition:—$CO=27.5\%$, $H_2=59.0\%$; $CH_4=32.0\%$, $C_nH_m=2.4\%$ and $CO_2+N_2=11.2\%$. The Residual Gas I was then mixed with steam in the proportion of 1.10 kgm. of steam per cubic metre of gas and the mixture heated in the absence of a catalyst at a temperature of 1250° C. There was thus obtained a gas of the following composition:—$CO=27.5\%$, $H_2=59.0\%$; $CH_4=1.2\%$ and $CO_2+N_4=12.8\%$. 1,510,000 cubic metres of this gas were then mixed with 700,000 cubic metres of blue water gas and 170,000 cubic metres of a gas obtained by heating blue water gas with steam in the presence of a nickel catalyst at 450° C. and then separating carbon dioxide by treatment with an aqueous solution containing a mixture of alkylolamine bases, and there was thus obtained 2,380,000 cubic metres of a gas hereinafter referred to as Synthesis Gas II of the following composition:—$CO=29.7\%$, $H_2=59.3\%$, $CH_4=0.9\%$, $CO_2+N_2=10.1\%$. By subjecting it to the Fischer-Tropsch process about 140 gms. of primary products and 0.25 cubic metres of residual gas can be obtained per cubic metre of gas.

The residual gas hereinafter referred as Residual Gas II obtained after the Synthesis Gas II has been subjected to the Fischer-Tropsch process may be used for heating the coke oven plant, the plant employed in treating the Residual Gas I with steam and for heating the plant employed in the sulphur purification and it is then found that the coal consumption is about 3.8 tons of coal per ton of primary products produced. The expression "primary products" does not include the oil yield in the coke oven plant.

Dated this 10th day of May, 1940.
ELKINGTON & FIFE,
Consulting Chemists & Chartered Patent Agents,
20 to 23, Holborn, London, E.C.1,
Agents for the Applicant.

COMPLETE SPECIFICATION

A Process for the Production of Gas Mixtures containing Carbon Monoxide and Hydrogen

I, MICHAEL STEINSCHLAEGER, of no nationality, formerly of Russian nationality, of 50, Portsea Hall, Connaught Square, London, W.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the production of gaseous mixtures containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch process.

In order to carry out the Fischer-Tropsch process in the most satisfactory manner the proportion of hydrogen to carbon monoxide should be between about 1.8 and 3.0 volumes of hydrogen per volume of carbon monoxide.

Gases occurring in nature or artificially produced do not have the desired composition because they are usually rich in carbon monoxide. It is therefore necessary to apply particular processes in order to obtain gases rich in hydrogen which are then mixed with gases rich in carbon monoxide.

When coal is coked, coke and coke oven gas are obtained. Water gas, a gas rich in carbon monoxide, may be obtained from the coke, and a gas rich in hydrogen may be produced from the coke oven gas by heating it with steam. If these gases are mixed a synthesis gas is obtained containing $CO:H_2$ in the proportion of 1:2. This process has the drawback that the coke being formed during coking and gasification is never completely used up and consequently the coal consumption is too high.

Specification No. 513,778 describes a process for the production of gaseous mixtures containing carbon monoxide and hydrogen and suitable for conversion into hydrocarbons in which a gas mixture consisting principally of carbon monoxide and hydrogen, for example water gas is mixed with coal distillation gases and the resulting mixture is passed over a catalyst, for example a cobalt or nickel catalyst, producing gases rich in methane, these gases being then converted at 1400—1450° C. with steam in a decomposing plant lined with refractory bricks, yielding a gas consisting principally of a mixture of carbon monoxide and hydrogen.

It is an object of the present invention to overcome the aforesaid drawback and produce a gas mixture which can be satisfactorily utilised in the Fischer-Tropsch process in a cheaper and more efficient manner than by the process of the aforesaid Specification No. 513,778, or to produce a gas mixture which by the mere addition of water gas will contain hydrogen and carbon monoxide in the correct proportions.

With this object in view, the present invention provides a process for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis which comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1100° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a temperature between 160 and 250° C., to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 800 and 900° C. in the presence of a nickel or iron catalyst to produce a gas which on admixture with normal blue water gas is suitable for use in the Fischer-Tropsch process.

The present invention also provides a process for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis which comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1000° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a temperature between 160 and 250° C., to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 1200 and 1500° C. in the absence of a catalyst to produce a gas, mixing said gas with normal blue water gas and a gas obtained by heating normal blue water gas with steam in the presence of a cobalt or nickel catalyst at a temperature of between 400 and 550° C. and then separating carbon dioxide, the gases being mixed in such proportion that a product is obtained which is suitable for use in the Fischer-Tropsch process.

The cobalt, nickel or iron catalyst employed may, if desired, be activated with an activator such as thoria and the catalyst may be mixed with a carrier such as kieselguhr, magnesia, silica, pumice or aluminium earths.

All the gases employed in the process should be purified so that they contain not more than 0.4 gms. of total sulphur per 100 cubic metres of gas.

The following examples illustrate how the process of the invention may be carried into effect:

1. Coke was treated with 200% of the theoretical proportion of steam required for the blue water gas reaction at a temperature of 950° C. and there was thus produced a gas having the following composition:—CO = 36.0%, H_2 = 53.0%, CH_4 = 1.0%, CO_2 = 7.0% and N_2 = 3.0%. This gas was washed with a solution containing a mixture of alkylolamine bases to remove carbon dioxide and a gas was obtained having the following composition:—CO = 38.4% H_2 = 56.4%, CH_4 = 1.0%. CO_2 = 1.0% and N_2 = 3.2%. 1,000,000 cubic metres of this gas was mixed with 500,000 cubic metres of a coke oven gas having the following composition:—CO = 7.0%, H_2 = 54.0%, C_nH_m = 3.6%, CH_4 = 29.0%, N_2 = 4.4% and CO_2 = 2.0%. There was thus produced 1,500,000 cubic metres of a gas hereinafter referred to as Synthesis Gas I of the following composition:—CO = 27.5%, H_2 = 55.3%; CH_4 = 10.4%; C_nH_m = 1.2% and $CO_2 + N_2$ = 5.6%. The Synthesis Gas I was then passed over a cobalt catalyst activated with thoria and mixed with a kieselguhr carrier at a temperature of 160—220° C. and there was obtained per cubic metre of Synthesis Gas I a yield of 70 gms. of primary products and 0.5 cubic metre of residual gas hereinafter referred to as Residual Gas I. It will thus be seen that a contraction of volume of 50% took place. The Residual Gas I had the following composition:—CO = 21.5%, H_2 = 32.9%, CH_4 = 32.0%, C_nH_m = 2.4% and $CO_2 + N_2$ = 11.2%. The Residual Gas I was then mixed with steam in the proportion of 0.56 kgm. of steam per cubic metre of gas and the mixture heated in the presence of a nickel catalyst containing 10% by weight of magnesium oxide at a temperature of 800° C. There was thus obtained per cubic metre of Residual Gas I, 3.15 cubic metres of a gas of the following composition:—CO = 24.0%, H_2 = 67.0%, CH_4 = 1.0% and $CO_2 + N_2$ = 8.0%. 1,610,000 cubic metres of this gas were then mixed with 1,000,000 cubic metres of blue water gas and there was thus obtained 2,610,000 cubic metres of a gas hereinafter referred to as Synthesis Gas II of the following composition:—CO = 30.5%, H_2 = 61.0%, CH_4 = 0.7% and $CO_2 + N_2$ = 7.8%. By subjecting this Synthesis Gas II to the Fischer-Tropsch process about 140 gms. of primary products and 0.25 cubic metre of residual gas can be obtained per cubic metre of gas.

The residual gas hereinafter referred to as Residual Gas II obtained after the Sythesis Gas II has been subjected to the Fischer-Tropsch process (the composition of the Residual Gas II was as follows:—CO = 21.0%, H_2 = 34.0%, CH_4 = 14.0%, and $CO_2 + N_2$ = 31.0%) may be used for heating the coke oven plant, the plant employed in treating the Residual Gas I with steam and for heating the plant employed in the sulphur purification and it is then found that the coal consumption is about 3.6 tons of coal per ton of primary products produced. The expression "primary products" does not include the oil yield in the coke oven plant.

2. Coke was treated with 175% of the theoretical proportion of steam required for the blue water gas reaction at a temperature of 950° C. and there was thus

produced a gas having the following composition:—$CO = 36.0\%$, $H_2 = 53.0\%$, $CH_4 = 1.0\%$, $CO_2 = 7.0\%$ and $N_2 = 3.0\%$. This gas was washed with water under pressure to remove carbon dioxide and a gas was obtained having the following composition:—$CO = 38.4\%$, $H_2 = 56.4\%$, $CH_4 = 1.0\%$, $CO_2 = 1.0\%$ and $N_2 = 3.2\%$. 1,000,000 cubic metres of this gas was mixed with 500,000 cubic metres of a coke oven gas having the following composition:—$CO = 7.0\%$, $H_2 = 54.0\%$, $C_nH_m = 3.6\%$, $CH_4 = 29.0\%$, $N_2 = 4.4\%$ and $CO_2 = 2.0\%$. There was thus produced 1,500,000 metres of a gas hereinafter referred to as Synthesis Gas I[1] of the following composition:—$CO = 27.5\%$, $H_2 = 55.3\%$, $CH_4 = 10.4\%$, $C_nH_m = 1.2\%$ and $CO_2 + N_2 = 5.6\%$. The Synthesis Gas I[1] was then passed over a cobalt catalyst activated with thoria and mixed with a kieselguhr carrier at a temperature of 160—220° C. and there was obtained per cubic metre of Synthesis Gas I[1] a yield of 70 gms. of primary products and 0.5 cubic metre of residual gas hereinafter referred to as Residual Gas I[1]. It will thus be seen that a contraction of volume of 50% took place. The Residual Gas I[1] had the following composition:—$CO = 21.5\%$, $H_2 = 32.9\%$, $CH_4 = 32.0\%$, $C_nH_m = 2.4\%$ and $CO_2 + N_2 = 11.2\%$. The Residual Gas I[1] was then mixed with steam in the proportion of 1.10 kgm. of steam per cubic metre of gas and the mixture heated in the absence of a catalyst at a temperature of 1250° C. There was thus obtained a gas of the following composition:—$CO = 27.5\%$, $H_2 = 59.0\%$, $CH_4 = 1.2\%$, and $CO_2 + N_2 = 12.3\%$. 1,510,000 cubic metres of this gas were then mixed with 700,000 cubic metres of blue water gas and 170,000 cubic metres of a gas obtained by heating blue water gas with steam in the presence of a nickel catalyst at 450° C. and then separating carbon dioxide by treatment with an aqueous solution containing a mixture of alkylolamine bases, and there was thus obtained 2,380,000 cubic metres of a gas hereinafter referred to as Synthesis Gas II[1] of the following composition:—$CO = 29.7\%$, $H_2 = 59.3\%$, $CH_4 = 0.9\%$ and $CO_2 + N_2 = 10.1\%$. By subjecting it to the Fischer-Tropsch process about 140 gms. of primary products and 0.25 cubic metre of residual gas can be obtained per cubic metres of gas.

The residual gas hereinafter referred to as Residual Gas II[1] obtained after the Synthesis Gas II[1] has been subjected to the Fischer-Tropsch process may be used for heating the coke oven plant, the plant employed in treating the Residual Gas I[1] with steam and for heating the plant employed in the sulphur purification and it is then found that the coal consumption is about 3.8 tons of coal per ton of primary products produced. The expression "primary products" as used herein means hydrocarbons containing three or more carbon atoms in the molecule obtained in the synthesis and does not include the oil yield in the coke oven plant.

By the term "coke" as used herein is to be understood all types of coke including coke made from coal by either high temperature or low temperature carbonisation and petroleum coke.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis which comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1100° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a temperature between 160 and 250° C. to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 800 and 900° C. in the presence of a nickel or iron catalyst to produce a gas which on admixture with normal blue water gas is suitable for use in the Fischer-Tropsch process.

2. A process for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis which comprises heating coke with at least 150%, for example 200% of the theoretical amount of steam required for the water gas reaction, at a temperature of between 900 and 1000° C., to produce a gas containing more hydrogen and carbon dioxide than is normally present in blue water gas, preferably removing carbon dioxide from the said gas, mixing the residue with coke oven gas in such proportion as to produce a gas containing carbon monoxide and hydrogen in a proportion suitable for use in the Fischer-Tropsch process, heating the mixture thus produced in the presence of a cobalt, nickel or iron catalyst at a tem-

perature between 160 and 250° C. to produce oils and gaseous products rich in methane, and heating the said gaseous products with steam at a temperature between 1200 and 1500° C. in the absence of a catalyst to produce a gas, mixing said gas with normal blue water gas and a gas obtained by heating normal blue water gas with steam in the presence of a cobalt or nickel catalyst at a temperature of between 400 and 550° C. and then separating carbon dioxide, the gases being mixed in such proportion that a product is obtained which is suitable for use in the Fischer-Tropsch process.

3. A process as claimed in claim 1 or 2 wherein the cobalt, nickel or iron catalyst is activated with an activator such as thoria.

4. A process as claimed in any one of the preceding claims wherein all the gases employed in the process are purified so that they contain not more than 0.4 gms. of total sulphur per 100 cubic metres of gas

5. A process for the production of a gas mixture containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch synthesis substantially as described with reference to the Examples given.

6. Gas mixtures containing carbon monoxide and hydrogen suitable for use in the Fischer-Tropsch process when produced by the process claimed in any one of the preceding claims.

Dated this 12th day of May, 1941.

ELKINGTON & FIFE,
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