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71 Applicant: SHELL INTERNATIONALE RESEARCH
MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
NL-2596 HR Den Haag(NL)

72 Inventor: Sie, Swan Tiong
Badhuisweg 3
NL-1031 CM Amsterdam(NL)

74 Representative: Puister, Antonius Tonnis, Mr. et al,
P.O. Box 302
NL-2501 CH The Hague(NL)

54 **Process for the generation of power and the preparation of liquid hydrocarbons.**

57 Power is generated and liquid hydrocarbons are prepared in a process in which less than 70%v of a mixture of carbon monoxide and hydrogen is converted by means of a hydrocarbon synthesis carried out above 300°C. From the reaction product are separated a liquid fraction which comprises the desired hydrocarbons and a gaseous fraction which, in addition to unconverted carbon monoxide and hydrogen, comprises light hydrocarbons formed during the synthesis and which latter fraction is combusted. The combustion gas is used for generating power in a gas turbine. High pressure steam is produced from water by pre-heating, vaporization and superheating by using the hot exit gas of the gas turbine. At least part of the reaction heat from the hydrocarbon synthesis is used in the vaporization stage of the steam production. The high-pressure steam is used for generating power in a steam turbine.

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PROCESS FOR THE GENERATION OF POWER AND THE
PREPARATION OF LIQUID HYDROCARBONS

The invention relates to a process in which, starting from a mixture of carbon monoxide and hydrogen, power is generated by means of a combined gas turbine-steam turbine system and, in addition, liquid hydrocarbons are prepared by means of a high-
5 temperature hydrocarbon synthesis and in which both exhaust heat and gaseous by-products obtained in the hydrocarbon synthesis are used in the generation of power.

An attractive method of generating power from a variety of gaseous and liquid fuels comprises the conversion by combustion
10 of the fuels into gas having a high pressure and a high temperature, which is used to generate power in a combined gas turbine-steam turbine system. In short the principle of the working of a combined gas turbine-steam turbine system is to the effect that the combustion gases are expanded in a gas turbine, thus generating
15 power and that the hot exhaust gas from the gas turbine is used for the production of high-pressure steam which, by expansion in a steam turbine, produces an additional quantity of power. The combined gas turbine-steam turbine system may be used very suitably for the generation of power from coal by gasifying the
20 coal, purifying and then combusting the synthesis gas obtained and generating power from the combustion gases by means of the combined gas turbine-steam turbine system. With a view to controlling air pollution due to sulphur emissions the afore-described method of energy generating from coal may be regarded
25 as an attractive alternative to the conventional coal-fired power plant equipped with flue gas cleaning facilities.

As regards the generation of power by using a combined gas turbine-steam turbine system, the following should be noted.

Among the various possibilities of combining the two turbines what is called the "recuperation scheme" is the preferred option for converting a clean fuel gas into power, since this scheme turns to optimum account the clean burning properties of the fuel, the relatively low capital cost per unit of power of gas turbines and the possibilities offered by advanced gas turbine technology. In this scheme the power is mainly generated in the gas turbine and the waste heat of the gas turbine is recuperated in a relatively simple way by using heat exchange to utilize the exhaust gases for the production of steam. In order to obtain maximum power from the gas turbine, it is desirable to have a high inlet temperature combined with a high pressure ratio. Considering the maximum entry temperature permitted by turbine technology, the pressure ratio cannot be increased at will without unduly lowering the outlet temperature of the turbine and thereby severely diminishing the possibilities of steam production.

Even at a reasonably high turbine outlet temperature, for instance of 500-600°C, the efficiency of the heat recuperation is poor, especially when steam of high temperature and high pressure is to be produced. When the exhaust temperature of the gas turbine is 550°C and when, by using counterflow and a minimum T of 30°C between steam and exhaust gas, steam is produced in an apparatus consisting of a pre-heater, an evaporator and a superheater successively, the cooled gas will leave the plant at a temperature of 223°C if the exhaust gas is used for producing steam of 165 bar and 520°C. In a combined gas turbine-steam turbine system-based power plant built in isolation there are hardly any uses to which the excess of low-grade heat can be put, so that stack losses will be quite substantial and the quantity of steam produced relatively small. By accepting a lower steam pressure and/or lower temperature of superheating more heat can be recuperated from the waste gas of the gas turbine, so that the cooled gas will leave the plant at a lower

temperature. Thus, if in the situation described hereinbefore the exhaust gas is used for generating steam of 80 bar and 450°C (instead of 165 bar and 520°C), the cooled gas will leave the plant at a temperature of 187°C (instead of 223°C). Although in this way more steam can be produced the amount of power that can be generated in the steam turbine will hardly grow (see Table A) owing to a loss of steam turbine efficiency. A slightly more favourable situation presents itself when a higher gas turbine outlet temperature is utilized. When an outlet temperature of 600°C is used, the temperature of the cooled gas will be 186°C with production of 165 bar/550°C steam and 157°C with production of 80 bar/450°C steam (see Table A). Some improvement may be achieved by raising the temperature of the gas-turbine exhaust gases by combusting an additional quantity of fuel. However, this is not an ideal use of the fuel, since it generates power in the steam turbine instead of in the combined gas turbine-steam turbine system. Moreover, if larger quantities of fuel are burned to obtain a maximum effect, the steam generation unit will no longer be a relatively simple unit without a combustion chamber, but it will become a more complex apparatus of the conventional type whose efficiency is relatively low due to the large excess of air required. Other measures that may be contemplated in order to improve the recuperation of low-grade heat from the exhaust gas of the gas turbine, for instance including a low-pressure steam cycle, are not very attractive since they increase the complexity of the plant and, in view of the temperature levels involved, have only low efficiency.

TABLE A

<u>Power generation from gas turbine exhaust gas</u> <u>without additional heat supply</u>				
$\Delta T_{\min} = 30^{\circ}\text{C}$ $c_p \text{ exhaust gas} = 1.118 \text{ kJ.kg}^{-1}.\text{C}^{-1}$ steam condensor: P = 0.04 bar, T = 29°C				
Gas turbine outlet temperature, °C	550		600	
Pressure of steam, bar	165	80	165	80
Temperature of steam, °C	520	450	550	450
Steam produced, kg/kg exhaust gas	0.1134	0.1286	0.1397	0.1571
Heat recuperated, kJ/kg exhaust gas	365.9	405.5	462.5	495.3
Temperature of stack gas, °C	223	187	186	157
Efficiency of steam turbine, %	40.5	36.5	41	36.5
Effective power, kJ/kg exhaust gas	148.2	148.0	189.6	180.8

A much more elegant solution to the problem of the utilization of heat may be found in combining the generation of power with high-temperature hydrocarbon synthesis and utilizing at least part of the high-grade waste heat of the hydrocarbon synthesis reaction evaporating water in the production of steam as the feed for the steam turbine. By combining the two processes in such a way that on the one hand unconverted synthesis gas, together with gaseous by-products formed, is used as fuel for the gas turbine, whilst on the other hand waste heat from the hydrocarbon synthesis is used for producing high-pressure steam the drawbacks both of the high-temperature hydrocarbon synthesis for the preparation of liquid hydrocarbons and of the combined gas turbine-steam turbine system, which present themselves when these two processes are each used in isolation, are overcome.

The above-mentioned "high-temperature hydrocarbon synthesis" refers to a hydrocarbon synthesis which is carried out at a temperature above 300°C. The products of said hydrocarbon synthesis are aliphatic and/or aromatic hydrocarbons, but not oxygenates like methanol, although oxygenates may be intermediates in the production of hydrocarbons from synthesis gas.

The present patent application therefore relates to a process for the generation of power and the preparation of liquid hydrocarbons, in which of a mixture of carbon monoxide and hydrogen less than 70%v is converted by means of a hydrocarbon synthesis carried out above 300°C, in which from the reaction product are separated a liquid fraction which in addition to unconverted carbon monoxide and hydrogen, comprises light hydrocarbons formed during the synthesis and which latter fraction is combusted, in which the combustion gas is used for generating power in a gas turbine, in which high-pressure steam is produced from water by preheating, vaporization and superheating by using the exit gas of the gas turbine, in which the high-pressure steam is used for generating power in a steam turbine and in which at least part of the reaction heat from the

hydrocarbon synthesis is used in the vaporization step of the steam production.

The process proposed here is very suitable for handling both hydrogen-rich and low-hydrogen synthesis gases.

5 With a proper choice of catalyst the high-temperature hydrocarbon conversion allows of partial conversion of low-hydrogen synthesis gases into liquid hydrocarbons without the necessity of previously subjecting the synthesis gas to the water gas shift reaction as is often required in methanol
10 synthesis. At equal pressures (for instance 30 bar) higher conversion can be achieved in the high-temperature hydrocarbon synthesis than in the methanol synthesis. The high-temperature hydrocarbon synthesis releases more heat (20-25% of the energy content of the synthesis gas) than the methanol synthesis. Since
15 the former reaction takes place at a high temperature, this high-grade heat can be put to good use, viz. in the vaporization step during the production of high-pressure steam which can be utilized in the steam cycle of the power plant. For instance, the reaction heat which is released when the hydrocarbon
20 synthesis is carried out at a temperature of 375-400°C can be very well used for producing steam of 350°C and 165 bar. The high-temperature hydrocarbon synthesis may yield in addition to liquid hydrocarbons, considerable quantities of gaseous hydrocarbons (C₁-C₄ paraffins). However, when the high-temperature
25 hydrocarbon synthesis is used in combination with power generation, this presents no difficulties, since these gaseous hydrocarbons fully contribute to the energy content of the fuel for the power plant and - as far as the calorific value of this fuel is concerned - even make up to some content for the
30 diluting effect of CO₂ which may be present in the fuel for instance as a result of an internal water gas shift reaction occurring during the hydrocarbon synthesis starting from a low-hydrogen synthesis gas. So long as the gas remains combustible there is no objection to the presence of CO₂ since

it can have the same function as excess air of restricting the combustion temperature, with the advantage that the CO_2 is already under pressure. Since many catalysts used in the high-temperature hydrocarbons synthesis have a much higher sulphur tolerance than several methanol synthesis catalysts, like a
5 Cu/ZnO catalyst, the sulphur-removing process required in the hydrocarbon synthesis when sulphur-containing synthesis gases are used - such as those formed during the gasification of coal - will be of a much simpler nature. In the high-temperature
10 hydrocarbon synthesis it is extremely difficult to attain a synthesis gas conversion of more than 70%v when using a space velocity which is acceptable in practice, but no recirculation. However, when the high-temperature hydrocarbon synthesis is used in combination with power generation, this presents no difficulties, since in this combination the synthesis gas is meant to
15 be converted only partly.

Depending on the catalyst chosen, the high-temperature hydrocarbon synthesis may yield either substantially aromatic hydrocarbons, or substantially paraffinic hydrocarbons. If
20 substantially aromatic hydrocarbons are to be prepared, preference is given to the use of a bifunctional catalyst combination comprising one or more metal components having catalytic activity for the conversion of a H_2/CO mixture into acyclic hydrocarbons and/or acyclic oxygen-containing organic
25 compounds and a crystalline metal silicate of a special structure which is capable of catalysing the conversion of acyclic compounds into aromatic hydrocarbons. If substantially paraffinic hydrocarbons are to be prepared, preference is given to the use of an iron-containing catalyst having activity for
30 the conversion of a H_2/CO mixture into paraffinic hydrocarbons.

As observed hereinbefore, the process according to the invention may be applied to both hydrogen-rich synthesis gases and low-hydrogen synthesis gases. The process according to the

invention is of particular interest for application to low-hydrogen synthesis gases. Such synthesis gases having a H_2/CO molar ratio of less than 2.0 may very suitably be obtained by gasification of carbonaceous materials, such as brown coal, anthracite, coke, crude mineral oil and fractions thereof, as well as oils produced from tar sand and bituminous shale. The gasification is preferably carried out at a temperature of 900-1500°C and a pressure of 10-100 bar. In the process according to the invention the preferred starting material is a synthesis gas having a H_2/CO molar ratio higher than 0.25.

If in the process according to the invention the starting material is a low-hydrogen synthesis gas, the catalyst preferably used in the high-temperature hydrocarbon synthesis is a bi- or trifunctional catalyst the latter comprising, in addition to the components of a bifunctional catalyst, one or more metal components having CO-shift activity.

If the high-temperature hydrocarbon synthesis is carried out with the object of preparing substantially aromatic hydrocarbons, preference is given to the use of a bi- or trifunctional catalyst which, in addition to the metal components having catalytic activity, comprises a crystalline metal silicate of a special structure which is capable of catalysing the conversion of acyclic hydrocarbons and acyclic oxygen-containing organic compounds into aromatic hydrocarbons, the metal silicate being described e.g. in British patent specification No. 1,555,928 and British patent application No. 2,055,893.

If the aim of the high-temperature hydrocarbon synthesis is to prepare substantially paraffinic hydrocarbons while starting from a low-hydrogen synthesis gas, preference is given to the use of an iron-containing bifunctional catalyst or catalyst combination which, in addition to activity for the conversion of a H_2/CO mixture substantially into paraffinic hydrocarbons, has CO-shift activity. Preference is given to the use of a

bifunctional catalyst prepared by impregnation and comprising iron supported on a carrier. Examples of such catalysts are Fe/Mg/Al₂O₃ and Fe/Cr/SiO₂ catalysts described in British patent specification No. 2,053,713 and No. 2,053,016, respectively.

5 Suitable conditions for carrying out the high temperature hydrocarbon synthesis are a temperature of 300-450°C, a pressure of 20-80 bar and a space velocity of 200-2000 Nl gas/l catalyst/hour. When the high temperature hydrocarbon synthesis is used for the preparation of substantially aromatic hydrocarbons, the following conditions are preferably used: a temperature of 10 325-400°C, a pressure of 30-60 bar and a space velocity of 300-3000 Nl gas/l catalyst/hour. When the high-temperature hydrocarbon synthesis is used for the preparation of substantially paraffinic hydrocarbons, the following conditions are 15 preferably used: a temperature of 300-350°C, a pressure of 20-50 bar and a space velocity of 500-2000 Nl gas/l catalyst/hour. Conversion in the high-temperature hydrocarbon synthesis should be less than 70%v. Depending on the object pursued the conversion may vary within wide limits. Usually the conversion will 20 be more than 10%v.

In general, the process according to the invention can be used for the generation of power and the preparation of liquid hydrocarbons from mixtures of carbon monoxide and hydrogen. The process is of particular interest for the generation of electricity and the preparation of synthetic gasoline, starting from 25 low-hydrogen synthesis gas obtained in the high-pressure gasification of coal. Excellent catalysts for the conversion of low-hydrogen synthesis gases into synthetic gasolines are the afore-mentioned trifunctional catalyst combinations consisting of a mixture of catalyst capable of converting a H₂/CO mixture 30 substantially into methanol and a crystalline metal silicate of a special structure capable of converting methanol into aromatic hydrocarbons. Since the use of these catalysts results in a liquid product which boils substantially in the gasoline range,

this hydrocarbon synthesis is sometimes referred to as the "direct gasoline synthesis" (DGS). Hereinafter whenever mention is made of DGS, it will be to designate the direct gasoline synthesis described hereinbefore.

5 In power plants periods of normal load and periods of peak load succeed each other. In order to be able to meet the demand for power in peak load periods, supplementary fuel is supplied to the gas turbine. To this end the process according to the invention utilizes the liquid hydrocarbons prepared by way of
10 the high-temperature hydrocarbon synthesis. Depending on the quality of the liquid hydrocarbons produced by high-temperature hydrocarbon synthesis, it may in some cases be more attractive to purchase the supplementary fuel needed to cope with peak loads elsewhere and to reserve the liquid hydrocarbons prepared
-15 in the process for other purposes. Such a situation may present itself, for instance, when the hydrocarbon synthesis is carried out as a DGS, which yields an extremely valuable product that can be put to excellent use as motor gasoline. However, as may be seen from the following, the process according to the
20 invention is highly flexible, so that to a certain extent it is possible to meet fluctuations in power demand without having to fall back on supplementary fuel purchased from external sources or produced in situ.

 The DGS produces a considerable quantity of reaction heat
25 of a temperature level of 375-400°C. A reactor that is very suitable for carrying out the DGS is a reactor whose heat discharge takes place by means of internal cooling pipes in which the heat is absorbed by water which boils, for instance, at 350°C and 165 bar. If the synthesis reactor is situated on
30 the same site as the power plant, this provides an excellent opportunity for integrating this steam system into the combined gas turbine-steam turbine system. Preferably, the DGS is carried out isothermally, so that it releases the heat at a very attractive constant temperature level. Therefore this heat is

excellently suitable for providing the heat of vaporization during the production of high-pressure steam and the utilization of the heat present in the exhaust gas of the gas turbine can be principally restricted to heating the water and superheating the steam. Data of situations in which 50 and 100%, respectively, of the heat of vaporization is provided by the DGS show that the process may be carried out more efficiently. (See Tables B and C). In particular in the case where 100% of the heat of vaporization is provided by the DGS the countercurrent exchange of heat is virtually ideal, resulting in a maximum gain of heat from the exhaust gas and consequently very low stack temperatures, of 91 and 67°C at gas turbine outlet temperatures of 550 and 600°C, respectively. The almost maximum quantity of heat recovered from the exhaust gas and the heat produced by the synthesis reaction together become available as high-pressure superheated steam (165 bar, 520-550°C) which can be converted into power with good efficiency. Not only is in this way the reaction heat of the hydrocarbon synthesis - which usually becomes available as saturated steam - upgraded, but more steam is produced besides. As shown in Table C, the reaction heat of the DGS is transformed to an additional quantity of superheated high pressure steam with an apparent efficiency of about 170% and finally it is transformed to extra power with an energy efficiency of about 70%. This is almost three times as high as when the reaction heat would have been simply utilized for the production of saturated steam to be used for the generation of power in a separate steam cycle of relatively poor efficiency. Not only is the latter option inferior from an energetic point of view, it is more costly as well, since a separate steam cycle has to be added to the system.

TABLE B

<u>Power generation from gas turbine exhaust gas, in which the reaction heat of a DGS supplies at least part of the heat of vaporization of the water</u>				
$\Delta T_{\min} = 30^{\circ}\text{C}$				
$c_p \text{ exhaust gas} = 1.118 \text{ kJ.kg}^{-1}.\text{C}^{-1}$				
steam condensor: P = 0.04 bar, T = 29°C				
Gas turbine outlet temperature, °C	550		600	
Pressure of steam, bar	165		165	
Temperature of steam, °C	520		550	
% of heat of vaporization supplied by DGS	50	100	50	100
Steam produced, kg/kg exhaust gas	0.151	0.220	0.182	0.247
Heat recovered, kJ/kg exhaust gas	419.6	512.9	521.1	596.5
Temperature of stack gas, °C	170	91	134	67
Heat supplied by DGS, kJ/kg exhaust gas	67.6	197.0	81.5	221.3
Total steam energy, kJ/kg exhaust gas	487.3	709.9	602.6	817.8
Steam turbine efficiency, %	40.5	40.5	41	41
Effective power, kJ/kg exhaust gas	197.4	287.5	247.1	335.3

TABLE C

<u>Effect of integration of DGS into a combined gas turbine-steam turbine system on power generation in steam cycle</u>						
	Gas turbine outlet temperature 550°C $P_{\text{steam}} = 165 \text{ bar}$ $T_{\text{steam}} = 520^\circ\text{C}$			Gas turbine outlet temperature 600°C $P_{\text{steam}} = 165 \text{ bar}$ $T_{\text{steam}} = 550^\circ\text{C}$		
% of heat of vaporization supplied by DGS	0	50	100	0	50	100
Temperature of stack gas, °C	223	170	91	186	134	67
Steam produced, kg/kg exhaust gas	0.113	0.151	0.220	0.140	0.182	0.247
Total steam energy, kJ/kg exhaust gas	365.9	487.3	709.9	462.5	602.5	817.8
Extra steam energy produced = ΔS , kJ/kg exhaust gas	0	121.4	341.0	0	140.1	355.3
Heat supplied by DGS = Q_p , kJ/kg exhaust gas	0	67.6	197.0	0	81.5	221.3

TABLE C (cont'd)

	Gas turbine outlet temperature 550°C P _{steam} = 165 bar T _{steam} = 520°C			Gas turbine outlet temperature 600°C P _{steam} = 165 bar T _{steam} = 550°C		
Apparent efficiency of utilization of DGS reac- tion heat = $\Delta S/G$, %	---	179	175	---	172	169
Extra power generated = ΔE , kJ/kg exhaust gas	0	49.2	139.2	0	57.5	152.0
Efficiency of conversion DGS reaction heat into power = $\Delta E/G$, %	---	73	71	---	71	69

As already observed hereinbefore, the process according to the invention has a high degree of flexibility, so that, within certain limits, it is possible to meet fluctuations in power demand. For in the process according to the invention an increase

5 in demand for power can be excellently met by reduction of the conversion in the hydrocarbon synthesis, resulting in more synthesis gas becoming available for use as fuel gas for the generation of power. The necessary fluctuations in degree of conversion in the hydrocarbon synthesis are preferably achieved by

10 feeding part of the synthesis gas into the gas turbine by way of a by-pass around the synthesis reactor. According as more synthesis gas is diverted, the space velocity in the reactor will decrease. This reduces the absolute quantity of synthesis gas converted and, consequently the conversion based on the

15 total quantity of synthesis gas feed. Since the reactor tempera-

ture is largely controlled by the boiling water in the internal cooling pipes, a reduction in the gas flow rate will have but little effect on the reactor temperature. The invention is now elucidated with the aid of the following example.

5 EXAMPLE

In order to assess the advantages of the integration of a DGS into a combined gas turbine-steam turbine system (CGSS), four schemes were elaborated describing the conversion of coal into nothing but electricity (A), into nothing but gasoline (D) and into both gasoline and electricity (B and C). In scheme B the same amount of electricity was generated as in scheme A, while the relative ratio between gasoline, energy and electricity were such that the reaction heat of the DGS supplied 100% of the heat of vaporization, whereas in scheme C only half this quantity of heat was supplied. The Table D was made with the aid of the following data:

Coal feed : Ash content 12%w; moisture content 6.5%w;

Analysis of coal: 78.1%w C;

5.5%w H; 4.3%w S; 1.2%w N; 10.9%w O.

Calorific value 31.6 MJ/kg moisture and ash free coal (MAF coal).

Gasification : High-pressure gasification using a mixture of steam and oxygen. Temperature 1500°C; pressure 30 bar; residence time of coal in reactor: 0.55 s.

O_2 /MAF coal = 0.89 kg/kg

H_2O /MAF coal = 0.08 kg/kg

Yield: 1.99 Nm³ purified synthesis gas per kg MAF coal having the composition: 32.8%v H₂; 66.5 %v CO; 0.7%v N₂ + Ar.

Calorific value of synthesis gas: 12 MJ/Nm³.

Energy needed for preparing oxygen and process steam is supplied by a waste heat boiler integrated into the coal gasifier.

- 5 Hydrocarbon synthesis : DGS over a catalyst consisting of a mixture of a ZnO-Cr₂O₃ composition and a crystalline iron/aluminium silicate of a special structure, as disclosed in British patent specification No. 1,555,928
 P = 30 bar, T = 400°C.
 C₃+ selectivity: 95%w on C₁+.
 C₅+ selectivity: 80%w on C₁+.
- 10 Gas turbine : Efficiency expressed as specific energy consumption: 11290 kJ/kWh
 Inlet temperature: 1130°C
 Outlet temperature: 552°C
 Pressure ratio ± 14.2:1
 Air flow rate 12.35 t/MWh
- 15 Exhaust gas boiler : preheater + superheater
 ΔT = 30°C, minimally
- Steam turbine: P_{steam} = 165 bar; T_{steam} = 520°C
 P_{condensor} = 0.04 bar; T_{condensor} = 29°C
 Energy conversion efficiency: 40.5%

20 In Table D the most significant results of the schemes are given. In scheme B about 35% more coal is gasified than in scheme A and about half of the synthesis gas is converted into gasoline. Although as compared with scheme A, less CO and H₂ is left over for use as fuel for the gas turbine, the same amount of electric power is produced. In case of gasoline

25 production of approximately the same energy content the total effective energy produced by scheme B is almost redoubled. The thermal efficiency of the coal conversion has been increased from less than 40% to over 50%.

30 Comparison of scheme B with scheme D and scheme A shows that a quantity of 173 t/h of coal would be needed to produce about the same quantities of electricity and gasoline as produced in scheme B starting from 134 t/h. This clearly shows the

advantage to be obtained from the integration of the two processes.

As regards peak shaving, the following may be observed. If the integrated process is constructed in such a way that scheme
5 B (about 50% synthesis gas conversion in DGS) corresponds with the base load, an increase in electricity demand can be met within certain limits by reduction of the conversion, so that more gas is available for use as fuel for the CGSS. In scheme C the same quantity of coal (134.5 t/h) is supplied to the gasifier
10 as in scheme B, but conversion in the DGS is reduced to 24%. Consequently the quantity of electricity produced grows (from 323 to 375 MW). As is seen from Table D, virtually the entire increase in electric power occurs in the section of the CGSS which is connected with the gas turbine, whereas the section
15 connected with the steam production is barely involved. This is very fortunate, since rapid response and relatively low cost make gas turbines eminently suitable for peak shaving. Thus, by installing sufficient gas turbine capacity, fluctuations in the demand for electricity can be met to a certain extent, while the
20 most important and most costly parts used in the conversion of coal to electricity are constantly operated at full capacity. The advantages of integration are still quite substantial at a low degree of synthesis gas conversion.

TABLE D

Scheme	A only electricity	B Gasoline and electricity, 100% of heat of vaporization of water supplied by DGS	C Gasoline and electricity, 50% of heat of vaporization of water supplied by DGS	D Only gasoline
Coal supply, t/h MAF MW equivalent	100.0 878	134.5 1180	134.5 1180	73.4 644
Synthesis gas produced, 10^3 Nm ³ /h MW equivalent	199 663	268 892	268 892	146 487
Synthesis gas converted in synthesis step, %	---	51.8	24.0	95.0
C ₅ ⁺ gasoline produced, t/h MW equivalent	--- ---	23.1 276	11.2 134	23.1 276

TABLE D (cont'd)

Scheme	A only electricity	B Gasoline and electricity, 100% of heat of vaporization of water supplied by DGS	C Gasoline and electricity, 50% of heat of vaporization of water supplied by DGS	D Only gasoline
Electricity generated, MW				
Gas turbine	212	160	221	--
Steam turbine	$\frac{111}{323} +$	$\frac{163}{323} +$	$\frac{154}{375} +$	--
Total	323	323	375	--
Total useful energy produced, MW	323	599	509	276
Thermal efficiency (synthesis gas to useful products), %	48.7	67.2	57.1	56.9
Thermal efficiency (coal to useful products), %	36.9	50.8	43.1	42.9

C L A I M S

1. A process for the generation of power and the preparation of liquid hydrocarbons, characterized in that of a mixture of carbon monoxide and hydrogen less than 70%v is converted by means of a hydrocarbon synthesis carried out above 300°C, that
5 from the reaction product are separated a liquid fraction which comprises the desired hydrocarbons and a gaseous fraction which, in addition to unconverted carbon monoxide and hydrogen, comprises light hydrocarbons formed during the synthesis and which latter fraction is combusted, that the combustion gas is
10 used for generating power in a gas turbine, that high pressure steam is produced from water by pre-heating, vaporization and superheating by using the hot exit gas of the gas turbine, that the high-pressure steam is used for generating power in a steam turbine and that at least part of the reaction heat from the
15 hydrocarbon synthesis is used in the vaporization stage of the steam production.
2. A process as claimed in claim 1, characterized in that the hydrocarbon synthesis is carried out at a temperature of 300-450°C, a pressure of 20-80 bar and a space velocity of
20 200-2000 Nl gas/l catalyst/hour.
3. A process as claimed in claim 1 or 2, characterized in that it is applied to a synthesis gas having a H₂/CO molar ratio in the range between 0.25 and 2.0.
4. A process as claimed in claim 3, characterized in that it
25 is applied to a synthesis gas obtained in the gasification of coal at a temperature of 900-1500°C and a pressure of 10-100 bar.
5. A process as claimed in any one of claims 1-4, characterized in that it is used for the generation of electricity and for the
30 preparation of gasoline.

6. A process as claimed in any one of claims 1-5, characterized in that all the heat required for the vaporization of water in the steam production is supplied by the hydrocarbon synthesis.

5 7. A process as claimed in any one of claims 1-6, characterized in that an increase in demand for power is met by reduction of the conversion in the hydrocarbon synthesis, resulting in more synthesis gas becoming available for use as fuel gas for the generation of power.

10 8. A process as claimed in claim 7, characterized in that reduction of the conversion in the hydrocarbon synthesis is achieved by feeding part of the synthesis gas into the gas turbine by way of a by-pass around the synthesis reactor.

15 9. A process for the generation of power and the preparation of liquid hydrocarbons as claimed in claim 1, substantially as described hereinbefore and in particular with reference to the example.

10. Power whenever generated and liquid hydrocarbons whenever prepared according to a process as described in claim 9.