PATENT SPECIFICATION

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3775

PROVISIONAL SPECIFICATION

Improvements in or relating to the Production of Hydrocarbons

I, ARTHUR JOSEPH VICTOR UNDERWOOD, D.Sc., M.I.Chem.E., A.M.I.Mech.E., F.I.C., a British Subject, of 38, Victoria Street, London, S.W.1, do hereby declare the nature of this invention to be as follows:—

The present invention relates to improvements in or relating to the manufacture of hydrocarbons.

Synthetic processes for the manufacture of hydrocarbons, in which a gaseous mixture produced by pressure gasification with steam of coal, coke and the like, is reacted in a water-cooled reaction chamber are known. These processes produce considerable heat of reaction much of which is normally converted into steam partly from the cooling water and partly from the reaction products and it is to the utilisation of the heat of such steam that the present invention relates.

Thus for example in the Fischer-Tropsch process a mixture containing hydrogen and carbon monoxide is produced for example by gasification of coal or coke with high pressure steam and oxygen, and the gaseous mixture is reacted to give hydrocarbons and steam by passage over suitable catalysts. A considerable amount of heat is evolved in this reaction, and as the reaction temperature needs to be carefully controlled, the catalyst units employed are water-cooled to remove this heat with consequent generation of steam from the cooling water; this steam has a pressure of from 7 to 10 atmospheres, depending on the temperature at which the catalyst is maintained. The steam used for the gasification process, on the other hand, must have a pressure of 9 to 12 atmospheres.

It is an object of the invention to utilise the heat of reaction of processes of the above type, and in particular to utilise the latent heat of the low pressure steam produced from the cooling water and/or contained in the reaction products for the production of high pressure steam for use in the gasification step.

According to the present invention I provide in a process of synthesising hydrocarbons, in which coal, coke or the like is gasified under pressure with steam and the products of gasification are reacted with evolution of heat in a water-cooled reaction chamber or chambers, the step of using low pressure steam produced from the cooling water and/or contained in the products of reaction for the production of steam of higher pressure and using the latter in the gasification step.

According to the present invention also, I provide an apparatus for carrying out the above process, comprising means for gasifying coal, coke or the like and connected thereto one or more reaction chambers provided with water-cooling means, means for utilising low pressure steam produced from the cooling water and/or contained in the products of reaction for the production of steam of higher pressure, and means for passing the latter to the gasification step. The low pressure steam will be passed to a high pressure steam injection thermo-compressor for the production of steam of higher pressure.

In the case of low pressure steam produced from the cooling water, the steam issuing from the thermo-compressor unit may then be used directly in the gasification step.

In the case of low pressure steam contained in the products of reaction, the total products of reaction, which include both steam and hydrocarbons, may similarly be passed to a high pressure steam injection thermo-compressor, but the resultant steam of higher pressure, which in this case will be associated with hydrocarbons etc., will not then be passed directly to the gasification process but will preferably be employed in a suitable apparatus for the generation by heat exchange of steam of suitable pressure, which latter may then be used in the gasification step or for other purposes.

It will be evident that the above-described processes may, if desired, be combined in any suitable manner. Thus for example the steam from the cooling water may be passed together with steam-containing products of reaction to a common thermo-compressor and subsequently employed for the generation of steam by heat exchange. Further steam generated by heat exchange by the steam-containing

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products of reaction may be led together with the steam generated from the cooling water to a common thermo-compressor and after compression passed to the gasification process.

Dated this 21st day of July, 1938.
For the Applicant,
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COMPLETE SPECIFICATION

Improvements in or relating to the Production of Hydrocarbons

I, ARTHUR JOSEPH VICTOR UNDERWOOD, D.Sc., M.I.Chem.E., A.M.I.Mech.E., F.I.C., a British Subject, of 38, Victoria Street, London, S.W.1, 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:—

The present invention relates to improvements in or relating to the manufacture of hydrocarbons.

Synthetic processes for the manufacture of hydrocarbons, in which a gaseous mixture produced by pressure gasification with steam of coal, coke and the like, is reacted in a water-cooled reaction chamber are known. These processes produce considerable heat of reaction much of which is normally converted into steam partly from the cooling water and partly from the reaction products and it is to the utilisation of the heat of such steam that the present invention relates.

Thus, for example, in the Fischer-Tropsch process a mixture containing hydrogen and carbon monoxide is produced for example by gasification of coal or coke with high pressure steam and oxygen, and the gaseous mixture is reacted to give hydrocarbons and steam by passage over suitable catalysts. A considerable amount of heat is evolved in this reaction, and as the reaction temperature needs to be carefully controlled, the catalyst units employed are water-cooled to remove this heat with consequent generation of steam from the cooling water; this steam has a pressure of from 7 to 10 atmospheres, depending on the temperature at which the catalyst is maintained. The steam used for the gasification process, on the other hand, must have a pressure of 9 to 12 atmospheres.

It is an object of the invention to utilise the heat of reaction of processes of the above type, and in particular to utilise the latent heat of the low pressure steam produced from the cooling water and/or contained in the reaction products for the production of high pressure steam for use in the gasification step.

According to the present invention I provide in a process of synthesising hydrocarbons, in which coal, coke or the like is gasified under pressure with steam and the products of gasification are reacted with evolution of heat in a water-cooled reaction chamber or chambers, the step of using low pressure steam produced from the cooling water and/or contained in the products of reaction for the production of steam of higher pressure and using the latter in the gasification step.

According to the present invention also, I provide an apparatus for carrying out the above process, comprising means for gasifying coal, coke or the like and connected thereto one or more reaction chambers provided with water-cooling means, means for utilising low pressure steam produced from the cooling water and/or contained in the products of reaction for the production of steam of higher pressure, and means for passing the latter to the gasification step. The low pressure steam derived from the cooling water will be passed to a high pressure steam injection thermo-compressor for the production of steam of higher pressure and the steam issuing from the thermo-compressor unit may then be used directly in the gasification step. If desired, however, such high pressure steam may be employed for generation of steam by heat exchange and this steam, if desired, after further injector thermo-compression may be employed in the gasification step.

Low pressure steam contained in the products of reaction, being mixed with hydrocarbons, will not be employed as such for the gasification step but will preferably be employed, if desired after raising the pressure by injector thermo-compression, in a suitable apparatus for the generation by heat exchange of steam of suitable pressure, which latter may then be used, if desired, after injector thermo-compression thereof, in the gasification step. If desired this steam may be used for injector thermo-compression of steam derived from the cooling water.

In order that the invention may be well understood a preferred embodiment thereof will now be described by way of example

only with reference to the accompanying drawing in which the single figure shows diagrammatically a form of apparatus according to and for carrying out the invention.

Referring to the drawing oxygen is supplied by a pipe 1, if desired, through a suitable injector device to a pipe 2 which is itself supplied with high pressure steam at from 9 to 12 atmospheres pressure in a manner hereinafter to be described. The mixture of high pressure steam and oxygen is conducted to a suitable retort 3 containing coke, coal or other suitable carbonaceous material and from there the products comprising largely hydrogen and carbon monoxide are passed, preferably after suitable purification by suitable means (not shown), to a reaction chamber 4 containing suitable catalyst elements. The reaction chamber is provided with a suitable heat exchange cooling device diagrammatically illustrated as a cooling coil 5 which is supplied with water through a supply pipe 6. The reaction products from the reaction chamber 4 comprising largely hydrocarbons and steam at low pressure are passed through a pipe 7 to a heat exchange device diagrammatically indicated as a heating coil 8 which generates steam in a boiler 9 supplied with water through a feed pipe 10. Steam generated in the boiler 9 is passed through a pipe 11 to the intake of a steam injection thermo-compressor 12 supplied with high pressure steam from a suitable source (not shown) through a pipe 13. The high pressure steam output from the injection thermo-compressor 12 is supplied by a pipe 14 to the pipe 2 for gasification of the material in the retort 3 as already described.

Low pressure steam is generated in the cooling coil 5 and is supplied by a pipe 16 to the intake of an injection thermo-compressor 15 supplied with high pressure steam from a suitable source (not shown) through a pipe 17. The resulting high pressure steam is supplied to the pipe 2 for admixture with oxygen and gasification of the material in the retort 3 as already described.

The mixture of condensed steam and hydrocarbons issuing from the heating device 8 is passed to any suitable condensing means and the hydrocarbons are separated from the water and, if desired, fractionated.

By way of example, the steam generated in the cooling coil 5 may have a pressure of say 7 atmospheres gauge pressure. To compress one ton of this steam to a pressure of 10 atmospheres in the compressor 15 would require one ton of steam at 40 atmospheres gauge to be supplied through the pipes 17.

It will be understood that any suitable valves, cocks or the like may be provided and any suitable safety devices may be provided. Moreover, any suitable separator or separators may be provided for removing drops of liquid that may be entrained with the steam especially the low pressure steam and/or any suitable means may be provided for supplying additional heat to the low pressure steam. Moreover, means may be provided for regulating the quantities of steam supplied by the boiler 9 and cooling coil 5 and for venting or by-passing any steam not required.

Whilst in the foregoing I have described with reference to one form of apparatus, a preferred method of carrying out the invention it is to be understood that various modifications may be made without departing from the scope thereof. Thus, for example, referring to the embodiment described the thermo-compressor 15 could be supplied with high pressure steam from the compressor 12. Again, if desired, the high pressure steam issuing from the compressor 15 could be used for generating further steam by heat exchange and this could be employed for gasification if desired after further injector thermo-compression thereof. Moreover, steam from the cooling device 5 and the mixed products from the reaction chamber 4 could be led to a common injection thermo-compressor and the high pressure mixture produced therein could then be used for generating steam by heat exchange. Further, if desired, steam from the boiler 9 could be passed together with steam from the cooling device 5 to a thermo-compressor supplied with high pressure steam from a separate source and then could be passed on to the gasification step. Again the products of reaction could be passed to an injection thermo-compressor, if desired with steam from the cooling coil 5 and could be used to produce high pressure steam in the boiler 9 which could be used directly for the gasification step if desired in admixture with high pressure steam from the injector 15 which latter would then be supplied with high pressure steam from a separate source. Alternatively, if high pressure steam is produced directly in the boiler 9, it could be used if its pressure is sufficiently high to compress low pressure steam in the compressor 15.

It will be understood, of course, that any desired number of thermo-compressors may be employed for raising the pressure of low pressure steam in stages.

Having now particularly described and ascertained the nature of my said inven-

tion and in what manner the same is to be performed, I declare that what I claim is:—

1. A process of synthesising hydrocarbons, in which coal, coke or other suitable carbonaceous material is gasified under pressure with steam and the products of gasification are reacted with evolution of heat in a water-cooled reaction chamber or chambers, including the step or steps of using low pressure steam produced by heating of the cooling water and/or contained in the products of reaction for the production of high pressure steam and using the latter in the gasification step.

2. A process as claimed in Claim 1 in which the pressure of the low pressure steam produced from the cooling water is raised by injector thermo compression and the resultant high pressure steam is used directly for gasification.

3. A process as claimed in Claim 1 in which the pressure of the low pressure steam produced from the cooling water is raised by injector thermo compression and the resultant high pressure steam is employed for the production of steam by heat exchange.

4. A process as claimed in Claim 3 in which the pressure of the steam produced by heat exchange is raised by injector thermo compression and the resulting high pressure steam is employed for the gasification step.

5. A process as claimed in any of the preceding Claims in which the hot reaction products are employed for the generation of steam by heat exchange.

6. A process as claimed in Claim 5 in which the pressure of the reaction products is raised by injector thermo compression prior to the heat exchange.

7. A process as claimed in either of Claims 5 or 6 in which the pressure of steam produced by absorption of heat from the reaction products is raised by injector thermo compression and the resulting high pressure steam is used for the gasification step.

8. A process as claimed in Claim 7 in which the high pressure steam is mixed with high pressure steam derived from the cooling water and the resultant steam is used for the gasification step.

9. A process as claimed in Claim 7 in which the said high pressure steam is employed for injector thermo compression of steam derived from the cooling water.

10. A process as claimed in either of Claims 5 or 6 in which steam produced by absorption of heat from the reaction products is mixed with steam derived from the cooling water and the pressure of the product is raised by injector thermo compression and the high pressure steam produced is used for the gasification step.

11. A process as claimed in Claim 6 in which high pressure steam is produced directly by heat absorption from the reaction products after injector thermo compression thereof and is used directly for the gasification step.

12. A process as claimed in Claim 6 in which high pressure steam is produced directly by heat absorption from the reaction products after injector thermo compression thereof and is used for injector thermo compression of steam derived from the cooling water.

13. A process as claimed in Claim 3 in which low pressure steam produced from the cooling water is mixed with the reaction products and the pressure of the mixture so produced is raised by injector thermo compression, the high pressure products being used for generation of steam by heat exchange.

14. A process of synthesising hydrocarbons substantially as described.

15. Apparatus for synthesising hydrocarbons by a method as claimed in Claim 1 comprising means for gasifying coal, coke or other suitable carbonaceous material and connected thereto one or more reaction chambers provided with water-cooling means, means for utilising low pressure steam produced from the cooling water and/or contained in the products of reaction for the production of steam of high pressure and means for passing the latter to the gasification means.

16. Apparatus as claimed in Claim 15 having means for connecting the outlet of the cooling means to the intake of an injection thermo compressor and means for connecting the output from the latter to a gasification chamber.

17. Apparatus as claimed in Claim 15 having means for connecting the outlet of the cooling means to the intake of an injection thermo compressor and means for connecting the outlet from the latter to a heat exchange device for the generation of steam.

18. Apparatus as claimed in Claim 17 including an injection thermo compressor for raising the pressure of the steam produced in the heat exchange device and means for supplying the high pressure steam to a gasification chamber.

19. Apparatus as claimed in any of Claims 15 to 18 having means for connecting the outlet from the reaction chamber or chambers to a heat exchange device for the generation of steam.

20. Apparatus as claimed in Claim 19 having means for connecting the outlet from the reaction chamber or chambers to the intake of an injection thermo com-

pressor and means for connecting the outlet of the compressor to a heat exchange device for the generation of steam.

21. Apparatus as claimed in either of Claims 19 or 20 having an injection thermo compressor for raising the pressure of steam produced in the heat exchange device heated by the reaction products.

22. Apparatus as claimed in any of Claims 19 to 21 having means for supplying steam produced in the said heat exchange device to a gasification chamber.

23. Apparatus as claimed in any of Claims 19 to 22 having means for mixing steam produced in the said heat exchange device with steam derived directly or indirectly from the cooling water.

24. Apparatus as claimed in any of Claims 19 to 23 having an injection thermo compressor for compressing steam derived from the cooling water and means for supplying to the high pressure steam inlet of said compressor high pressure steam produced by heat absorption from the reaction products, if desired after compression of such steam.

25. Apparatus as claimed in Claim 20 having means for connecting the outlet of the cooling means and the outlet of the reaction chamber to a common injection thermo compressor.

26. Apparatus as claimed in Claim 23 having means for conducting steam derived from the cooling means and from the heat exchange device to a common injection thermo compressor.

27. Apparatus for synthesising hydrocarbons substantially as described or as shown in the accompanying drawing.

Dated the 14th day of July, 1939.

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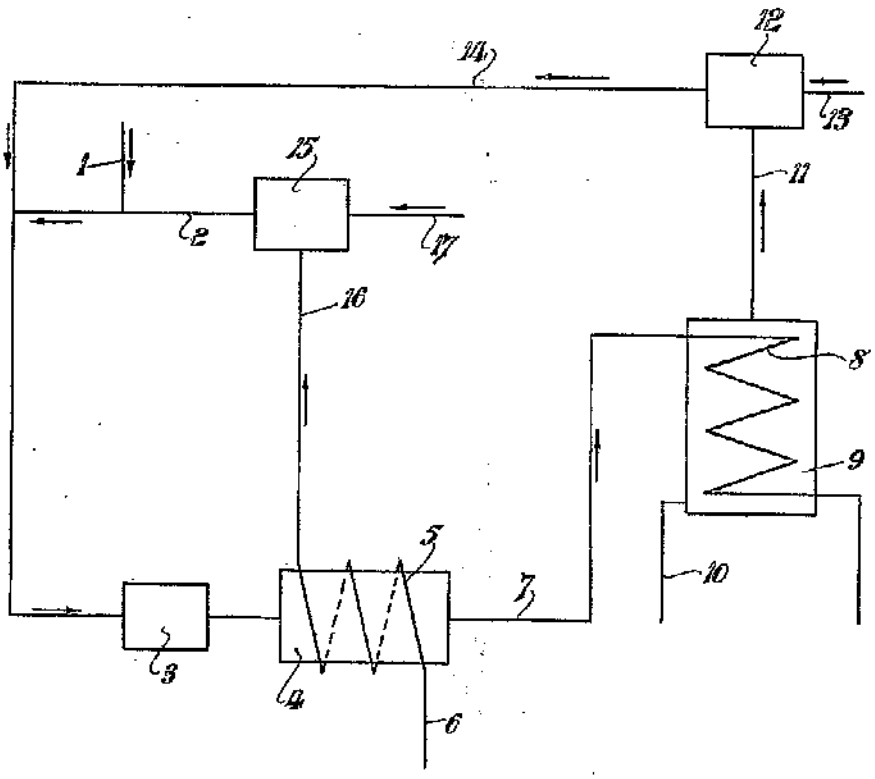
[This Drawing is a reproduction of the Original on a reduced scale.]



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