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THERMAL CRACKING METHOD OF HYDROCARBONS

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FIG. 1

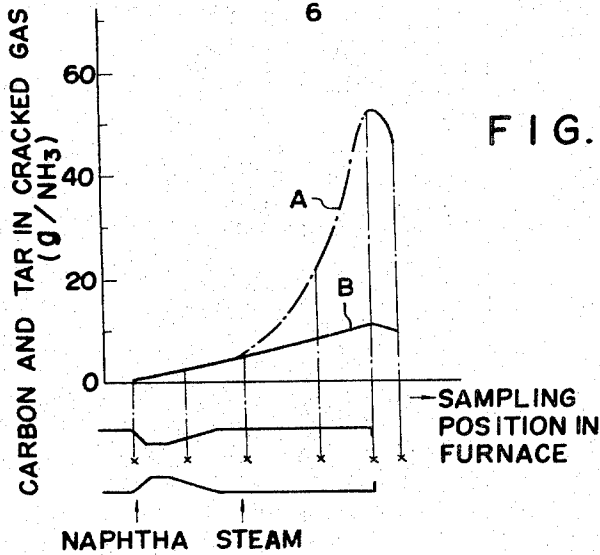
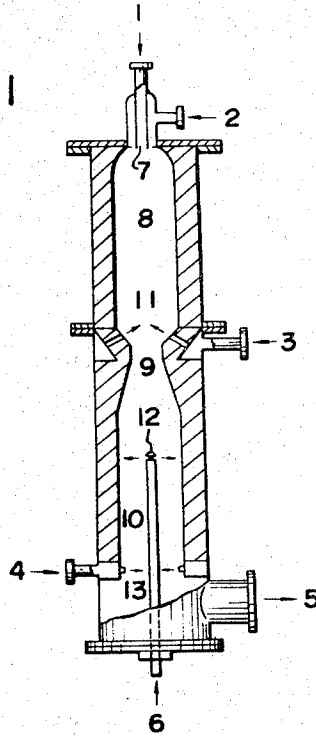


FIG. 2

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THERMAL CRACKING METHOD OF HYDROCARBONS

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ABSTRACT OF THE DISCLOSURE

Method for thermal cracking of hydrocarbons in a two-zone operation wherein overcracking and polymerization are avoided in the first zone by cooling said first zone by means of introducing a coolant, thereafter continuing the cracking step in a second zone which is then completely quenched at the end thereof.

The present invention relates to a process for the thermal cracking of hydrocarbons.

Generally, in a prior process for the manufacture of unsaturated hydrocarbons such as acetylene and ethylene by a flame cracking of hydrocarbons, the reaction temperature is defined by the combustion temperature and the ratio of the combusting amount to the supplying amount of raw material and for the cracking and thus the thermal cracking has been carried out in one step for a suitable reaction time at that temperature. Because of this, there are disadvantages in that the reaction temperature and residence time are naturally decided by the aimed for product and consequently the quantities of by-products are also decided.

The present invention was accomplished as a result of our various studies in order to avoid the above disadvantages. The essential feature of the present invention is a process for the thermal cracking the hydrocarbons characterized in that in the thermal cracking of hydrocarbons in a combustion gas at a high temperature, a cooling medium is injected into and mixed with a reaction gas which is obtained by the thermal cracking in a first thermal cracking reaction chamber to lower the reaction temperature by 50° C. to 200° C. and thus to suppress an overcracking and polymerization of the aimed for product in the first thermal cracking reaction, and then the uncracked material and intermediate products in a second thermal cracking reaction chamber are thermally cracked and thereafter quenched to complete the thermal cracking reaction.

The process of this invention will now be more fully described with reference to the accompanying drawings. It is to be understood that such description is included merely by way of illustration and is in no way intended to limit the scope of the invention.

In the drawings:

FIGURE 1 shows a vertical section of furnace which is suitable for the practice of the process of the present invention, and

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FIGURE 2 shows a graph in which the carbon and tar formation in the furnace in the process of the present invention is compared with that in the process of the prior art.

In FIGURE 1, a fuel gas and oxygen or oxygen containing gas are respectively supplied from a nozzle 1 and a nozzle 2 and are simultaneously injected into a combustion chamber 8 and are burnt therein. A preheated raw material hydrocarbon for cracking is supplied from a nozzle 3 and then is injected into the combustion chamber 8 from injection nozzles 11 to mix it with the combustion gas and to crack it. A first thermal cracking is carried out at a reaction temperature of 1,000° to 2,000° C. for a reaction time of 0.01 to 0.0001 sec. in a first thermal cracking reaction chamber 9 which is positioned over the level of coolant injection nozzle 12. A coolant is supplied from a nozzle 6 and is injected into the first thermal cracking chamber from an injection nozzle 12 and mixed with the reaction gas therein, and thus the reaction temperature is lower by 50° to 200° C. The reaction gas is further thermally cracked at a reaction temperature of 800° C. to 1950° C. which is lower by 50° to 200° C. than the reaction temperature in the first thermal cracking for a reaction time of 0.1 to 0.001 sec. in a second thermal cracking reaction chamber 10 which is positioned below the level of coolant injection nozzle 12. The reaction is completed by supplying a coolant from a nozzle 4 and then injecting the coolant from an injection nozzle 13 into the cracked gas to quench the cracked gas. The cracked gas obtained is sent to a next step from a nozzle 5. When the coolant injection nozzle 6 is constructed to be movable along with the vertical axial direction of the cracking furnace, it is able to freely control and vary the volume ratio of the first thermal cracking reaction chamber to the second thermal cracking reaction chamber during the operation of the furnace, and the composition of the gas can be freely controlled by changing the combination of the quantity of the coolant with the ratio of volume of the first to the second thermal cracking reaction chambers.

And further, the coolant injection nozzle 12 may be fixed onto the furnace wall and the coolant may be injected towards center of the furnace. And also the quenching nozzle 13 for the stopping of the reaction can be designed to be movable.

In the process for the thermal cracking of the present invention, the selection of effective reaction can be attained by utilizing difference in the cracking velocity inherent to the reaction temperature of each component, based on the control of reaction temperature so as to lower the temperature in a range of 50°-200° C. by the injection of coolant. Selection of proper coolant also enables to suppress a side reaction only by the choice of coolant. For instance the coolant such as hydrogen and/or steam greatly suppresses the formation of carbon and tar. The admixing of the coolant to the reaction gas is also effective for such as suppression of polymerization of the aimed product. The present invention is, therefore, especially effective when the mixed raw material containing various components having different characteristics such as petroleum fraction is thermally cracked, and also when the products are considerably reactive and contain many components.

For instance, when acetylene is produced according to the process of the present invention, the higher temperature is favourable as the condition of acetylene formation, however, such condition also accelerates decomposition and polymerization of the acetylene. Therefore, in the process of the present invention, the first thermal cracking is carried out at a desirable high temperature to accelerate the formation of acetylene. After a short reaction time, the reaction temperature is lowered by 50°-200° C. by the injection of for example steam to be able to easily suppress the decomposition of acetylene into carbon and tar and the polymerization, and further to easily convert the higher hydrocarbons which are by-produced or undecomposed, into acetylene in the second thermal cracking reaction. The steam itself has a suppression effect, an effect for the suppression of carbon formation, therefore, the yield of acetylene is increased and the cracked gas composition (by-products) is also freely controlled by the selection of injection position of coolant and the quantity thereof.

The present invention is illustrated by the following examples.

Example 1

The type of cracking furnace used is shown in FIGURE 1. 665 m.³/hr. (standard condition) of fuel gas (petroleum cracking gas), 7.02 m.³/hr. (standard condition) of oxygen and 1,260 kg./hr. of steam were burnt. 1,000 kg./hr. of naphtha which was preheated to 500° C. were injected into the combustion gas thus obtained and thus were cracked. The first thermal cracking reaction was carried out at the temperature of 1,135° C. during the retention time of 0.001 sec. and then the second thermal cracking reaction was carried out by injecting 300 kg./hr. of steam into the second thermal cracking reaction chamber and by lowering the reaction temperature to 1,030° C. during the retention time of 0.005 sec. and thereafter the reaction was stopped by a water cooling. As a result, the amount of the cracked gas thus obtained was 2,170 m.³/hr. (standard condition).

Another cracking was carried out by the identical flow condition but without the rapid steam cooling and the results obtained were compared with the results which were obtained by the process of the present invention carrying out the rapid steam cooling. The results of the comparison are shown in Table 1.

TABLE 1

	Steam quenching, according to the present invention	No steam quenching
Acetylene yield, wt. percent.....	25.4	24.2
Ethylene yield, wt. percent.....	28.9	26.5
Acetylene plus ethylene yield, wt. percent.....	54.3	50.7
C ₃ -C ₆ olefin yield, wt. percent.....	10.5	11.2
Carbon balance, percent.....	97.2	94.0
Amount of carbon and tar in the cracked gas, g./m. ³	11.1	15.2

¹ Standard condition.

The results of the formation of carbon and tar in the reaction furnace are shown in FIGURE 2. In FIGURE 2, curve A represents the result of which a rapid steam cooling is not carried out and curve B represents the results of which a rapid steam cooling is carried out according to the present invention.

From the above results, it is clear that when the process for cracking hydrocarbons according to the present invention is carried out the yield of C₂H₄ is increased and the formation of carbon and tar are considerably decreased.

Example 2

157 m.³/hr. (standard condition) of fuel gas, 146

m.³/hr. (standard condition) of oxygen and 430 kg./hr. of steam were burnt. 280 kg./hr. of naphtha which was preheated to 500° C. were injected therein. After the first thermal cracking was carried out at the temperature of 1,090° C. for the reaction time of 0.002 sec., 150 kg./hr. of steam were injected herein and the second thermal cracking reaction was carried out by lowering the reaction temperature by 100° C. for the reaction time of 0.03 sec. Thereafter the reaction was completed by quenching the cracked gas with the blowing of water.

Another cracking was carried out by the identical flow condition but without the rapid steam cooling and the results obtained were compared with the results which were obtained by the process of the present invention carrying out the rapid steam cooling. The results of the comparison are shown in Table 2.

TABLE 2

	Steam quenching, according to the present invention	No steam quenching
Acetylene yield, wt. percent.....	7.5	7.7
Ethylene yield, wt. percent.....	45.2	41.6
Propylene yield, wt. percent.....	6.0	6.3
Carbon balance, percent.....	95.0	91.0
Amount of carbon and tar in the cracked gas, g./m. ³	1.07	14.8

¹ Standard condition.

From the above results, it is clear that when the process for cracking hydrocarbons according to the present invention is carried out the yield of C₂H₄ which is the aimed product is increased and the formation of carbon and tar are considerably decreased.

What we claim is:

1. A process for continuous thermal cracking of hydrocarbons to produce products including acetylene and ethylene comprising:

- (a) producing a stream of flowing gases by first introducing combusting gases into a first zone;
- (b) admitting a hydrocarbons stream into said stream of combusting gases in said first zone whereby the temperature of the zone is 1000° C. to 2000° C.;
- (c) thermally cracking in a first thermal cracking reaction a first portion of said hydrocarbons stream;
- (d) introducing cooling fluid other than a hydrocarbon into said partially cracked hydrocarbons stream downstream of said first zone in a second zone to
 - (1) lower the temperature of the gases in the second zone by 50° to 200° C.,
 - (2) suppress said first thermal cracking reaction, and
 - (3) suppress polymerization and decomposition of the products of said first cracking reaction;
- (e) thermally cracking a second portion of said hydrocarbons stream in said second zone according to a second thermal cracking reaction said second portion being an effluent from said first zone;
- (f) quenching said second thermal cracking reaction; and
- (g) recovering the products of the reactions including acetylene and ethylene.

2. The process of claim 1 wherein the hydrocarbon is naphtha.

3. The process of claim 1 wherein the residence time of the hydrocarbon in the first zone is 0.01 to 0.0001 second.

4. The process of claim 1 wherein the residence time of the hydrocarbon in the second zone is 0.1 to 0.001 second.

5. The process of claim 3 wherein the residence time of the hydrocarbon in the second zone is 0.1 to 0.001 second.

6. The process of claim 5 wherein the hydrocarbon is naphtha.

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7. The process of claim 6 wherein the naphtha is preheated to 500° C. before being introduced into the first zone.

8. The process of claim 1 wherein said cooling fluid is selected from the group consisting of steam and hydrogen. 5

9. The process of claim 1 wherein said second portion are higher hydrocarbons.

10. The process of claim 6 wherein said cooling fluid is selected from the group consisting of steam and hydrogen, and wherein said second portion are higher hydrocarbons. 10

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