



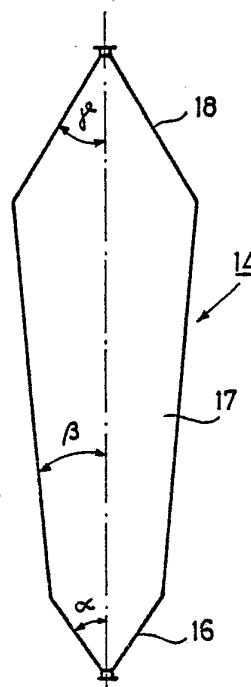
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(54) Title: PROCEDURE FOR THERMAL CRACKING OF HYDROCARBON OILS

(57) Abstract

Procedure for thermal cracking of hydrocarbons. In the procedure the hydrocarbons are heated to reaction temperature and conducted into a reaction zone, where the flow is upward from below. The reaction zone (17) is formed of a pressure vessel (14) of which the cross section increases in the direction upward from below, whereby is achieved a uniform retention time without any perforated intermediate bottoms or equivalent placed in the reaction vessel. The walls of the reaction zone (17) subtend with the central axis an angle (β) of which the magnitude is between 2 and 15 degrees.



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Procedure for thermal cracking of hydrocarbon oils

The present invention concerns a procedure for thermal cracking of hydrocarbon oils, in which procedure the hydrocarbons are heated to reaction temperature and conducted into a reaction zone, where the flow is upward from below.

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In thermal cracking of hydrocarbon oils, heavy oil fractions are cracked to lighter fractions, thereby increasing the yield of the latter. In cracking, the feed oil is heated in the heating tubes of the cracking furnace to cracking temperature. As a rule, two alternative procedures are available. In one of them, cracking takes place in the heating tubes of the cracking furnace and partly in the pipelines which lead to the process steps following after the cracking. In this cracking procedure the delay times are not exactly known, but they are relatively short, that is in the order of one minute. The pressure varies greatly, going down from the furnace entrance to the furnace exit. In the other cracking procedure, the hydrocarbon feed is first heated in the cracking furnace to a suitable reaction temperature, and the actual cracking reaction takes place in a separate reaction zone, where the delay time is considerably longer than in the preceding procedure, that is, of the order of 10 to 30 minutes. No heat is introduced to the reaction zone.

In the procedure last mentioned, the reaction zone as a rule consists of an upright, cylindrical pressure vessel, at one end of which the oil feed heated in the cracking furnace is introduced, at the other end being extracted a mixture of liquid and gas to go to further refining steps, for instance to distilling. The flow direction in the reaction zone has been either downward from above or upward from below.

In thermal cracking of hydrocarbon oils, reactions of substantially two kinds take place. One of them is the cracking reaction proper,



the long-chain molecules being split into smaller molecules, causing reduction of viscosity. The other reaction type is called polycondensation, whereby the molecules combine and produce pitch and coke as hydrogen is set free. The last-mentioned reaction is an undesired reaction because it results in greater quantities of asphaltenes. Since the condensing reactions grow to be significant at higher temperatures, endeavours are made to use lower reaction temperatures and correspondingly longer delay times.

10 The delay time is very important for thermal cracking. The cracking has not time to take place if the delay time is too short. In a case when the delay time is too long, the cracking products begin to react and to form undesired reaction products. As a result, an unstable product is formed which causes difficulties in the further use of the fuel. The aim is therefore a cracking as uniform as possible. If the flow in the pressure vessel serving as reaction zone are non-uniform, the result will be varying delay times.

In the cracking reaction, light components are formed which evaporate at the temperature and pressure in the reaction zone. Therefore, the density of the liquid/gas mixture decreases as the mixture flows upward in the pressure vessel. Owing to the hydrostatic pressure differential in the pressure vessel, the density of the gas part also decreases as the mixture flows upward. The liquid fractions formed in the cracking reactor have lower density than the feed, which also lowers the density of the liquid/gas mixture. Therefore, the flow velocity is not constant in the usually employed cylindrical reactor with uniform thickness, but accelerates as the mixture flows upward.

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The thermal cracking procedure disclosed in U.S. Patent No. 4,247,387 has a cylindrical vertical pressure vessel serving as reaction zone, and in which a view to preventing refluxes within the reactor have been disposed perforated intermediate bottoms constituting a plurality of mixing sites in the reactor. This aims towards achieving a delay time as uniform as possible for the fraction fed into the zone. The use of intermediate plates

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has its drawbacks. Faulty operation of the reactor may cause the whole reactor to be coked to occlusion. The intermediate bottoms make the coke removal and reactor cleaning inconvenient and expensive.

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The object of the invention is to provide an improvement in presently known procedures. The more detailed object of the invention is to provide a procedure wherein it is possible to obtain a uniform delay time without any perforated intermediate bottoms or equivalent to be placed in the reaction vessel.

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The objects of the invention are achieved by a procedure which is mainly characterized in that the reaction zone is formed of a pressure vessel of which the cross section area increases upward from below.

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The other characteristic features of the procedure are stated in claims 2 to 8.

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By using according to the invention in the reaction zone a cross section are increasing upward from below the generation of major velocity gradients is prevented and a plug-type flow pattern is promoted, which is optimal in view of the result of cracking. Although the density of the liquid/gas mixture flowing upward from below decreases during the reaction, the conical, upwardly expanding shape of the reaction zone counteracts this, tending to slow down the flow in the reaction zone.

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The angle of the walls of the reaction zone with reference to the central axis is preferably dimensioned so that the velocity of the liquid/gas mixture will be approximately constant under normal conditions. This is usually achieved when said angle is between 2 and 15 degrees. With angles larger than this, harmful refluxes are produced; similarly if the angle is less than 2 degrees, its effect becomes insignificant.

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Since at the entrance of the reaction zone velocity gradients of



the flows are readily incurred, it is to advantage, according to the invention, to make the entrance section of the reaction zone conical as well. The cone angle is selected on the basis of the flow velocity in the feed tube. The higher the velocity in the feed tube, the smaller should the angle be chosen. In practice, the appropriate angles vary between 2 and 30 degrees.

The exit from the reaction zone may be shaped to be conical. In that case the angle is selected on the basis of the velocity normally present in the exit tube. The higher the exit velocity, the smaller should the angle be chosen. Angles appropriate in practice vary in the range from 2 to 30 degrees. The exit section may also be rounded to conform to an elliptic or spherical surface, or it may be provided with flow guides or equivalent members to prevent refluxes in this region.

It has been found in view of the cracking reaction that the appropriate temperature is between 410 and 470 degrees and the pressure between 2 and 20 bar. The ratio of the average diameter and length of the reaction zone preferably ranges from 1:1 to 1:20.

The invention is described in detail with reference to an advantageous embodiment of the invention presented in the figures of the attached drawing, but to which the invention is not meant to be exclusively confined.

Fig. 1 presents an advantageous embodiment of the procedure of the invention, in the form of a schematical process diagram.

Fig. 2 shows on a larger scale the reaction vessel of Fig. 1.

In Fig. 1, the feed oil is conducted by the pipe 11 into the furnace 12, where its temperature is elevated to be between 410 and 470 degrees. From the furnace 12, the oil is conducted by the pipe 13 to the reactor 14, where it flows upward from below and exits from the top of the reactor through the pipe 15 to a separate unit (not depicted), in which for instance gas, petrol,



light and heavy oil may be separated. The average retention time in the reaction zone is between 5 to 100 minutes.

Fig. 2 shows the reaction vessel 14 of Fig. 1, with the entrance section 16, the actual reaction zone 17 and the conical exit section 18. In the respective parts the angle between the walls and the central axes has been denoted with α , β and γ . In the reaction zone depicted in Fig. 2, the angle α is larger than the angle β . It is fully possible that the angles α and β are chosen equal, whereby no separate entrance section 16 is noticeable. It is likewise possible, and even advisable, to round the transitions, if any, between the cone angles so that no sharp angulations occur.



Claims

1. A procedure for thermal cracking of hydrocarbons wherein the hydrocarbons are heated to reaction temperature and conducted into a reaction zone, where the flow is upward from below, characterized in that the reaction zone is formed of a pressure vessel (14) of which the cross section area increases in the direction upward from below.
2. Procedure according to claim 1, characterized in that the walls of the reaction zone and the central axis include an angle (β) of which the magnitude is 2 to 15 degrees.
3. Procedure according to claim 1 or 2, characterized in that the velocity of propagation of the hydrocarbons in the reaction zone (17) is maintained substantially uniform.
4. Procedure according to any one of the preceding claims, characterized in that for entrance section (16) of the reaction zone (17) is used a conical entrance section.
5. Procedure according to claim 4, characterized in that the angle (α) between the wall of the entrance section (16) and the central axis is 2 to 30 degrees.
6. Procedure according to any one of the preceding claims, characterized in that in the reaction zone the temperature is between 410 and 470 degrees, the pressure between 2 and 20 bar and the average retention time between 5 and 100 minutes.
7. Procedure according to any one of the preceding claims, characterized in that for exit section (18) of the reaction zone (17) is used a cone where the angle (γ) between the wall and the central axis is 2 to 30 degrees.
8. Procedure according to any one of the preceding claims, characterized in that for average ratio of the reaction zone's



(17) diameter to its height is used a ratio between 1:1 and 1:20.



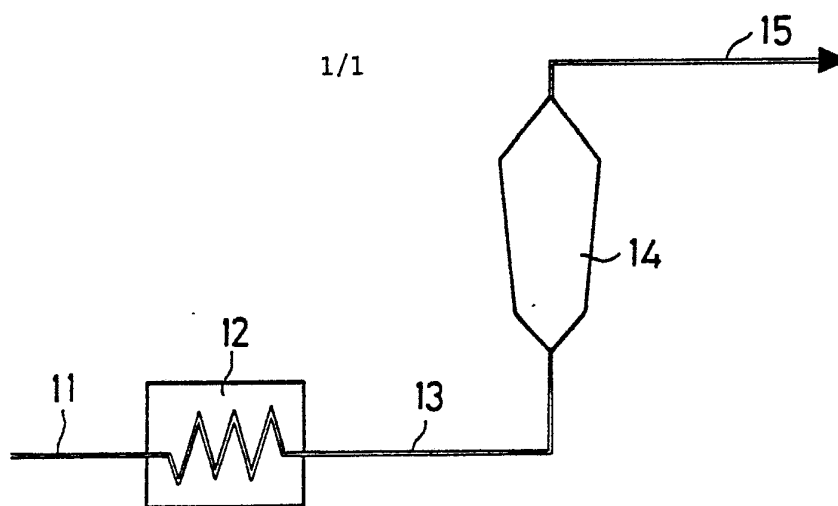


FIG. 1

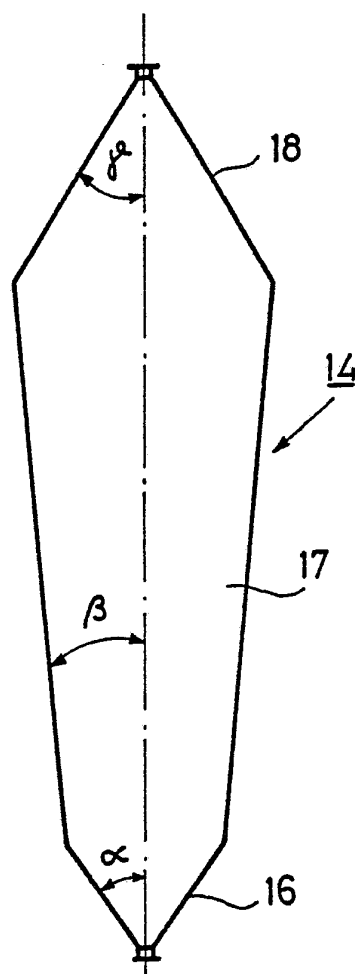


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI83/00045

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC 3		
C 10 G 9/16		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
IPC 3	C 10 G 9/00-42, 47/00, 22-36, 51/00-06, 55/00-08, 57/00-02	
US Cl	208:46, 48-50, 106, 125-132	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT 14		
Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
Y	GB, A, 1 174 870 (THE JAPANESE GEON COMPANY) 17 December 1969 & NL, 6 709 231 US, 3 498 753 DE, 1 645 847 BE, 700 902	
X	GB, A, 1 332 426 (MITSUBISHI JUKOGYO KK) 3 October 1973 & NL, 7 118 072 FR, 2 120 113 DE, 2 163 988 US, 3 763 262	
X	US, A, 3 563 709 (CHEPOS, ZAVODY CHEMICKHEO A POTRAVINARSKHEO STROJIRENSTVI) 16 February 1971 & FR, 1 555 656 GB, 1 178 449 DE, 1 643 811 US, 3 692 862	
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search *	Date of Mailing of this International Search Report *	
1983-08-25	1983-09-09	
International Searching Authority *	Signature of Authorized Officer 19	
Swedish Patent Office	Jack Hedlund	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No ¹⁸
X	US, A, 4 136 015 (UNION CARBIDE CORPORATION) 23 January 1979 & NL, 7 806 159 BE, 867 861 FR, 2 393 844 GB, 2 000 180 DE, 2 824 839 JP, 54 003 102 CA, 1 116 114 SE, 427 672 SE, 7 806 635	
X	US, A, 4 142 963 (UNION CARBIDE CORPORATION) 6 March 1979 & NL, 7 806 160 BE, 867 860 FR, 2 393 842 GB, 2 000 181 DE, 2 824 838 JP, 54 003 103 CA, 1 107 220 SE, 7 806 634 SE, 427 755	
Y	US, A, 4 247 387 (SHELL OIL COMPANY) 27 January 1981 & EP, 0 007 656	