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D E C I S I O N
of 6 July 1999

Case Number: T 0240/95 - 3.3.6

Application Number: 89203073.5

Publication Number: 0372652

IPC: C10G 55/04

Language of the proceedings: EN

Title of invention:
Process for the conversion of a heavy hydrocarbonaceous feedstock

Applicant:
Shell Internationale Research Maatshappij B.V.

Opponent:
-

Headword:
Conversion of heavy feedstock/SHELL

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no); obvious alternative"

Decisions cited:
-

Catchword:
-

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Case Number: T 0240/95 - 3.3.6

D E C I S I O N
of the Technical Board of Appeal 3.3.6
of 6 July 1999

Appellant: Shell Internationale Research
Maatschappij B.V.
Carel van Bylandtlaan 30
2596 HR Den Haag (NL)

Representative: -

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 17 November 1994 refusing European patent application No. 89 203 073.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: P. Krasa
Members: G. Dischinger-Höppler
M. Lewenton

Summary of Facts and Submissions

I. European patent application No. 89 203 073.5 relating to a process for the conversion of a heavy hydrocarbonaceous feedstock was refused by a decision of the examining division. The decision was based on an amended set of claims.

II. The grounds for refusal were that the subject-matter of Claim 1 did not meet the requirements of Article 56 EPC in view of document

(1) EP-A-0 202 099.

The examining division held that the subject-matter of Claim 1 was novel over the disclosure of document (1), but not based on an inventive step, since it was evident from the disclosure of document (1), that it was well-known to someone skilled in the art to adjust the temperature, pressure and residence time employed for the thermal cracking so that the desired conversion occurred.

III. The appellant lodged an appeal against this decision. In response to a communication of the board, he filed the following document

(2) Dr. Ing. M. Akbar and Dr. Ir. H. Geelen, "The Shell Soaker Visbreaking Process"

which was presented as paper AM-81-35 during the 1981 National Petroleum Refiners Association, held at San Antonio, Texas in March 1981.

IV. During oral proceedings held before the board on 6 July 1999, the appellant submitted amended claims according to a main and an auxiliary request, the only independent claim of the main request reading:

"1. Process for the conversion of a heavy asphaltenes-containing hydrocarbonaceous feedstock comprising at least 25% wt of hydrocarbons with a boiling point of at least 520°C into products with a lower boiling point, which process comprises preheating the carbonaceous feedstock, passing the preheated feedstock through a thermal cracking zone so that a conversion of the hydrocarbons with a boiling point of 520°C and above of at least 35% wt is obtained, separating the effluent from the cracking zone into one of more distillate fractions and a residual fraction, and deasphalting the residual fraction to obtain an asphalt and a deasphalted oil, characterized in that the cracking conditions include a residence time of 0.5 to 60 minutes, related to the cold feedstock, whereby the preheated feedstock is passed in an upward direction through the thermal cracking zone."

The only independent claim of the auxiliary request differs therefrom by the addition of the feature "at a temperature in the range from 465 to 510°C" at the very end of Claim 1 of the main request.

VI. The appellant's arguments can be summarized as follows:

- The object of the invention resided in a high conversion of at least 35% wt of heavy feed into good quality liquid products at a short time in combination with controllable formation of sludge.

- This was achieved by combining upward flow conditions for the feedstock in the thermal cracking zone with a short residence time and in the absence of stripping steam.

- In contrast document (1) combined long residence time, presence of steam and downward flow direction of the feedstock.

- The claimed residence time of up to 60 minutes did not include a residence time of 60 minutes.

- The presence of stripping steam was an essential feature in document (1). Substantial amounts thereof were needed, thereby creating large amounts of polluted steam which had to be regenerated. No steam was wanted in the process of the application in suit. On page 4 of the application in suit, the mentioning of steam being possibly present in the claimed process meant only very minor amounts required only to uphold a desired velocity in the cracker. Moreover, this mention was necessary to enforce the patent rights against third parties.

- From the comparative example of document (1) which operated at short residence time and downward flow direction in the absence of steam, it was clear that the teaching of document (1) tended away from the claimed teaching.

- In respect of the "upward flow", the appellant filed the above document (2) in order to show that upward flow direction was the appellant's

preferred embodiment. In this context, the appellant also referred to document

(3) EP-A-0 007 656

which is cited in the application in suit.

- The appellant further opined that conversion rate and residence time gave a complete definition of the operating conditions. Therefore, Claim 1 of the main request contained all the essential features of the process concerned.

VII. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request or of the auxiliary request as submitted during the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments (Article 123(2) EPC)*

Claim 1 of the main request is based on a combination of the features of original Claim 1 with features mentioned in Claims 4 and 7 of the application as originally filed (see also application as originally filed, page 4, lines 18 to 21 and page 5, lines 17 to 20).

The additional amendment made to Claim 1 of the auxiliary request consists in a restriction of the

temperature conditions which is based on the temperatures mentioned in the examples (see Tables II and IV).

The dependent claims are also based on the original version of the application in suit. Hence, the requirements of Article 123(2) EPC are met.

3. *Novelty*

No prior art is available which combines thermal cracking under upflow conditions with a step for deasphalting the residual fraction. The claimed subject-matter of both requests is, therefore, considered to be novel.

4. The only relevant question that remains to be answered in the present appeal is therefore that of inventive step.

4.1 Technical background

The application in suit relates to a process for the conversion of a heavy asphaltenes-containing hydrocarbonaceous feedstock comprising at least 25% wt of hydrocarbons with a boiling point of at least 520°C into products with a lower boiling point, which process comprises the steps of thermally cracking the feedstock and deasphalting the residual fraction. A very convenient feedstock is a vacuum residue of a crude oil, a so-called short residue (see application as originally filed, page 1, lines 1 to 4, page 2, line 29 to page 3, line 4 and page 3, lines 14 to 24).

4.2 Closest prior art

Document (1) discloses a process for treating heavy asphaltenes-containing petroleum oil residues such as vacuum residues e.g. from Middle and Near East crude oils (page 1, lines 3 to 8, page 5, line 23 to page 6, line 3 and the example) to obtain useful oil fractions. The process comprises preheating the feedstock, passing the preheated feedstock through a thermal cracking zone in downward direction and in the presence of stripping steam flowing upwardly in countercurrent direction. The cracking conditions include a residence time of one hour, preheating temperatures selected from 450 to 550°C and pressures being at least atmospheric (page 3, line 22 to page 5, line 2). Thereafter, the effluent is separated into distillate and residual fractions, the latter being deasphalted to obtain asphalt and deasphalted oil (page 5, lines 2 to 14, Claims 1 and 5). As was agreed by the appellant, this document qualifies, therefore, as the closest prior art.

The appellant argued, however, that the process of document (1) differed from the claimed one in various essential aspects, in particular in respect of the longer residence time and the mandatory application of steam.

Concerning the residence time, the appellant opined that 0.5 to 60 minutes do not include 60 minutes as such inclusion would have to be worded "0.5 up to and including 60 minutes". In accordance with the established Case Law of the Boards of Appeals of the European Patent Office, however, the board does not accept this argument but, instead, considers the

disclosure of a range as an explicit disclosure of the end values.

The appellant further argued that the presence of stripping steam distinguished the process of document (1) from the claimed one. The stripping steam according to document (1) had the function to facilitate the removal of lighter components and to uphold plug flow conditions, whereas only small amounts of steam, if any, were present in the claimed process to maintain the flow velocity in the cracking zone in order to avoid deposition of coke. Therefore, the statement in the application in suit that the cracking can be carried out in the presence of steam could not be interpreted to include large amounts of steam as required for the countercurrent stripping in accordance with document (1).

However, in the present case it is decisive that, given the fact that present Claim 1 is not restricted to the absence of steam or to the presence of less steam as compared with document (1), the claimed subject-matter is not distinguished from document (1) in this respect.

The appellant further objected that in document (1) the feedstock was not defined since the amount of very high boiling hydrocarbons was not indicated, and suggested that the feedstock used in the application in suit was different. However, the range of products covered by the definition "a heavy petroleum oil resid feed stream containing large amounts of asphaltenes" (document (1), page 3, lines 13 to 15) broadly overlaps, in the board's judgment, the range of products defined in Claim 1 of the application in suit as "heavy

asphaltenes-containing hydrocarbonaceous feedstock comprising at least 25% wt of hydrocarbons with a boiling point of at least 520°C".

This finding is corroborated by the fact that the amount of hydrocarbons with a boiling point of at least 520°C in the heavy asphaltenes-containing hydrocarbonaceous feedstock is, according to the application in suit, over 90% wt for short residues derived from Middle East crudes, i.e. the same kind of short residue as in document (1), as well as from the Venezuela and the North Sea crudes (Table I of the application in suit). This means that short residues even from different origins have like compositions. The board is, therefore, convinced that, even if it is known that the composition of the crudes may vary from oilfield to oilfield and despite the fact that in document (1) the feedstock used, except for its origin, is not further defined, it is not possible to objectively distinguish the heavy feedstock of Claim 1 from that used in document (1).

Finally, it is undisputed that the conversion indicated in document (1) of 30 to 65% of hydrocarbons boiling above 500°C into lower boiling products includes a conversion of at least 35% of hydrocarbons boiling at 520°C and above.

Thus, the process of document (1) differs from that claimed in the application in suit only in that the feedstock is passed through the thermal cracking zone in a different (downward) direction.

4.3 Technical problem

It is set out in the application in suit that too severe thermal cracking of asphaltenes-containing feedstock leads to the formation of sludge or coke, and thus to stability problems of the cracked residue after blending with suitable diluents to give the resultant fuel the desired product specifications. This can be avoided either by selecting less severe conditions for the thermal cracking such that the conversion of the heavy hydrocarbons, i.e. those having a boiling point of 520°C and above, is below 30% wt, or by deasphalting the feedstock prior to the thermal cracking process. Both attempts to avoid sludge formation will, however, be at a loss of yield in distillates (see page 1, line 17 to page 2, line 15). In contrast, by using the claimed process conversion can be increased without incurring the problems of an unstable residue, whilst the yield of distillates is enhanced (page 2, lines 25 to 28).

High conversion with a minimal production of sludge or coke and high yield of distillates has, however, already been attained by the process taught in document (1), which is disclosed as thermally converting in an asphaltenes-containing feedstock from 30 to 65% of the components having a boiling point of above 500°C into components having a boiling point below 500°C, with minimum loss and improved overall yield and quality of the useful oil components contained in the feedstock (page 3, lines 13 to 21, page 4, line 23 to page 5, line 14, page 5, lines 20 to 23 and page 9, line 24 to page 10, line 3).

In the appellant's view the objective technical problem with respect to document (1) is to provide an improved

continuous process for thermally converting a heavy asphaltenes-containing hydrocarbonaceous feedstock at high conversion levels whereby sludge formation is effectively controlled. The improvement should reside in a higher throughput rate of feedstock combined with a higher yield of useful oil products, i.e. distillates and deasphalted oil.

Considering the fact that Claim 1 is not restricted with respect to an upper limit of cracking temperature to be applied, Claim 1 does not in the board's judgment contain all the features necessary to solve this problem, because it covers the possibility of high conversion but at conditions where mainly coke is produced instead of distillates and deasphalted oil. Therefore, the claimed subject-matter covers embodiments which do not provide the desired high yield of useful oil products and, thus, would not solve the technical problem as suggested by the appellant.

More important are, however, the following considerations:

Bearing in mind that applying a "short" residence time of 0.5 to 60 minutes cannot serve as a distinguishing feature, the alleged increase in throughput rate cannot be accepted as a basis for defining the technical problem. Therefore, the above stated problem boils down to the increase of the yield of useful oil products.

According to the appellant, the single example of document (1), which yielded 71% wt of useful oils, and the working example 4 and 8 of the application under appeal (Tables II and III), which gave a yield of

80.5% wt (see Appendix A filed with the statement of ground of appeal), shows that the stated problem has been solved. As plausibly stated by the appellant in the oral proceedings, the flow of the feedstock was upward in the examples of the application in suit.

However, in the compared examples different conditions were applied, in particular as far as the presence of steam, the pressure conditions (atmospheric versus 5 bar gauge) and the residence time (120 minutes versus 38 minutes) are concerned. It is, therefore, not possible to ascribe the different results presented in the above Appendix A solely to the different flow direction.

Hence, no evidence has been forwarded by the appellant in support of the contention that the technical problem stated above in view of document (1) has been solved by the features as set out in present Claim 1.

Therefore, the board concludes that the technical problem actually solved by the claimed process consists in the less ambitious task of providing a further process for thermally converting a heavy, asphaltenes-containing hydrocarbonaceous feedstock at high conversion levels whereby sludge formation is effectively controlled.

4.4 Inventive step

The question remaining to be answered is, therefore, whether it was obvious in the light of the available prior art to reverse the flow direction of the feedstock in the thermal cracker in the process known

from document (1) in order to arrive at such an alternative process.

4.4.1 Main Request

In document (2) an overview is presented concerning the visbreaker operation as one special application of the thermal cracking process. From the two options available for visbreaking, one is the so-called soaker cracking which is also applied in the examples of the application in suit and which comprises between furnace and quench a soaker vessel designed to allow for a long residence time for the feedstock and for a lower cracking temperature (see page 4, point 3). In this context, long residence time means around 8 minutes (see Figure 2). As is set out under point 4 (pages 4 and 5) upflow operation is the most favourable option in soaker cracking with regard to the size of the vessel and the ease of operation. This is a clear suggestion to the skilled person to apply this feature in the process of citation (1).

The same thermal cracking process with upward flow conditions is also described in document (3) (see e.g. page 2, lines 28 to 34). This document is also concerned with maximum conversion and good stability of the cracked residue, i.e. control of sludge formation (see page 2, lines 19 to 25) which is attained by using a residence time of 0.5 to 60 minutes and upflow conditions in the cracking zone and, thus, would have further encouraged the skilled person to avail himself of the upward flow of the feedstock when looking for a solution of the technical problem as defined.

Relying on the results of the comparative example of document (1), the appellant emphasized that a skilled person would not have renounced the use of steam in the process under consideration. The board cannot accept this argument. Apart from the fact that the absence of steam is not a distinguishing feature (see above point 4.2) the following has to be noted:

The comparative example described in document (1) was carried out with a residence time of only 10 minutes, however at a high pressure (14.8 atm), relatively low preheating temperature (450°C) and without stripping steam, and it gave worse conversion results than the working example of document (1). With only 20% wt, the conversion rate in this comparative example is, indeed, much lower than in the working example of document (1) where a conversion of 55% wt is achieved. Also, the total yield of useful products is much worse. However, the board notes that the different results cannot be explained solely by the absence of steam when considering the widely different working conditions applied in respect of residence time (10 minutes versus 120 minutes), preheating temperature (450°C versus 480°C) and pressure (14.8 atm versus atmospheric). Considering merely the different temperatures applied, the application in suit shows the same trend concerning the conversion rate: from Table II of the application in suit it is evident that cracking Middle East short residue at a coil outlet temperature (preheating temperature) of 450°C on the one hand and 481°C on the other - all other conditions being the same - the conversion rate increases from 23.7% wt to 46.5% wt. In this context it is further noted that the skilled person knows that a conversion deficit due to low

temperature can be compensated by a long residence time. Likewise, short residence time can be offset by a higher temperature (see application in suit, page 5, lines 6 to 13). Hence, those skilled in the art would have recognized that the conditions used in the comparative example of document (1) were, prima facie, unfavourable for the conversion rate as far as the selected low temperature in combination with short residence time is concerned and would have had no reason to link the unfavourable results of the comparative example solely to the absence of steam.

For sake of completeness, the board notes that document (3) does not mention any application of steam. Moreover, from Figure 8 of document (2) it is known that vapour cracking is applied in downflow operation, whereas it is minimal in upflow operation. Hence, in both, document (2) and (3), the upflow cracking is carried out without the application of stripping steam. Therefore, any such restriction of the claimed subject-matter could not reverse the situation concerning inventive step.

The appellant further submitted that the process of Claim 1 was inventive since its deasphalting step was not contemplated in the citations (2) and (3). The board cannot accept this argument, either. Document (2) is silent about any content of asphaltenes in the feedstock, and the feed used in document (3) is low in asphaltenes (see Table I). Consequently, asphaltenes not being a problem, these documents do not suggest any deasphalting of the heavy residue. However, once the problem of accumulation of asphaltenes in the residual fraction arises - due to the feedstock used and the

operational conditions applied in the cracking zone - the skilled person would of course consider to subsequently carry out a deasphalting step as is taught in document (1). Hence, the requirement of a deasphalting step after the thermal cracking would not prevent the skilled person from considering the teaching of documents (2) and (3) as far as the cracking step is concerned, the more so as document (2) indicates that crackability does not correlate with the asphaltenes content of the feed (see page 9, paragraph 4).

The board concludes, therefore, that in the light of this prior art there was an incentive for a skilled person to modify the process of document (1) with respect to the flow direction in the thermal cracking zone with the reasonable expectation of achieving an alternative process, and thus, solving the above technical problem in a way as now suggested in Claim 1 which, therefore, does not involve an inventive step (Articles 52(1) and 56 EPC).

4.4.2 Auxiliary Request

Claim 1 of the auxiliary request differs from that of the main request only in that the initial cracking temperature or coil outlet temperature, has been specified to range from 465°C to 510°C. It is, therefore, plausible that this claim does not, contrary to Claim 1 of the main request, include overcracking or coking with the loss of useful oil products.

However, document (1) uses broadly the same coil outlet temperature, i.e. initial cracking temperature. It

ranges from 450°C to 550°C (page 4, lines 1 to 4); the only working example uses 480°C, i.e. a temperature right in the middle of the claimed range.

As this feature cannot, as a consequence, be used as a basis for inventive step, the same considerations as set out in points 4.3 and 4.4.1 above apply to the subject-matter of Claim 1 of the auxiliary request which, therefore, also lacks inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Rauh P. Krasa