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Bezeichnung der Erfindung:
Title of invention:
Titre de l'invention : Separation of aromatic hydrocarbons from petroleum fractions

Klassifikation / Classification / Classement : C10G 21/28

ENTSCHEIDUNG / DECISION
vom / of / du 26 July 1988

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : Union Carbide Corporation

Einsprechender / Opponent / Opposant : Krupp Koppers GmbH

Stichwort / Headword / Référence : Separation/Union Carbide

EPÜ / EPC / CBE Article 56

Schlagwort / Keyword / Mot clé : "Inventive step (denied)"

Leitsatz / Headnote / Sommaire

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Case Number : T 260/87 - 3.3.1

D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 26 July 1988

Appellant : (Opponent)
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Representative :

Respondent : (Proprietor of the patent)
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Decision under appeal :
Decision of the Opposition Division of the European Patent Office dated 10 June 1987 rejecting the opposition filed against European patent No. 0 033 512 pursuant to Article 102(2) EPC

Composition of the Board :

Chairman : K.J.A. Jahn
Members : R.W. Andrews
C.V. Payraudeau

Summary of Facts and Submissions

I. The mention of the grant of the patent No. 0 033 512 in respect of European patent application No. 81 100 597.4, filed on 28 January 1981 and claiming a priority of 31 January 1980 from a prior application in the United States of America, was announced on 22 August 1984 (cf. Bulletin 84/34) on the basis of four claims. The only independent claim reads as follows:

"1. A continuous solvent extraction-steam-distillation process for the recovery of aromatic hydrocarbons in the range of C_6 to C_{16} from a feed stream containing such aromatics and aliphatic hydrocarbons in the range of C_5 to C_{16}, characterised by the steps of:

(a) providing a first distillation zone and a second distillation zone and passing as a feed stream to said first distillation zone an aromatic rich solvent from preceding solvent extraction;

(b) passing said aromatic rich solvent liquid stream from said first distillation zone in heat exchange relationship with a top vapor stream of steam and hydrocarbons from said second distillation zone thereby partially vaporizing the aromatic rich solvent liquid stream to a hydrocarbon and steam stream and partially condensing said vapor stream;

(c) passing said vaporized hydrocarbon and steam stream from step (b) back into said first distillation zone to provide steam for purifying said aromatic rich solvent liquid stream in said

first distillation zone by further removing non-aromatics from such stream;

(d) passing the liquid portion of said partially vaporized aromatic rich solvent stream from the bottom of said first distillation zone to a heat exchanger;

(e) heat exchanging said liquid portion of said aromatic rich solvent stream with a lean liquid solvent stream from the bottom of such second distillation zone;

(f) introducing the aromatic rich solvent liquid stream after heat exchange as in step (e) to the top of said second distillation zone;

(g) contacting said aromatic rich solvent liquid stream in said second distillation zone with steam to remove substantially all aromatic hydrocarbons from said rich solvent stream to provide the lean solvent stream used in step (e);

(h) passing said partially condensed vapor stream of steam and aromatic hydrocarbons from step (b) to a condensing zone to fully condense such stream; and

(i) decanting such condensed stream into an aromatic rich product phase and a water rich phase.

II. On 7 May 1985 the Appellant filed a notice of opposition requesting the revocation of the patent on the grounds that the requirements of Articles 54 and 56 EPC were not met. The opposition was supported by the following documents:

(1) US-A-3 639 497 and
(2) DE-A-1 444 360.

III. By a decision dated 10 June 1987 the Opposition Division rejected the opposition on the basis that the subject-matter of the disputed patent was novel and involved an inventive step. The Opposition Division concluded that the proposed solution to the technical problem of reducing the heat requirement necessary to recover aromatic hydrocarbons from a petroleum fraction by a process involving steam distillation and solvent extraction was not rendered obvious by the teaching of document (1) of the recovery of heat from the overhead streams from the fractionating columns in which the desired aromatic hydrocarbons are separated from each other. Document (2) disclosed the use of two distillation columns for the recovery of aromatic hydrocarbons, but did not disclose the recovery of heat. Therefore, there was no indication from the combined teaching of documents (1) and (2) to recover the heat of condensation of the stripping stream and aromatic product by using two thermally linked distillation zones.

IV. An appeal was lodged against this decision on 21 July 1987 with payment of the prescribed fee. A statement of grounds of appeal was submitted on 18 September 1987. In this statement and during the oral proceedings held on 26 July 1988 the Appellant argued that document (1) discloses a similar process to that of the disputed patent for the recovery of aromatic hydrocarbons from a feedstock containing such aromatic hydrocarbons and aliphatic hydrocarbons. Although this document also disclosed the fractionation of the aromatic hydrocarbons after the removal of the extraction solvent, the Appellant considered that the extract recycle column 4 and the solvent stripper column 6 of this document are equivalent to high and low pressure columns 24 and 25 respectively of the disputed

process. The necessary reboil heat for the above-mentioned columns 4 and 6 was obtained by cycling part of their bottoms products through heat exchangers in which heat is extracted from the overhead product of the ethylbenzene column and the ethylbenzene and toluene columns respectively. Thus, document (1) teaches the use of the heat of condensation of the overhead vapours of one distillation column to heat the reboiler of another distillation column. The amount of heat saved by the prior art process can be seen from a comparison of Tables I and II of this document. Document (1) also teaches that by increasing the operating pressure of a distillation column the temperature of the overhead vapour and its condensation temperature are increased.

Therefore, in the Appellant's view document (1) indicates to the skilled person a solution to the problem of reducing the heat requirement needed to work-up the extract phase obtained by the liquid-liquid extraction of petroleum fractions to recover a mixture of aromatic hydrocarbons.

V. The Respondent argued that document (1) does not provide the skilled person with any teaching to use the overhead stream from the high pressure column to provide heat for the reboiler of the low pressure column. Document (1) describes the use of streams of substantially pure aromatic hydrocarbons obtained by the fractionation of the mixture resulting from the removal of the extraction solvent to provide heat to the reboilers of other distillation columns, such as 4 and 6. However, although document (1) discloses heat exchange between the overhead vapours of the aromatic fractionation towers and the extraction unit, it does not disclose any heat exchange between the two columns of the extraction unit. Furthermore, the process of the patent in suit makes use of the heat of condensation of a mixture of aromatic hydrocarbons and water, which due to

the presence of water, provides a much higher heat duty than a stream of containing only organic compounds.

In the Appellant's opinion document (1) leads away from the claimed process insofar as the overhead product of column 6, considered by the Appellant to be equivalent to the present column 25, is condensed without any use being made of the heat of condensation. The Respondent also contended that the claimed process did not reside merely in step (b) of Claim 1, but in the novel sequence of process steps set out in Claim 1, for example, in particular steps (e) and (f), to reduce the heat requirements necessary to recover the aromatic hydrocarbons present in the treated feed stock.

VI. The Appellant requested that the decision under appeal be set aside and the patent in suit revoked. The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. There are no formal objections to Claims 1 to 4 as granted since they are adequately supported by the original disclosure. However, in view of the general tenure of the description, in particular those passages on page 3 at lines 8 to 10, 33 to 36 and 42 to 45 and on page 4 at lines 60 and 61, the Board has construed Claim 1 in the Respondent's favour as if the additional feature that the first distillation zone is operated at a lower pressure than the second distillation were included within the terms of Claim 1.

3. The patent in suit relates to a process for the separation of aromatic hydrocarbons from petroleum fractions by extracting the aromatic hydrocarbons from the feedstock with a selected solvent and stripping the solvent from resulting extract phase. Such a process is disclosed in document (1). This document discloses a process for recovering high purity aromatic hydrocarbons from mixed hydrocarbon feedstocks comprising extracting the aromatic hydrocarbons from the feedstock by means of a suitable solvent and stripping the resulting extract to produce an aromatic rich stream which is fractionated into its components. In order to reduce the operating costs the overhead vapours from the aromatic fractionation columns are used as a source of reboil heat in the extraction unit and the benzene recovery column (cf. column 1, lines 16 to 27 in combination with the drawing).

4. In the light of this prior art the technical problem underlying the patent in suit may be seen in providing a further economic process with regard to the heat load requirements for the separation of aromatic hydrocarbons from petroleum fractions. According to the disputed patent this technical problem is essentially solved by a solvent extraction-steam distillation process wherein two extractive distillation zones are operated in series; the first zone is operated at low pressure and the second one at high pressure and the heat of condensation of the overhead vapours of the second distillation zone is used to heat the reboiler of the first distillation zone. Further reductions in the heat load to the process are achieved by passing the aromatic rich solvent stream from the bottom of the first distillation zone in heat exchange with the lean solvent stream from the bottom of the second distillation zone and further raising steam for feeding to the bottom of the second distillation zone by passing the combined water rich phase obtained by condensing and separating the

overhead products from the first and second distillation zones in heat exchange relationship with the aromatic rich solvent stream from the bottom of the extraction unit (cf. Claims 1 and 2 in combination with the drawing).

The Board is satisfied that the technical problem as defined above is plausibly solved.

5. After examination of the cited documents the Board has reached the conclusion that this technical teaching is not disclosed in any of them. The claimed subject-matter is, therefore, novel. Since novelty is not disputed it is not necessary to substantiate this conclusion.

6. It still remains to be examined whether the requirement of inventive step is met by the claimed subject-matter.

6.1 As previously mentioned document (1) discloses a process for recovering aromatic hydrocarbons from mixed hydrocarbon feedstocks by extracting the aromatic hydrocarbons with a suitable solvent and stripping the solvent from resulting extract. This document also discloses the fractional distillation of the mixture of aromatic hydrocarbons so obtained to separate and recover high-purity products. In this prior art process the extraction unit comprises an extractor in which the feedstock is contacted with the selected solvent, an extract recycle column from which part of the overhead product is returned to the bottom stage of the extractor as reflux and the bottoms product is fed to a solvent stripper column from which the overhead product is condensed and part of the condensate fed, via a heat exchanger, to the benzene distillation column and the bottoms product comprising the stripped solvent is recycled back to the extractor via a heat exchanger in which it exchanges its heat with the extract (cf. column 1, line 55 to column 2, line 57). Thus, the extract recycle column and

the solvent recovery column of the prior art process may be regarded as corresponding to the present low and high pressure columns respectively, although in the Example of document (1) it is specified that the extract recycle column is operated at atmospheric pressure and the solvent stripper column under a partial vacuum (cf. column 6, lines 23 to 27).

This prior art document further discloses that the necessary reboil heat for the extract recycle column is obtained by recycling part of its bottoms product through a heat exchanger in which heat is extracted from the overhead product of the ethylbenzene column and that the reboil heat of the solvent stripper column is provided by two reboilers which are in heat exchange relationship with the overhead products of the toluene and ethylbenzene columns (cf. column 3, lines 37 to 41 and 44 to 49). Furthermore, this document also teaches that in order to maintain the overhead vapours of the toluene and ethylbenzene columns at a temperature to provide an adequate differential temperature for the direct exchange of heat from the overhead products of these columns to the bottoms products of the extract recycle and solvent stripper columns, the former columns are operated at elevated pressures since by increasing the pressure of the columns it is possible to obtain vapours that are at a higher temperature and condense at a higher temperature (cf. column 5, lines 64 to 69 and column 6, lines 29 to 35).

6.2 After studying document (1) the skilled person in this field would be able to derive the following general teaching:

(a) the extract phase from the solvent extraction of a mixed hydrocarbon feedstock may be worked up by two distillation columns operating in series.

(b) The necessary reboil heat for one distillation column in a series of such columns may be provided by the heat of condensation of the overhead vapour product from a later distillation column in the series.

(c) The temperature difference between the condensation temperature of the overhead vapour product of the later column and reboil temperature of the earlier column may be adjusted by varying the operating pressure of the later column.

(d) The heat capacity of the bottoms product from the solvent stripping column may be recovered via a heat exchanger.

6.3 It is well known in the art that the solvent may be stripped from the extract phrase comprising a mixture of aromatic hydrocarbons and solvent by means of steam distillation (cf. under (1) on page 2, lines 19 to 21 of the disputed patent). From his common general knowledge the skilled person is also aware that the heat of condensation of a mixture of steam and aromatic hydrocarbon vapours is higher than that of the same amount of pure aromatic hydrocarbon vapours and would, therefore, provide a much higher heat duty. This was acknowledged by the Respondent during the oral proceedings.

Therefore, the skilled person seeking to solve the problem of providing a further economic process with regards to the heat load requirements for separating aromatic hydrocarbons from petroleum fractions using a solvent extraction process in which steam distillation is employed to strip the solvent from the extract phase would, in the light of the disclosure of document (1) and his knowledge of heats of condensation, be immediately led to consider using the heat

of condensation of the overhead vapours of the high pressure stream distillation zone as a source of heat for the reboiler of the first distillation zone. The skilled person would also realise that in order to provide the necessary temperature differential between the condensation temperature of overhead product of the high pressure steam distillation zone and the reboil temperature of the first distillation the operating pressure in this steam distillation zone must be adjusted to a suitable value.

6.4 In view of the emphasis placed in recent years on the conservation of energy, the skilled person would not allow heat energy to go to waste. The most obvious method of recovering heat energy is via heat exchangers in which streams of material at lower temperatures extract heat from streams of material at higher temperatures. Being aware of the temperature difference between the various streams, it would fall within the routine duties of the skilled person to thermally link suitable streams via heat exchangers. Therefore, the heat exchange linkage between the bottoms product of the low pressure distillation zone and the bottoms product of the high pressure distillation zone is considered to be a selection of one possibility from several equally obvious possibilities.

6.5 In the Board's judgement, the claimed solution to the technical problem underlying the patent in suit is obvious in the light of the teaching of document (1) and common general knowledge. Therefore, the subject-matter of Claim 1 does not involve an inventive step.

7. Dependent Claims 2 to 4, which relate to preferred embodiments of the process in accordance with Claim 1, do not contain any independent inventive features and are, therefore, unpatentable in the absence of an allowable main claim.

7.1 The only additional feature of Claim 2 which contributes to the solution of the problem underlying the disputed patent is the requirement that the water rich phases resulting from the condensation and separation of the overhead products of the first and second distillation zones are combined and the combined water is passed in heat exchange relationship with the aromatic rich solvent from the bottom of the extraction zone. However, for the reasons given in paragraph 6.4 above this feature does not involve an inventive step.

Order

For these reasons, it is decided that:

1. **The decision under appeal is set aside.**

2. **The patent is revoked.**

The Registrar: **The Chairman:**