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Datasheet for the decision of 9 March 2021

Case Number: T 1991/19 - 3.3.05

Application Number: 12795124.2

Publication Number: 2773449

IPC: B01J3/00

Language of the proceedings: EN

Title of invention:
SUPERCRITICAL WATER PROCESS TO UPGRADE PETROLEUM

Applicant:
Saudi Arabian Oil Company

Headword:
Supercritical water process/Saudi Arabian Oil

Relevant legal provisions:
RPBA 2020 Art. 13(2)
EPC Art. 123(2), 84, 56

Keyword:
Amendment after summons - exceptional circumstances (yes)
Amendments - allowable (yes)
Claims - clarity (yes)
Inventive step - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
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Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 1991/19 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 9 March 2021

Appellant: (Applicant)	Saudi Arabian Oil Company 1 Eastern Avenue Dhahran 31311 (SA)
Representative:	Stafford, Jonathan Alan Lewis Marks & Clerk LLP 1 New York Street Manchester M1 4HD (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 7 December 2018 refusing European patent application No. 12795124.2 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	E. Bendl
Members:	G. Glod
	R. Winkelhofer

Summary of Facts and Submissions

I. The applicant's (appellant's) appeal lies from the examining division's decision to refuse European patent application No. 12 795 124.2.

The examining division found that the requests then on file did not meet the requirements of Articles 123(2), 84 and 56 EPC.

II. The following documents were cited during proceedings before the examining division:

D1= M. Hossain et al.: 20th Annual Saudi-Japan Symposium, 6 December 2010, retrieved from the Internet; URL:http://www3.kfupm.edu.sa/catsymp Symp20th/11 Mozahar.pdf
D2= US 4 483 761 A
D3= US 7 922 895 B2
D4= US 2009/166262 A1
D5= US 7 754 067 B2
D6= WO 2009/073446 A2

III. In the communication pursuant to Article 15(1) RPBA, the board expressed the preliminary opinion that no patent could be granted on the basis of the requests then on file, in particular because they did not meet the requirements of Article 84 EPC.

IV. During oral proceedings before the board on 9 March 2021 the appellant filed a new main request.

The only independent claim of this request is as follows:

"*1. A method for upgrading a petroleum feedstock with supercritical water while preventing plugging in equipment process lines, the method being performed under continuous operation and comprising the steps of:*
priming an upgrading reactor to receive the petroleum feedstock, the priming of the apparatus comprising the steps of:
supplying a heated and pressured water stream to a first mixing device, wherein the water stream is heated using a first heater and pressurized to a temperature and pressure greater than the critical point of water;
supplying a heated and pressurized start-up hydrocarbon stream to the first mixing device, wherein the start-up hydrocarbon stream is heated using a second heater and pressurized to a temperature of between 10 and 250°C and wherein the start-up hydrocarbon is selected from benzene, toluene, xylene, and ethylbenzene, or from reformate from a catalytic reformer, light cracked naphtha from an FCC unit, visbreaker naphtha, coker naphtha, and pyrolysis gasoline from a steam cracker;
wherein the volumetric flow rate of the start-up hydrocarbon stream and water is between 1:5 and 1:1;
mixing the heated and pressurized water stream and the heated and pressurized start-up hydrocarbon stream in the first mixing device to produce a water and start-up hydrocarbon containing primer stream;
supplying the water and start-up hydrocarbon containing primer stream to the upgrading reactor, said reactor being maintained at a temperature that is between 380 and 550°C to produce a treated primer stream, wherein the primer stream has a residence time in the upgrading reactor of between 10 seconds and 60 minutes;
cooling the treated primer stream to a temperature of less than 150°C using a cooling device,
depressurizing the cooled treated primer stream;

separating the cooled treated primer stream into treated primer gas and treated primer liquid phase streams;
separating the treated primer liquid phase into a recycle start-up hydrocarbon stream and a recycle water stream;
continuing the priming step until the temperature of the streams within the first heater, the second heater, the supercritical upgrading reactor and the cooling device are maintained to within 5% of their set point for a period of at least 10 minutes;
stopping the flow of the start-up hydrocarbon containing primer stream to the upgrading reactor and then supplying a heated and pressurized petroleum feedstock to the first mixing device, wherein the heated and pressurized petroleum feedstock is maintained at a temperature of between 10 and 250°C and wherein the petroleum feedstock is selected from the group consisting of whole range crude oil, topped crude oil, the product stream from a petroleum refinery, the product stream from a steam cracker, liquefied coal, the liquid product recovered from oil sand, bitumen, and asphaltene;
mixing the heated and pressurized water stream and the heated and pressurized petroleum feedstock in the first mixing device to produce a mixed water and start-up petroleum feedstock stream;
supplying the mixed water and start-up petroleum feedstock stream to the upgrading reactor, said reactor being maintained at a temperature that is between 380 and 550°C and at a pressure greater than the critical pressure of water to produce an upgraded petroleum containing stream, wherein the mixed water and start-up petroleum feedstock stream has a residence time in the upgrading reactor of between 10 seconds and 60 minutes;

cooling the upgraded petroleum containing stream to a temperature of less than 150°C,
depressurizing the cooled upgraded petroleum containing stream;
separating the cooled upgraded petroleum containing stream into a gaseous phase upgraded and desulfurized petroleum containing stream and liquid phase upgraded and desulfurized petroleum containing stream;
separating the liquid phase upgraded and desulfurized petroleum containing stream into an upgraded and desulfurized petroleum product stream and a recycle water stream".

Claims 2 to 10 relate to preferred embodiments.

V. The appellant's relevant arguments are reflected in the reasoning below.

VI. The appellant requests that the impugned decision be set aside and that a patent be granted on the basis of the main request submitted during oral proceedings before the board, or alternatively on the basis of auxiliary requests 1 or 2 to which the impugned decision relates, or on the basis of auxiliary request 4 submitted on 4 March 2021.

Reasons for the Decision

Main request

1. Article 13(2) RPBA

This request was only submitted during oral proceedings before the board.

Requests submitted at such a late stage of the proceedings are, in principle, not be taken into account unless there are exceptional circumstances, which have been justified with cogent reasons.

In the present case such exceptional circumstances are acknowledged, since the request is considered to be a response to the clarity objections raised by the board for the first time in the communication pursuant to Article 15(1) RPBA and to objections that arose - in view of the somewhat poor reasoning on inventive step in the impugned decision - during the discussion during oral proceedings before the board.

The amendments made are easy to understand and result in an allowable set of claims, as set out below.

Therefore, the request is taken into consideration.

2. Article 123(2) EPC

The requirements of Article 123(2) EPC are met, for the following reasons.

2.1 Claim 1 is based on claims 1 to 3, 6 and 8 as originally filed. In addition, the feature "and at a pressure greater than the critical pressure of water",

relating to the upgrading reactor, is directly and unambiguously derivable from paragraph [0045] and in particular from page 12, lines 12 to 16, which indicate that the pressure in the reactor 238 (upgrading reactor) was above the critical pressure of water.

The feature relating to the continuous operation is directly and unambiguously derivable from paragraph [0048], which states that the use of a start-up agent, as present in claim 1, allows for continuous operation of the process.

The specification of antecedents in the step "continuing the priming step until the temperature of the streams within the heater, supercritical upgrading reactor and cooling devices are maintained to within 5% of their set point for a period of at least 10 minutes" is directly and unambiguously derivable from figure 2 in combination with the method steps already present in claim 1 as originally filed.

2.2 Claims 2 to 10 are based on claims 4, 5, 7, 9, 10, 11, 13, 14, 15 and 16 of the application as filed.

3. Article 84 EPC

The requirements of Article 84 EPC are met, for the following reasons.

3.1 The claimed method concerns a method for upgrading a petroleum feedstock while preventing plugging in equipment process lines that is performed under continuous operation. The steps that are essential for said method are the priming of the apparatus and the subsequent treatment of the petroleum feedstock as defined in claim 1, since these steps make it possible

to upgrade a petroleum feedstock, and have an effect on plugging of the process lines.

The board does not concur with the examining division that other steps are required in order to obtain the presumed object. It may be true that the features referred to in point II.2.2 of the impugned decision are beneficial, but they are not essential to the object of claim 1, which does not require that no plugging at all occurs. The features essential for executing the claimed method are not necessarily the same as those making it possible to solve the technical problem vis-à-vis the closest prior art.

3.2 The set point of the temperature within the first heater, the second heater, the supercritical upgrading reactor and the cooling device is a temperature within the ranges given in claim 1 that is to be maintained for 10 minutes before the priming step ends. The supercritical upgrading reactor is understood to be identical to the upgrading reactor previously mentioned, since upgrading of the petroleum feedstock is performed under conditions that result in supercritical water.

3.3 Then the flow of the start-up hydrocarbon is stopped, and it is replaced by a heated and pressurised petroleum feedstock, which is mixed with water in the first mixing device. Since the process is operated continuously, it is clear to the skilled person that stopping can be performed in different ways, for example continuously or step-wise.

4. Article 56 EPC

4.1 The present invention relates to a method performed under continuous operation for upgrading a petroleum feedstock with supercritical water.

4.2 D6 is considered the closest prior art, since it also relates to such a method (paragraph [0020]). It discloses, for example in figure 1, a mixing zone [30] for mixing the highly waxy crude oil with water. The obtained mixture is then fed into heating zone [40] and subsequently into main reactor [50] (paragraphs [0052] and [0053]), where the upgrading takes place in the presence of supercritical water.

D1 relates to batch experiments (D1: second page, third paragraph). D2, which indicates that the method may be performed in a continuous flow reactor (column 3, lines 57 to 59), discloses only examples run in an autoclave. Neither D1 nor D2 discloses a priming step as claimed.

D3 to D5 were not mentioned by the examining division as evidence of a lack of inventive step, and they are not closer prior art than D6, since they do not disclose a priming step either.

4.3 The problem to be solved is to provide a more effective upgrading method with less formation of sludge (paragraph [0007] of the application as filed).

4.4 The problem is solved by a method according to claim 1 characterised in that priming of the apparatus is performed by the steps indicated in claim 1.

4.5 There is no reason to doubt that the problem is solved successfully, for the following reasons.

It is set out in paragraph [0048] that use of the start-up agent allows for continuous operation of the process, since it prevents and/or reduces the formation of sludge, coke and coke precursors. This is confirmed by comparing examples 1 and 2 and in particular figures 3 and 4. The embodiment according to claim 1 (example 2, figure 4) did not lead to a pressure increase upstream of reactor 238. Although the process according to example 2 was conducted at specified temperatures and pressures and included two mixers as shown in figure 2, there is no indication that it is not credible that a similar effect - albeit less pronounced - is obtained with other embodiments falling within claim 1.

4.6 It needs to be determined whether the solution is obvious in view of the cited prior art.

As already indicated under point 4.2 above, none of documents D1 to D6 discloses a priming step as claimed. Although D2 discloses the use of light olefins when cracking heavy hydrocarbons with supercritical water (column 1, lines 9 to 13 and column 2, lines 14 to 20), there is no disclosure that the reactor should first be supplied with a start-up hydrocarbon before stopping this supply and providing the petroleum feedstock. D2 discloses the simultaneous presence of petroleum feedstock, water and an olefin containing five or less carbon atoms (e.g. example 1 and claim 1).

The solution is not obvious in view of the prior art.

4.7 Consequently, the requirements of Article 56 EPC are met.

5. The set of claims of the main request is allowable.

Auxiliary requests

6. Since the main request is allowable, there is no need to discuss the other requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of the main request, filed during the oral proceedings before the board, and a description to be adapted thereto.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated