

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.: 11/615,539

Confirmation No.: 1057

Applicant: Stuart N. Milligan et al.

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Examiner: Boyle, Robert C.

Docket No.: 34249US

Customer No.: 28841

Title: Drag Reduction of Asphaltenic Crude Oils

Commissioner for Patents

P.O. Box 1450

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RESPONSE TO FINAL OFFICE ACTION

Sir:

In response to the Office Action of June 15, 2010, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begin on page 2 of this paper.

Remarks/Arguments begin on page 7 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-96. (Cancelled)

97. (Withdrawn) A composition comprising:

a drag reducing polymer and a liquid hydrocarbon,

wherein the solubility parameter of the drag reducing polymer is within $4 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

98. (Withdrawn) The composition of claim 97, wherein the solubility parameter of the liquid hydrocarbon is at least $17 \text{ MPa}^{1/2}$.

99. (Withdrawn) The composition of claim 97, wherein the drag reducing polymer comprises at least about 25,000 repeating units.

100. (Withdrawn) The composition of claim 99, wherein a plurality of the repeating units comprise a heteroatom.

101. (Withdrawn) The composition of claim 100, wherein the heteroatom is selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and/or a phosphorus atom.

102. (Withdrawn) The composition of claim 97, wherein the drag reducing polymer has a weight average molecular weight of at least $1 \times 10^6 \text{ g/mol}$.

103. (Withdrawn) The composition of claim 97, wherein the drag reducing polymer has a solubility parameter within $2.5 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

104. (Withdrawn) The composition of claim 97, wherein the solubility parameter of the liquid hydrocarbon is determined by the following equation:

$$\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$$

where ΔH_v is the energy of vaporization, R is the universal gas constant, T is the temperature in Kelvin, V is the molar volume and δ_2 is the solubility parameter.

105. (Withdrawn) The composition of claim 97, wherein the solubility parameter of the drag reducing polymer is determined by the following equation:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$$

where δ is the solubility parameter, $\delta_d = \sum F_{di}/V$, $\delta_h = (\sum F_{hi}/V)^{1/2}$, $\delta_p = (\sum F_{pi}^2)^{1/2}/V$.

106. (Withdrawn) A composition comprising:

a drag reducing polymer and a liquid hydrocarbon,

wherein the solubility parameter of the drag reducing polymer is within $4 \text{ MPa}^{1/2}$ of the liquid hydrocarbon and the solubility parameter of the liquid hydrocarbon is at least $17 \text{ MPa}^{1/2}$.

107. (Withdrawn) A method comprising:

calculating the solubility parameter of a liquid hydrocarbon; and

selecting a drag reducing polymer that is within $4 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

108. (Withdrawn) The method of claim 107, wherein the solubility parameter of the liquid hydrocarbon is at least $17 \text{ MPa}^{1/2}$.

109. (Withdrawn) The method of claim 107, wherein the drag reducing polymer has a solubility parameter within $2.5 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

110. (Withdrawn) The method of claim 107, wherein the solubility parameter of the liquid hydrocarbon is determined by the following equation:

$$\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$$

where ΔH_v is the energy of vaporization, R is the universal gas constant, T is the temperature in Kelvin, V is the molar volume and δ_2 is the solubility parameter.

111. (Withdrawn) The composition of claim 107, wherein the solubility parameter of the drag reducing polymer is determined by the following equation:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$$

where δ is the solubility parameter, $\delta_d = \sum F_{di}/V$, $\delta_h = (\sum F_{hi}/V)^{1/2}$, $\delta_p = (\sum F_{pi}^2)^{1/2}/V$.

112. (Withdrawn) A method comprising:

calculating the solubility parameter of a liquid hydrocarbon; and

selecting a drag reducing polymer that is within $4 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

wherein the solubility parameter of the liquid hydrocarbon is determined by the following equation:

$$\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$$

where ΔH_v is the energy of vaporization, R is the universal gas constant, T is the temperature in Kelvin, V is the molar volume and δ_2 is the solubility parameter and

wherein the solubility parameter of the drag reducing polymer is determined by the following equation:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$$

where δ is the solubility parameter, $\delta_d = \sum F_{di}/V$, $\delta_h = (\sum F_{hi}/V)^{1/2}$, $\delta_p = (\sum F_{pi}^2)^{1/2}/V$.

113. (Currently Amended) A method comprising:

introducing a drag reducing polymer into a liquid hydrocarbon having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° to thereby produce a treated liquid hydrocarbon wherein the viscosity of the treated liquid hydrocarbon is not less than the viscosity of the liquid hydrocarbon prior to treatment with the drag reducing polymer;

wherein the drag reducing polymer has a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the liquid hydrocarbon.

114. (Currently Amended) The method of claim 113, wherein the solubility parameter of the drag reducing polymer ~~parameter~~ is at least about $17 \text{ MPa}^{1/2}$.

115. (Previously Presented) The method of claim 113, wherein the drag reducing polymer comprises at least about 25,000 repeating units.

116. (Previously Presented) The method of claim 113, wherein a plurality of the repeating units comprise a heteroatom.

117. (Previously Presented) The method of claim 116, wherein the heteroatom is selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and/or a phosphorus atom.

118. (Previously Presented) The method of claim 113, wherein the drag reducing polymer has a weight average molecular weight of at least 1×10^6 g/mol.

119. (Previously Presented) The method of claim 113, wherein the drag reducing polymer has a solubility parameter within $2.5 \text{ MPa}^{1/2}$ of the liquid hydrocarbon.

120. (Previously Presented) The method of claim 113, wherein the solubility parameter of the liquid hydrocarbon is determined by the following equation:

$$\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$$

where ΔH_v is the energy of vaporization, R is the universal gas constant, T is the temperature in Kelvin, V is the molar volume and δ_2 is the solubility parameter.

121. (Previously Presented) The method of claim 113, wherein the solubility parameter of the drag reducing polymer is determined by the following equation:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$$

where δ is the solubility parameter, $\delta_d = \sum F_{di}/V$, $\delta_h = (\sum F_{hi}/V)^{1/2}$, $\delta_p = (\sum F_{pi}^2)^{1/2}/V$.

122. (Previously Presented) The method of claim 113, wherein the drag reducing polymer is added to the liquid hydrocarbon in the range from about 0.1 to about 500 ppmw.

123. (Previously Presented) The method of claim 113, wherein the drag reducing polymer is added to the liquid hydrocarbon in the range from about 2 to about 50 ppmw.

124. (Currently Amended) A method comprising:

introducing a drag reducing polymers having a solubility parameter of at least about $17 \text{ MPa}^{1/2}$ into a liquid hydrocarbon having a solubility parameter of at least about $17 \text{ MPa}^{1/2}$ having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° to

thereby produce a treated liquid hydrocarbon wherein the viscosity of the treated liquid hydrocarbon is not less than the viscosity of the liquid hydrocarbon prior to treatment with the drag reducing polymer;

wherein the drag reducing polymer has a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the liquid hydrocarbon and the drag reducing polymer comprises at least about 25,000 repeating units, and wherein a plurality of the repeating units comprise a heteroatom, wherein the heteroatom is selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and/or a phosphorus atom and wherein the drag reducing polymer has a weight average molecular weight of at least $1 \times 10^6 \text{ g/mol}$.

125. (Currently Amended) A method comprising:

introducing a drag reducing polymer into a liquid hydrocarbon;

wherein the drag reducing polymer has a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the liquid hydrocarbon having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° to thereby produce a treated liquid hydrocarbon wherein the viscosity of the treated liquid hydrocarbon is not less than the viscosity of the liquid hydrocarbon prior to treatment with the drag reducing polymer;

wherein the solubility parameter of the liquid hydrocarbon is determined by the following equation:

$$\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$$

where ΔH_v is the energy of vaporization, R is the universal gas constant, T is the temperature in Kelvin, V is the molar volume and δ_2 is the solubility parameter; and

wherein the solubility parameter of the drag reducing polymer is determined by the following equation:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$$

where δ is the solubility parameter, $\delta_d = \sum F_{di}/V$, $\delta_h = (\sum F_{hi}/V)^{1/2}$, $\delta_p = (\sum F_{pi}^2)^{1/2}/V$.

REMARKS/ARGUMENTS

Claims 97-125 are currently pending. Claims 97-112 are withdrawn. Claims 113, 124 and 125 are currently amended. Claims 114-123 are previously presented.

Election/Restrictions

The office action has explained the previous made elections related to the current set of claims. Accordingly Claims 97-112 are currently withdrawn.

Claims Rejections – 35 USC § 102

Claims 113-125 are rejected under 35 USC § 102(b) as being anticipated by Choi, *Polymer-Induced Turbulent Drag Reduction*, Ind. Eng. Chem. Res. 1996, 35, 2993-2998.

The liquid hydrocarbon of Choi does not contain the property limitations as set forth by Applicant's claims.

Applicant's amended independent claims 113, 124 and 125 specify that the liquid hydrocarbon has an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. Choi does not contain this limitation.

Choi only describes solubility parameters within 4 Mpa^{1/2} of each other when their liquid hydrocarbon is kerosene (page 2977), a substance devoid of asphaltenes. Furthermore, the API gravity of kerosene is above 40° (<http://zenstoves.net/MSDS/CrownKI.pdf>).

Therefore, it would be improper to utilize the reference of Choi to teach, suggest, or motivate one skilled in the art of combining a drag reducing polymer into a liquid hydrocarbon with an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. Reconsideration of the rejection is respectfully requested.

Claims 113-121, 124-125 are rejected under 35 USC § 102(b) as being anticipated by Castner US 4,736,005.

The drag reducing polymer of Castner does not contain the property limitations as set forth by Applicant's claims.

Applicant's amended independent claims 113, 124 and 125 specify that the viscosity of the treated liquid hydrocarbon is not less than the viscosity of the liquid hydrocarbon prior to treatment with the drag reducing polymer. Castner does not contain this limitation.

Castner describes a method of "increasing the viscosity of the aqueous medium and decreasing the viscosity of the petroleum by the addition of suitable chemical agents" (Castner Column 2, lines 9-12).

Reconsideration of the rejection is respectfully requested.

Claims 113-125 are rejected under 35 USC § 102(b) as being anticipated by Inaoka (EP 0882739).

Inaoka does not teach, suggest or motivate one skilled in the art to introduce a drag reducing polymer into a liquid hydrocarbon having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. The specific characteristics of applicant's liquid hydrocarbon are defined by one skilled in the art as "heavy crude oil" or "heavy crude". This specific species is not obvious in light of the genus teaching of "crude oil" in Inaoka. (MPEP 2144.08)

The limitations put forth in applicant's independent claims limit the scope of the application to only heavy crude oil. Inaoka does not teach, suggest or motivate one skilled in the art to operate their drag reducer in heavy crude oil or properties that are inherent to heavy crude oil. Applicant's specific limitations in the independent claims enable applicant's application to be a new, useful and unobvious invention.

The specific species of heavy crude oil presents special challenges compared to the production, transportation, and refining of the genus crude oil. Prior to applicant's invention, one skilled in the art would not have transported applicant's liquid hydrocarbon via pipelines due to the specific challenges such as the high viscosity and asphaltene content of heavy crude oil.

Broadly speaking, the genus of crude oil can be broken down to three different broad species of heavy, medium and light crude oil. A drag reducer is incapable of operating well in all three species of crude oil due to the specific characteristics of each. (please see affidavit by Ray L. Johnston) Therefore, one skilled in the art would not manufacture, describe, teach, suggest or

motivate anyone to produce a drag reducer that operates under the broad genus of “crude oil”, since it is scientifically impossible to overcome the extreme variances between the different species of crude oil.

The drag reducer of Inaoka is described as one that is used to impart drag reduction on the broad genus of “crude oil”, specifically the specific genus of light crude oil. This can be established from the Inaoka where the evaluation of the drag reducer was done in a liquid of only xylene and kerosene. As explained in the affidavit by Ray L. Johnston, a drag reducer for heavy crude oil can only be tested in heavy crude oil and that testing in light crude oil or xylene and kerosene does not establish that Inaoka had any conceptual knowledge of the ability to introduce drag reducer to heavy crude oil, nor has Inaoka established that it has enabled the ability to introduce a drag reducer in heavy crude oil.

As shown in the independent claims of our application, the liquid hydrocarbon where we are introducing our drag reducing polymer has an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°, characteristics of heavy crude oil. The specific introduction of our drag reducing polymer into a specific species of crude oil not previously tried or thought feasible makes our method new, useful and unobvious.

As established by the affidavit by Ray L. Johnston, one of ordinary skill in the art would not have previously thought it was possible to impart a drag reducing polymer into the specific genus of heavy crude oil. When one typically hears that a drag reducing polymer is introduced into a crude oil, the immediate assumption by one skilled in the art would be that the drag reducing polymer would only work in light or medium crude oils.

Furthermore, as shown in the following video prior to the use of applicant’s invention, the successful drag reduction of a heavy crude oil through a pipeline was never considered possible. (<http://www.extremepowerflowimprovers.com/EN/study/Pages/index.aspx>).

Since Inaoka does not teach introducing a drag reducing polymer into the specific species of heavy crude oil, and the specific species of heavy crude oil is vastly different from the broad genus of crude oil, one skilled in the art would not consider a statement in the art that teaches introducing a drag reducer to “crude oil” to include the specific species of heavy crude oil.

Reconsideration of the rejection is respectfully requested.

Claims 120-121, 125 are rejected under 35 USC § 103(a) as being unpatentable over Choi in view of Gharagheizi.

The liquid hydrocarbon of Choi does not contain the property limitations as set forth by Applicant's claims.

Applicant's amended independent claims 113, 124 and 125 specify that the liquid hydrocarbon has an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. Choi does not contain this limitation.

Choi only describes solubility parameters within 4 Mpa^{1/2} of each other when their liquid hydrocarbon is kerosene (page 2977), a substance devoid of asphaltenes. Furthermore, the API gravity of kerosene is above 40° (<http://zenstoves.net/MSDS/CrownK1.pdf>).

Gharagheizi does not contain the missing limitations of Choi. Gharagheizi only teaches a method to determine the Hansen Solubility Parameters for a polymer.

Therefore, it would be improper to utilize the reference of Choi combined with Gharagheizi to teach, suggest, or motivate one skilled in the art of combining a drag reducing polymer into a liquid hydrocarbon with an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. Reconsideration of the rejection is respectfully requested.

Applicants respectfully request that a timely Notice of Allowance be issued in this case. No fees are believed due at this time. If, however, fees are due, the Commissioner is authorized to deduct any fees or credit any overpayment to Deposit Account 16-1575, ref. 34249US.

Respectfully Submitted,

Date: August 27, 2010

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Appl. No. 11/615,539

Amdt. dated 08/27/2010

Reply to Office Action of 06/15/2010

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