

Filed on behalf of Baker Hughes Incorporated

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BAKER HUGHES INCORPORATED,
Petitioner

v.

LUBRIZOL SPECIALTY PRODUCTS, INC.,
Patent Owner

Case IPR2016-01896
Patent No. 8,022,118

PETITION FOR *INTER PARTES* REVIEW

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PETITIONER’S EXHIBIT LIST

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 8,022,118 B2 (“the 118 patent”)
1002	U.S. Patent No. 8,426,498 B2 (“the 498 patent”)
1003	U.S. Patent No. 8,450,249 B2 (“the 249 patent”)
1004	U.S. Patent No. 8,450,250 B2 (“the 250 patent”)
1005	Holtmyer, Marlin D. and Chatterji, Jiten, “Study of Oil Soluble Polymers as Drag Reducers,” <i>Polymer Engineering and Science</i> , vol. 20, no. 7, 1980 (“the Holtmyer Publication”).
1006	U.S. Patent No. 3,758,406, “Methods and Compositions for Reducing Frictional Pressure Loss in the Flow of Hydrocarbon Liquids,” granted 9/11/1973 (“the Holtmyer Patent”)
1007	European Patent Application No. EP 0,882,739 A2, High molecular weight polymer and producing method the same and drag reducer, published 12/9/1998 (“Inaoka”)
1008	Carnahan, Norman F., “Precipitation of Asphaltenes in Heavy Oil and Tar Sands,” in <i>Asphaltenes and Asphalts</i> , 2, Developments in Petroleum Science 40B, Elsevier Science B.V., 2000 (“Carnahan”)
1009	Strausz, O.P. and Lown, E.M., <i>The Chemistry of Alberta Oil Sands, Bitumens and Heavy Oils</i> , Alberta Energy Research Institute, Calgary, 2003 (“Strausz”)
1010	<i>Curriculum Vitae</i> of Thomas H. Epps III, Ph.D.
1011	Brandrup et al., <i>Polymer Handbook</i> , 4 th ed., John Wiley & Sons, Inc., 1999 (“Brandrup”)
1012	Young & Lovell, <i>Introduction to Polymers</i> , 2nd ed., CRC Press, 1991 (“Young & Lovell”)
1013	Odian, George, <i>Principles of Polymerization</i> , 4th ed., John Wiley & Sons, Inc., 2004 (“Odian”)
1014	Zakin, J.L. and Hunston, D.L., “Effect of Polymer Molecular Variables on Drag Reduction,” <i>J. Macromol. Sci.-Phys.</i> , B18(4), 795-814 (1980)

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1015	Mowla, D. and Naderi, A., “Experimental study of drag reduction by a polymeric additive in slug two-phase flow of crude oil and air in horizontal pipes,” <i>Chemical Engineering Science</i> 61, 1549-1554, available online as of November 4, 2005
1016	Burger et al., “Studies of Drag Reduction Conducted over a Broad Range of Pipeline Conditions when Flowing Prudhoe Bay Crude Oil,” <i>Journal of Rheology</i> , 24(5), 603-626 (1980)
1017	Buckley, J.S., et al., “Asphaltene Precipitation And Solvent Properties of Crude Oils,” <i>Petroleum Science and Technology</i> , vol. 16, no. 3-4, 1998
1018	Ferguson, K.R., et al., “Microbial Pilot Test for the Control of Paraffin and Asphaltenes at Prudhoe Bay,” Society of Petroleum Engineers, Inc., 1996
1019	U.S. Pat. Appl. No. 11/615,539, Preliminary Amendment, Mar. 10, 2008
1020	U.S. Pat. Appl. No. 11/615,539, Request for Reconsideration to Office Action, Jun. 24, 2009
1021	U.S. Pat. Appl. No. 11/615,539, Request for Reconsideration to Office Action, Apr. 8, 2010
1022	U.S. Pat. Appl. No. 11/615,539, Response to Final Office Action, Aug. 27, 2010
1023	U.S. Pat. Appl. No. 11/615,539, Affidavit Under 37 CFR 1.132, signed by Ray L. Johnston, Aug. 13, 2010
1024	U.S. Pat. Appl. No. 11/615,539, Office Action, Nov. 18, 2010
1025	U.S. Pat. Appl. No. 11/615,539, Response to Office Action, Apr. 8, 2011
1026	U.S. Pat. Appl. No. 11/615,539, Notice of Allowance and Fees Due, May 11, 2011
1027	Martinez-Palou, R. et al., “Transportation of Heavy and Extra-Heavy Crude Oil by Pipeline: A Review,” <i>J. Pet. Sci. Eng.</i> 75:274-82, 2011

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EXHIBIT	DESCRIPTION
1028	Conoco CDR [®] 102 Flow Improver, filed in U.S. Pat. Appl. No. 381,232, issued as U.S. Pat. No. 4,983,186, Jan. 8, 1991
1029	ConocoPhillips LP _™ 300 Product Datasheet, accessed at https://web.archive.org/web/20040604182725/http://liquidpower.com/ProductSolution/ProductSolution.asp
1030	ConocoPhillips LP _™ 400 Product Datasheet, accessed at https://web.archive.org/web/20040604182725/http://liquidpower.com/ProductSolution/ProductSolution.asp
1031	<i>Reserved</i>
1032	<i>Reserved</i>
1033	<i>Reserved</i>
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1035	<i>Reserved</i>
1036	<i>Reserved</i>
1037	<i>Reserved</i>
1038	<i>Reserved</i>
1039	Transcript of Deposition of Brian Dunn, Ph.D., (excerpt), <i>Lubrizol Specialty Prods., Inc. v. Baker Hughes Inc.</i> , No. 4:15-cv-02915 (S.D. Tex.), Feb. 9, 2016
1040	Horn, A.F. et al., “High Viscosity Crude Drag Reduction,” <i>Pipeline & Gas Journal</i> , pages 22-25, June 1986.
1041	Declaration of Professor Thomas H. Epps, III

I. Introduction

Baker Hughes Incorporated petitions for *inter partes* review of claims 1-11 of U.S. Patent No. 8,022,118 (“the 118 patent”; Ex.1001), entitled “Drag Reduction of Asphaltenic Crude Oils.” The 118 patent claims methods of “introducing a drag reducing polymer into a pipeline . . . into a liquid hydrocarbon.” Ex.1001, claim 1. Adding drag reducing polymers to crude oil, however, was not new. They had been used in oil pipelines for decades prior to the filing date of the 118 patent.

To obtain allowance of the claims, Patent Owner added limitations that specify certain properties of the drag reducing polymer and the liquid hydrocarbon. For example, the claims recite a drag reducing polymer “wherein a plurality of the repeating units comprise a heteroatom” and having a “weight average molecular weight of at least 1×10^6 g/mol.” But those are properties of many prior art drag reducing polymers. Similarly, while the claims recite adding the drag reducing polymer to a liquid hydrocarbon “having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° ,” crude oil having those properties was transported in pipelines well before the filing date of the 118 patent.

In fact, though the claims of the 118 patent are so exceedingly broad that they encompass the use of virtually any drag reducing polymer in any heavy crude oil, Patent Owner did not even invent the two specific drag reducing polymers

exemplified in the 118 patent (“Polymer A” and “Polymer B”). Thus, Patent Owner has done nothing more than claim the addition of known drag reducing polymers to known crude oils, with nothing novel, unexpected, or inventive about the result. This is a textbook case of “the mere application of a known technique to a piece of prior art ready for the improvement.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007).

II. Mandatory Notices

Real Parties-In-Interest: Baker Hughes Incorporated and Baker Petrolite LLC are the real parties-in-interest.

Related Matters: The 118 patent is one of four related patents asserted against Petitioner in district court infringement litigation. The other three are U.S. Patent No. 8,426,498 (“the 498 patent”; Ex.1002); U.S. Patent No. 8,450,249 (“the 249 patent”; Ex.1003); and U.S. Patent No. 8,450,250 (“the 250 patent”; Ex.1004). All four patents are entitled, “Drag Reduction of Asphaltenic Crude Oils,” all four share a common specification, and all four contain similar claims. Accordingly, Petitioner is challenging all four patents on the same or similar grounds.

In addition to the three other petitions for *inter partes* review being filed concurrently with this one, the following judicial or administrative matters would affect or be affected by a decision in the proceedings:

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1. *Lubrizol Specialty Products, Inc. v. Baker Hughes Inc.*, Case No. 4:15-cv-02915 (S.D. Tex.), filed October 5, 2015;
2. U.S. Patent Application No. 13/209,119, filed on August 12, 2011, which is pending and which claims benefit to and is a continuation in part of U.S. Patent Application No. 11/615,539 (now the 118 patent); and
3. *Baker Hughes Incorporated v. Lubrizol Specialty Products, Inc.*, Case IPR2016-00734, in which trial was instituted on October 4, 2016.

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Service Information: Petitioner consents to service by email at:
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III. Grounds For Standing

The 118 patent is available for *inter partes* review, and Petitioner is not barred or estopped from requesting an *inter partes* review challenging claims 1-11 of the 118 patent on the grounds identified in this Petition.

IV. Identification Of Challenge

Petitioner identifies the following grounds of unpatentability:

Ground 1: Claims 1-11 are obvious over Holtmyer, Marlin D. and Chatterji, Jiten (1980) “Study of Oil Soluble Polymers as Drag Reducers,” *Polymer Engineering and Science*, vol. 20, no. 7, pp. 473-477 (Ex.1005; “the Holtmyer Publication”) in view of U.S. Patent No. 3,758,406, “Methods and Compositions for Reducing Frictional Pressure Loss in the Flow of Hydrocarbon Liquids,” granted September 11, 1973 (Ex.1006, “the Holtmyer Patent”), and Strausz, O.P. and Lown, E.M., *The Chemistry of Alberta Oil Sands, Bitumens and Heavy Oils*, Alberta Energy Research Institute, Calgary, 2003 (Ex.1009, “Strausz”).

Ground 2: Claims 1-11 are obvious over European Patent Application No. EP 0,882,739 A2, “High Molecular Weight Polymer and Producing Method the Same and Drag Reducer,” published December 9, 1998 (Ex.1007; “Inaoka”) in view of Strausz.

V. The 118 Patent

A. The Subject Matter of the 118 Patent

The 118 patent “relates generally to high molecular weight drag reducers for use in crude oils.” Ex.1001, 1:7-8. More specifically, the 118 patent relates to “high molecular weight drag reducing polymers for use in crude oils having an asphaltene content of at least about 3 weight percent and an API gravity of less than about 26°.” *Id.*, 1:8-12. The 118 patent refers to such crude oil as “heavy crude oil.” *See id.* at Table 1; *see also* Ex.1023 ¶9 (“The limitations put forth by our patent application of a liquid hydrocarbon [having] an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° place the liquid hydrocarbon in the range of ‘heavy crude oils’ as known by one skilled in the art.”).

As the 118 patent explains, “[w]hen fluids are transported by a pipeline, there is typically a drop in fluid pressure due to friction between the wall of the pipeline and the fluid. Due to this pressure drop, for a given pipeline, fluid must be transported with sufficient pressure to achieve the desired throughput.” Ex.1001, 1:15-19. The 118 patent further teaches in the Background of the Invention:

To alleviate the problems associated with pressure drop, many in the industry utilize drag reducing additives [also referred to as drag reducing agents (“DRAs”)] in the flowing fluid. When the flow of fluid in a pipeline is turbulent, high molecular weight polymeric drag

reducers can be employed to enhance the flow. A drag reducer is a composition capable of substantially reducing friction loss associated with the turbulent flow of a fluid through a pipeline. The role of these additives is to suppress the growth of turbulent eddies, which results in higher flow rate at a constant pumping pressure. Ultra-high molecular weight polymers are known to function well as drag reducers, particularly in hydrocarbon liquids. In general, drag reduction depends in part upon the molecular weight of the polymer additive and its ability to dissolve in the hydrocarbon under turbulent flow. Effective drag reducing polymers typically have molecular weights in excess of five million.

Id., 1:28-43.

Thus, the 118 patent recognizes that several limitations of claims 1-11 were known in the prior art. Specifically, the patent acknowledges that:

- (1) DRAs were known in the art;
- (2) the mechanism of action of DRAs—i.e., “substantially reducing friction loss associated with the turbulent flow of a fluid through a pipeline [by] suppress[ing] the growth of turbulent eddies”)—was known in the art;
- (3) it was known in the art that “drag reduction depends in part upon the molecular weight of the polymer additive” and that “[e]ffective drag reducing polymers typically have molecular weights in excess of five million”; and

(4) it was known in the art that “drag reduction depends in part upon [the] ability [of the DRA] to dissolve in the hydrocarbon under turbulent flow.”

In describing the problem addressed by the 118 patent, the patent states:

Conventional polymeric drag reducers, however, typically do not perform well in crude oils having a low API gravity and/or a high asphaltene content. Accordingly, there is a need for improved drag reducing agents capable of reducing the pressure drop associated with the turbulent flow of low API gravity and/or high-asphaltene crude oils through pipelines.

Id., 1:44-49. The 118 patent purports to fill this need, describing the synthesis and testing of two purported “improved drag reducing agents”— i.e., “Polymer A” (a 2-ethylhexyl methacrylate homopolymer) and “Polymer B” (a copolymer of 2-ethylhexyl methacrylate and n-butyl acrylate). *Id.*, 12:64-18:24. But, as demonstrated below, these methacrylate-based polymers were already known to be effective drag reducing agents in crude oil, and it would have been obvious to a person of ordinary skill in the art to have used them as such in the heavy crude oils encompassed by the claims of the 118 patent.

B. Prosecution History of the 118 Patent

The 118 patent was filed as U.S. Patent Application No. 11/615,539 (“the 539 application”), on December 22, 2006. Accordingly, the critical date in this case is December 22, 2005.

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The 539 application, as amended by preliminary amendment, contained 92 claims, many of which recited a method of 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°. Ex.1019. After a number of Office Actions rejecting these claims, applicants amended the independent claims to limit the drag reducing polymers to those with a “weight average molecular weight of at least 1×10^6 g/mol.” Ex.1020, p.32. Although applicants argued that this limitation was not taught by the cited references, applicants admitted that “[i]t is well known in the art that to be an effective drag reducer, in liquid hydrocarbon with the properties currently claimed, ultra-high molecular weights are required.” *Id.*, p.33.

After a subsequent Office Action, applicants canceled all pending claims and added new claims directed to a drag reducing polymer having a specific solubility parameter. Ex.1021. After receiving another rejection, however, applicants amended the remaining independent claims by again adding a limitation reciting that the liquid hydrocarbon has an asphaltene content of at least 3 weight percent and API gravity of less than about 26°. Ex.1022.

Applicants then argued, for the first time, that the amended claims were novel and nonobvious because no drag reducing additives had, prior to 2006, been used in heavy crude oil (as opposed to light or medium crude oil) having the

claimed asphaltene content and API gravity. *Id.*, pp.8-9. Applicants also offered an affidavit by Ray L. Johnston (one of the inventors of the 539 application) alleging that in 2006, “heavy crude oil was scientifically thought to be impossible to effectively drag reduce in pipelines due to the high viscosity and asphaltene content and resultant lack of sufficient turbulence within the pipeline,” and that, thus “any mention of effective crude oil drag reduction prior to 2006 only meant use of a drag reducer in light or medium crude oil.” Ex.1023 ¶¶15-16.¹

In the next Office Action (November 18, 2010), the examiner continued to reject the claims under sections 102 and 103 because the prior art taught adding the

¹ Applicants’ assertions that use of a drag reducing agent in heavy crude oil was thought impossible are belied by their own marketing materials. *See* Exs. 1028, 1029, and 1030 (promoting ConocoPhillips drag reducing agents for use in heavy crude oil); *see also* Ex.1040, p.25 (“The experiments show that drag reduction is indeed possible in fluids of high viscosity.”). Note also the inconsistency between applicants’ new position and their earlier admission that “[i]t is well known in the art that to be an effective drag reducer, in liquid hydrocarbon with the properties currently claimed [i.e., an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°], ultra-high molecular weights are required.” Ex.1020, p.33.

drag reducing polymer to “crude oil.” Ex.1024, pp.2-3. The examiner found that, because the genus of crude oil is limited to three species (light, medium, and heavy), “the genus of ‘crude oil’ anticipates the claimed species ‘heavy crude oil.’” *Id.*

In response, applicants again amended the independent claims, this time adding two limitations: (1) a limitation relating to the mechanism by which the drag reducing polymer acts to reduce drag (i.e., “suppressing the growth of turbulent eddies”); and (2) a limitation reciting the concentration of drag reducing polymer that is added to the heavy crude oil (i.e., “0.1 to about 500 ppmw”). Ex.1025. In addition, as evidence of “secondary considerations,” applicants alleged that a peer reviewed journal article “describe[s] that the only true drag reducer ever thought about or conceived to be feasible with the heavy crude oil is applicants own patent application.” *Id.*, pp.6-7.² The next Office Action was a Notice of Allowance. Ex.1026. The 539 application issued as the 118 patent on September 20, 2011.

² A copy of the article cited in applicants’ response is provided as Exhibit 1027. While the article discusses the subject matter of the 539 application, (*see* Ex.1027, p.280), it does not support applicants’ assertion that the article describes the 539 application as disclosing the only drag reducer feasible with heavy crude oil.

C. Person of Ordinary Skill in the Art

As mentioned above, the 118 patent “relates generally to high molecular weight drag reducers for use in crude oils.” Ex.1001 at 1:7-8. Specifically, the drag reducers described and recited in the claims are ultra-high molecular weight polymers.

As Prof. Epps explains, a person of ordinary skill in the art relating to the subject matter of the 118 patent in 2005 would have had a Bachelor of Science degree in chemical engineering, polymer science and engineering, or a closely related field, and at least two years of work experience or three years of further academic experience with drag reducing polymers and/or the impact of polymer additives on the flow properties of fluids. Ex.1041 ¶22. Such a person would also have a general knowledge of the composition and properties of liquid hydrocarbons such as crude oils. *Id.*

Such a person would have been familiar with and routinely utilized basic principles relating to polymers and polymer synthesis, such as the chemical composition of monomers and polymers; common types of polymerization processes; and the properties of polymers, including the solubility properties of polymers. He or she would have regularly consulted standard reference materials and texts in the field, such as Brandrup et al., *Polymer Handbook*, 4th ed., John Wiley & Sons, Inc., 1999 (Ex.1011; “Brandrup”); Young & Lovell, *Introduction to*

Polymers, 2nd ed., CRC Press, 1991 (Ex.1012); and Odian, George, *Principles of Polymerization*, 4th ed., John Wiley & Sons, Inc., 2004 (Ex.1013). Ex.1041 ¶18.

Thus, such a person would have been readily able to determine the solubility parameters of polymers, including by using well-known approaches such as group contribution theory calculations. *Id.* ¶20. As explained by Prof. Epps, the purpose of solubility parameters is to predict the solubility of one compound in another, or more generally, the potential of two compounds to mix. *Id.* ¶42. The closer the solubility parameters of two materials, the more likely they are to form a homogenous solution. *Id.* While a comparison of solubility parameters does not provide conclusive evidence of solubility, solubility parameters were (and are) commonly used in this manner to predict solubility. *Id.*

Such a person would also have been readily able to determine properties of polymers, such as the weight average molecular weight of a polymer sample and the average number of repeat units in a polymer, using well-known methods. *Id.* ¶20.

Further, such a person would have been aware of and consulted technical and scientific publications specifically directed to the physical and chemical properties of drag reducing polymers and to the study of polymer flow properties in solution. Representative of such publications are Zakin, J.L. and Hunston, D.L., *Effect of Polymer Molecular Variables on Drag Reduction*, J. Macromol. Sci.-

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Phys., B18(4), 795-814 (1980) (Ex.1014); Mowla, D. and Naderi, A., *Experimental study of drag reduction by a polymeric additive in slug two-phase flow of crude oil and air in horizontal pipes*, Chem. Eng. Sci. 61, 1549-1554, available online as of November 4, 2005 (Ex.1015); and Burger et al., *Studies of Drag Reduction Conducted over a Broad Range of Pipeline Conditions when Flowing Prudhoe Bay Crude Oil*, J. Rheology, 24(5), 603-626 (1980) (Ex.1016). Ex.1041 ¶19.

D. Claim Construction

Petitioner submits that the Board need not construe any claim terms to determine whether to institute *inter partes* review of the 118 patent. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“only those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy”). Depending on the course of the proceedings, Petitioner may propose claim constructions at a later stage.

VI. Summary Of The Primary References

A. The Holtmyer Publication

The Holtmyer Publication, entitled “Study of Oil Soluble Polymers as Drag Reducers,” was published in *Polymer Engineering and Science* in 1980. Ex.1005. The Holtmyer Publication was not cited by the applicants or considered by the examiner during prosecution of the 118 patent. The Holtmyer Publication describes an investigation “to find the most effective material which would reduce

the friction coefficient in turbulent flow when added in small quantities to oil pipelines.” *Id.*, p.473 (Abstract). According to Prof. Epps, “[b]ecause of its subject matter and its publication prior to 2005, a person of ordinary skill in the art considering the use of a drag reducing polymer in crude oil would have been familiar with the Holtmyer Publication.” Ex.1041 ¶53.

Like the “Background” section of the 118 patent, the Holtmyer Publication describes the problem of frictional pressure losses associated with the turbulent flow of a fluid through a conduit: “When a liquid is pumped under pressure, friction pressure is apparent as a pressure drop along the conduit. Such pressure drops are particularly noticeable under conditions where the velocity of liquid has surpassed the critical limit for laminar flow.” Ex.1005, p.473. Holtmyer explains that an appreciable reduction in friction loss is desirable because “a decrease in friction loss would allow lower energy consumption or alternatively an increase flow rate under the original pumping conditions.” *Id.*

Holtmyer investigated the drag reduction properties of “a series of homo- and copolymers of alkyl styrenes, acrylates, and methacrylates in hydrocarbon solvents.” *Id.*; *see also id.*, p.474 (listing polymers synthesized in Table 1). Among the polymers prepared, tested, and found by Holtmyer to be effective at reducing frictional pressure drop in hydrocarbon fluids is a poly(isodecyl methacrylate) homopolymer, referred to as “iDMA” by Holtmyer. *Id.*

Holtmyer tested the drag reduction properties of iDMA and found that it reduces drag in kerosene, in two types of crude oil (named Cardium and Ellenberger), and in QC-1156. Notably, Holtmyer states that “QC-1156 is primarily an aromatic hydrocarbon with an API gravity of 22.5°,” i.e., a liquid hydrocarbon having an API gravity of less than about 26°. The results are shown in Table 9 of the Holtmyer Publication, reproduced below:

Table 9. Drag Reduction and Shear Stability Properties of iDMA Compared with Polyisobutylene

Polymer (0.06 wt percent)	Solvent	Percent drag reduction		
		Initial	Final	Difference
iDMA*	Kerosene	79	64	15
Polyisobutylene	Kerosene	75	37	38
iDMA*	QC-1156**	78	64	14
Polyisobutylene	QC-1156	76	31	45
iDMA*	Cardium***	69	55	14
Polyisobutylene	Cardium	67	34	33
iDMA*	Ellenberger***	71	50	21
Polyisobutylene	Ellenberger	69	29	40

*Intrinsic viscosity of 5.5 dl/g at 23°C in butyl acetate.

**QC-1156 is primarily an aromatic hydrocarbon with an API gravity of 22.5° and a boiling point in the range of 395-500°F.

***Crude oils.

Ex.1005, p.476. As shown in the “Final” column of Table 9, iDMA caused 64% drag reduction in both kerosene and QC-1156, 55% drag reduction in Cardium crude oil, and 50% drag reduction in Ellenberger crude oil. *Id.* Prof. Epps concludes, “Table 9 shows that the introduction of iDMA into each of these liquid hydrocarbons significantly reduced the frictional pressure loss through the pipeline apparatus.” Ex.1041 ¶70.

B. Inaoka

The Inaoka reference, a European patent application entitled “High Molecular Weight Polymer and Producing Method [for] the Same and Drag Reducer,” was published as EP 0 882 739 A2 in 1998. Ex.1007. Inaoka discloses “a high molecular weight polymer (a) having higher molecular weight than the conventional polymer, (b) having a straight-chain structure with less branching, and (c) being soluble in an organic solvent. . . .” *Id.*, p.1 (Abstract). Inaoka describes the polymer as “suitably adopted as a drag reducer.” *Id.* According to Prof. Epps, “[b]ecause of its subject matter and its publication prior to 2005, a person of ordinary skill in the art considering the use of a drag reducing polymer in crude oil would have been familiar with Inaoka.” Ex.1041 ¶146.

Like the Holtmyer Publication and the “Background” section of the 118 patent, Inaoka describes the problem of frictional pressure losses associated with the turbulent flow of a fluid through a conduit:

[W]hen an organic liquid such as crude oil is transported through a conduit such as a pipeline, there is a case that the transport of the liquid is not carried out smoothly. This is caused by the fact that the transporting pressure on the liquid is lost by the friction generated between the liquid and the conduit. Especially, in a long distance transport, because the transporting pressure is lost in a short distance, a problem is presented that it is required to provide large numbers of pump stations.

Ex.1007, 3:9-13.

Inaoka also describes the conventional use of drag reducers to address the problem of pressure loss:

In order to suppress such a loss of transportation pressure (referred to as pressure loss hereinafter), a drag reducer has been used conventionally. The drag reducer includes a high molecular weight polymer, and the fluidity of the liquid is improved by adding the drag reducer to the liquid, thus suppressing the pressure loss and reducing the transporting pressure on the liquid.

It is known that as the high molecular weight polymer used as a drag reducer, it is preferable to adopt a material with a molecular weight as high as possible and with a straight-chain structure with a small number of branching. For example, a polymer with a molecular weight of substantially 1,800,000 to 7,400,000 is known to exhibit the effect of a drag reducer.

Id., 3:14-21.

Inaoka states that conventional drag reducing polymers may be produced by “a method disclosed in USP No. 3,758,406 [the Holtmyer Patent].” *Id.*, 3:27. The Holtmyer Patent describes much of the same subject matter as the Holtmyer Publication. *Compare* Ex.1006 (the Holtmyer Patent) and Ex.1005 (the Holtmyer Publication). Inaoka notes, however, that “there is a need for a high molecular weight polymer which can be suitably adopted as a drag reducer and a method for efficiently producing thereof.” Ex.1007, 3:30-31.

Inaoka therefore sought to improve upon the polymeric drag reducing agents disclosed by the Holtmyer Patent. *Id.*, 3:35-51. For instance, Inaoka teaches that “since the high molecular weight polymer in accordance with the present invention has a higher molecular weight than the conventional polymer, and has a straight-chain structure with less branching, and is soluble in an organic solvent, it is possible to provide a drag reducer having higher quality than the conventional drag reducer.” *Id.*, 4:4-7. Thus, according to Inaoka, the drag reducing polymer “can be suitably adopted in transporting of an organic liquid such as crude oil through a conduit, such as a pipeline.” *Id.*, 17:1-5.

Inaoka describes a number of preferred monomers that may be used for preparing the drag reducers, including “(meth)acrylates represented by a general formula $\text{CH}_2 = \text{CR}_1\text{COOR}$ (R_1 being H or CH_3 , and R being a monovalent hydrocarbon group with a carbon number of 1-30). . .” with R preferably having a carbon number of 4-18 or even more preferably 8-18. *Id.*, 4:26-27, 4:47-48. Further, Inaoka states that by “selecting a compound whose R in the general formula has a carbon number falling in the above range, the compatibility of a fluid such as crude oil and the high molecular weight polymer of the present invention is increased, and the effect as a drag reducer is improved.” *Id.*, 4:50-52.

Inaoka further states that two drag reducing polymers are “particularly preferable”: 2-ethylhexylacrylate (2EHA) and 2-ethylhexylmethacrylate

(2EHMA). *Id.*, 4:48-50. Inaoka describes the preparation of a 2EHMA homopolymer in each of Examples 4, 5, 12, and 13. *Id.*, pp.10-12. According to Prof. Epps, the 2EHMA homopolymer disclosed by Inaoka is the same polymer as Polymer A of the 118 patent. Ex.1041 ¶155 (citing Ex.1001, 13:12-36).

C. Differences Between the Holtmyer Publication and Inaoka

The Holtmyer Publication discloses the successful use of a methacrylate polymer as a drag reducing additive in a hydrocarbon fluid having an API gravity of less than about 26°, but it does not explicitly disclose the use of that polymer in a hydrocarbon fluid having an asphaltene content of at least 3 weight percent.

Inaoka, on the other hand, discloses the use of Polymer A of the 118 patent in crude oil, but it does not specifically disclose the use of that polymer in a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°.

VII. Ground 1: Claim 1 is unpatentable as obvious over the Holtmyer Publication in view of the Holtmyer Patent and Strausz

1. A method comprising:

introducing a drag reducing polymer, into a pipeline, such that such that the friction loss associated with the turbulent flow through the pipeline is reduced by suppressing the growth of turbulent eddies, 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 MPa^{1/2} of the solubility parameter of the liquid hydrocarbon and the drag reducing polymer is added to the liquid hydrocarbon in the range from about 0.1 to about 500 ppmw.

Ex.1001 at 19:32-48.

- 1. The Holtmyer Publication discloses an iDMA drag reducing polymer and demonstrates its effectiveness at achieving drag reduction in a liquid hydrocarbon having an API gravity less than 26°.**

The Holtmyer Publication discloses most of the limitations of claim 1. For instance, Holtmyer discloses introducing an iDMA drag reducing polymer into a pipeline containing a liquid hydrocarbon having an API gravity of 22.5° to achieve drag reduction, i.e. a reduction in frictional pressure loss.

A person of ordinary skill in the art would have understood that introduction of the iDMA polymer into a liquid hydrocarbon, such as that defined by the claims of the 118 patent, would reduce “friction loss associated with the turbulent flow through the pipeline . . . by suppressing the growth of turbulent eddies,” as recited in claim 1. According to Prof. Epps:

A person of ordinary skill in the art would have understood that the reduction in frictional pressure loss demonstrated by Table 9 is

brought about by the ability of the iDMA drag reducing polymer to suppress the growth of turbulent eddies, that suppression being the mechanism by which drag reducing polymers were (and are) understood to function in turbulent flow by persons of ordinary skill in the art.

Id. ¶71. Indeed, the 118 patent itself admits that this was the manner by which drag reducing polymers were understood to function:

When the flow of fluid in a pipeline is turbulent, high molecular weight polymeric drag reducers can be employed to enhance the flow. A drag reducer is a composition capable of substantially reducing friction loss associated with the turbulent flow of a fluid through a pipeline. *The role of these additives is to suppress the growth of turbulent eddies*, which results in higher flow rate at a constant pumping pressure.

Ex.1001, 1:30-37 (emphasis added).

Prof. Epps also explains that a person of ordinary skill in the art would have understood that adding the iDMA polymer to a liquid hydrocarbon, such as that defined by the claims of the 118 patent, would “produce a treated liquid hydrocarbon in which 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,” as recited in claim 1. Ex.1041 ¶¶76-77. Rather, as noted by Prof. Epps, Holtmyer demonstrates that adding increasing amounts of iDMA to kerosene actually results in an *increase* in the viscosity of the treated kerosene. *Id.*

(citing Ex.1005 at Table 8). Similarly, Patent Owner's 30(b)(6) witness testified in concurrent litigation involving the 118 patent that a drag reducing polymer itself, when dissolved in a hydrocarbon, would never decrease the viscosity of the hydrocarbon. Instead, it would only increase the viscosity of the hydrocarbon. *See* Ex.1039, 5:15-6:25.

Finally, as explained by Prof. Epps, the Holtmyer Publication would have directed a person of ordinary skill in the art to add the iDMA homopolymer to a liquid hydrocarbon, such as that defined by the claims of the 118 patent, at a concentration within the "about 0.1 ppmw to about 500 ppmw" range recited by claim 1. Ex.1041 ¶¶72-75. For instance, Table 6 in the Holtmyer Publication demonstrates that the degree of drag reduction achieved by an iDMA polymer having a molecular weight of about 26 million g/mol was essentially the same when added at 300 ppm as when added at 600 ppm. Ex.1005 at Table 6 (76% drag reduction at 300 ppm; 77% drag reduction at 600 ppm). Holtmyer also describes an evaluation of the concentration dependence of this "optimum molecular weight" sample of iDMA, with the results showing that the degree of drag reduction actually decreased as the concentration of the iDMA was increased from 300 ppm (0.03 wt.%) to 600 ppm (0.06 wt.%). Ex.1005, p.475, col. 2; Table 8.

In view of these disclosures, Prof. Epps concluded that "a person of ordinary skill in the art would have been led to add the high molecular weight iDMA

polymer disclosed by Holtmyer to a liquid hydrocarbon at a concentration of about 300 ppm to make efficient use of the material.” Ex.1041 ¶75.

The only limitation of claim 1 that the Holtmyer Publication does not explicitly disclose is the introduction of the iDMA drag reducing polymer into a liquid hydrocarbon having the following properties: (i) an asphaltene content of at least 3 weight percent and (ii) a solubility parameter that is within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the iDMA polymer.

2. It would have been obvious to introduce the iDMA drag reducing polymer into a crude oil having the claimed properties.

Although Holtmyer does not explicitly disclose introducing the iDMA drag reducing polymer into a liquid hydrocarbon having (i) an asphaltene content of at least 3 weight percent and (ii) a solubility parameter that is within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the iDMA polymer, it would have been obvious to a person of ordinary skill in the art to do so.

i. Crude oils having the claimed properties were well known.

Crude oils having an asphaltene content of at least 3 weight percent and an API gravity of less than 26° were well known in 2005 and earlier, as acknowledged in the 118 patent itself. Ex.1001, Table 1 (spanning cols. 13-16); *see also* Ex.1017, p.12 (identifying Alaska-93, Alaska-95, Schuricht, and Heavy California crude oils meeting the asphaltene content and API gravity claim limitations); Ex.1018,

pp.557-558 (identifying Prudhoe Bay Alaskan crude oil meeting the asphaltene content and API gravity claim limitations).

ii. One of ordinary skill would have been motivated by the known economic benefits associated with drag reduction to introduce the iDMA polymer into a crude oil having the claimed properties.

There was a clear motivation to utilize drag reducing polymers, such as the iDMA polymer disclosed by the Holtmyer Publication, in crude oils having the claimed properties to alleviate the adverse effects of frictional pressure loss during pipeline flow. As acknowledged by the 118 patent:

When fluids are transported by a pipeline, there is typically a drop in fluid pressure due to friction between the wall of the pipeline and the fluid. . . . Such pressure drops can result in inefficiencies that increase equipment and operational costs. To alleviate the problems associated with pressure drop, many in the industry utilize drag reducing additives in the flowing fluid. . . . Ultra-high molecular weight polymers are known to function well as drag reducers, particularly in hydrocarbon liquids.

Ex.1001, 1:15-40. The Holtmyer Publication also describes a significant economic incentive to reduce frictional pressure loss during the transport of crude oils through pipelines. For instance, Holtmyer explains that decreasing such pressure loss would “allow lower energy consumption or alternatively an increased flow rate under the original pumping conditions,” rendering the use of drag reducing

agents “economically profitable to industrial organizations engaged in movement of large volumes of liquid at high flow rates for considerable distances.” Ex.1005, p.473.

According to Prof. Epps, a “person of ordinary skill in the art would have recognized that these advantages would be realized in the transport of crude oil in general, which would include the ‘heavy’ crude oil recited in the claims of the [118] patent.” Ex.1041 ¶¶114-115. Therefore, Prof. Epps concludes that “a person of ordinary skill in the art would have been motivated to introduce the iDMA drag reducing polymer disclosed by Holtmyer into a pipeline containing a flow of crude oil having the claimed asphaltene content and API gravity properties to obtain the well-known economic benefits associated with drag reduction.” *Id.* ¶116. Thus, at a minimum, it would have been obvious to try using iDMA as a drag reducer in heavy crude oil. *See KSR*, 550 U.S. at 421 (“the fact that a combination was obvious to try might show that it was obvious under § 103”).

iii. One of ordinary skill would have had a reasonable expectation that the iDMA polymer would be effective at reducing drag in a crude oil having the claimed properties.

As noted, the Holtmyer Publication demonstrates that the iDMA drag reducing polymer achieved drag reduction in a liquid hydrocarbon having an API gravity of less than about 26°. Ex.1005, Table 9; *see also* Ex.1041 ¶118.

Although Holtmyer describes adding the iDMA drag reducing polymer into a number of crude oils, the asphaltene contents of those oils are not disclosed. The Holtmyer Publication does not, therefore, explicitly demonstrate that the iDMA polymer is effective at achieving drag reduction in a liquid hydrocarbon having an asphaltene content of at least 3 weight percent.

- **Asphaltene**

The Holtmyer Publication does not specifically disclose the use of an iDMA drag reducing polymer in a liquid hydrocarbon having at least 3 weight percent asphaltene. Therefore, a person of ordinary skill in the art contemplating the use of the iDMA drag reducing polymer of Holtmyer in a heavy crude oil that also had a high asphaltene content would have investigated the potential effect of a relatively high asphaltene content on the ability of the iDMA polymer to achieve drag reduction. Ex.1041 ¶119. As described below, the Holtmyer Patent addresses the effect of asphaltene content on the ability of the iDMA polymer to achieve drag reduction. *Id.*

The Holtmyer Patent issued in 1973. Ex.1006. According to Prof. Epps, “[b]ecause of its subject matter and its publication prior to 2005, a person of ordinary skill in the art considering the use of a drag reducing polymer in crude oil (and particularly a person of ordinary skill in the art considering the use of a drag

reducing polymer disclosed by the Holtmyer Publication) would have been familiar with the Holtmyer Patent.” Ex.1041 ¶120.

As explained by Prof. Epps, the Holtmyer Patent discloses “that the optimum quantity of polymer to be introduced to a hydrocarbon liquid may vary depending on the type of liquid hydrocarbon involved” and “that when a solid agent is suspended in the liquid hydrocarbon, it is preferable to use a somewhat larger amount of the polymer additive, such as from about 1 to about 10 pounds per 1000 gallons (between about 160 ppm and 1600 ppm).” *Id.* ¶121. Because asphaltenes were understood to be present as suspended particles in crude oil, Prof. Epps explains, “a person of ordinary skill in the art would have understood the Holtmyer Patent as teaching that crude oils having relatively high asphaltene contents may require the introduction of a higher amount of the drag reducing polymer than would be necessary for crude oils with low asphaltene contents.” *Id.* ¶122.

It was well understood that the degree to which one could successfully introduce higher amounts of a polymer into a liquid hydrocarbon depends upon the capacity of the polymer to be soluble in the liquid hydrocarbon at the resulting higher polymer concentrations. *Id.* ¶123. Accordingly, to determine whether the iDMA drag reducing polymer could be added to a crude oil having an asphaltene content of at least 3 weight percent in the amounts disclosed by the Holtmyer

Patent, a person of ordinary skill in the art would have evaluated the solubility of the iDMA polymer in such a crude oil. *Id.*

- **Solubility**

According to Prof. Epps, “to evaluate the solubility of a drag reducing polymer in a particular liquid hydrocarbon such as a crude oil, a person of ordinary skill in the art would have understood that the solubility could either be tested by experimental methods or be predicted by comparing the solubility parameters of the two materials.” Ex.1041 ¶124. Solubility parameters were (and are) commonly consulted in order to predict solubility of one compound in another without the need for time-consuming, and sometimes expensive, experimentation. *Id.*

Prof. Epps states, therefore, that “[t]o easily evaluate the solubility of the iDMA drag reducing polymer in a crude oil having at least 3 weight percent asphaltene and an API gravity of less than about 26°, a person of ordinary skill in the art would have sought to compare the solubility parameters of the drag reducing polymer and the crude oil.” *Id.*

A person of ordinary skill in the art would have been able to easily identify the solubility parameter of the iDMA drag reducing polymer of Holtmyer, such as by using well-known group contribution methods. Indeed, Prof. Epps calculated

the solubility parameter of the iDMA polymer and arrived at a value of about 17.84 MPa^{1/2}. *Id.* ¶¶125-127.

A person of ordinary skill in the art also would have been able to identify a range of solubility parameters for a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. Such a person would have recognized that, due to the complexity of crude oil, it would be very difficult to calculate the solubility parameter of a crude oil using group contribution methods. Therefore, such a person would have looked to calculate the solubility parameter of a crude oil by other methods. *Id.* ¶128.

Crude oil is a complex fluid containing many components. When faced with calculating its solubility parameter, a person of ordinary skill in the art would have examined the solubility characteristics of the individual components of the crude oil to determine a range within which the solubility parameter of the crude oil falls. *Id.* ¶129. In particular, as explained by Prof. Epps, a person of ordinary skill in the art would have considered the solubility characteristics of the high molecular weight components of the fluid, which for an asphaltenic crude oil would include asphaltene. *Id.* ¶¶130-132, 134.

For example, a person of ordinary skill in the art would have consulted a book such as *The Chemistry of Alberta Oil Sands, Bitumens and Heavy Oils*, by Otto P. Strausz and Elizabeth M. Lown, published by Alberta Energy Research

Institute in 2003 (“Strausz”). Ex.1009. Strausz addresses a number of topics related to the composition and properties of crude oils. Chapter 14 describes the properties of asphaltene, including its solubility characteristics. Ex.1009. According to Prof. Epps, “[b]ecause of its subject matter and its publication prior to 2005, a person of ordinary skill in the art looking to determine the solubility parameter of a heavy, asphaltenic crude oil would have been led to Strausz.” Ex.1041 ¶133.

Strausz describes a study of the correlation between the solubility of asphaltene in a variety of test solvents and the solubility parameter of each of those test solvents. Ex.1009, pp.467-468. The results of the study demonstrate that “the solvation energy of the solvents with [a solubility parameter] in the 17.1-22.1 MPa^{1/2} range is sufficiently large to overcome the cohesion energy of asphaltene and cause solubilization.” Ex.1009, p.467. Therefore, according to Prof. Epps, “[a] person of ordinary skill in the art would have understood from Strausz that, generally, in order for a heavy crude oil flowing through a pipeline to have had an asphaltene content of at least 3 weight percent, that crude oil would have a solubility parameter within the disclosed range of about 17.1 MPa^{1/2} to about 22.1 MPa^{1/2}.” Ex.1041 ¶¶136-137.

Because the solubility parameter of the iDMA polymer (17.84 MPa^{1/2}) falls squarely within the range disclosed by Strausz, a person of ordinary skill in the art

would have expected that the iDMA polymer could be used in heavy, asphaltenic crude oils at the concentrations disclosed by the Holtmyer Patent to achieve drag reduction in a liquid hydrocarbon containing suspended solids. *Id.* ¶138.³

As noted, the Holtmyer Publication showed that the iDMA polymer achieved significant drag reduction in a liquid hydrocarbon having an API gravity of less than 26°. Moreover, as described in detail above, a person of ordinary skill in the art would have expected that the iDMA polymer would be effective when introduced into a heavy, asphaltenic crude oil at the concentrations disclosed by the Holtmyer Patent. Thus, Prof. Epps concludes that “a person of ordinary skill in the art would have had a reasonable expectation that the iDMA drag reducing polymer

³ Prof. Epps also explains that a person of ordinary skill in the art would have expected that the solubility parameters of methacrylate-based polymers (such as iDMA) would be higher than those of known polyalphaolefin-based drag reducing polymers. Ex.1041 ¶¶46-47. Accordingly, such a person would have expected that methacrylate-based polymers may have increased solubility in heavy, asphaltenic crude oil, which would have been understood to have higher solubility parameters than light and medium crude oils. *Id.* ¶48. Indeed, this would also have provided a motivation to try methacrylate-based drag reducing polymers such as iDMA in heavy, asphaltenic crude oil in the first place.

would be effective at achieving drag reduction in a liquid hydrocarbon having both an API gravity of less than about 26° and an asphaltene content of at least 3 weight percent undergoing turbulent flow through a pipeline.” *Id.* ¶139.⁴

iv. One of ordinary skill would have been motivated to utilize the iDMA polymer in crude oils in which it was expected to be most effective.

Claim 1 also recites that the drag reducing polymer has a solubility parameter within 4 MPa^{1/2} of the solubility parameter of a liquid hydrocarbon. Based on the disclosure of Strausz, a person of ordinary skill in the art would have understood that at least some, and likely a fairly large proportion, of heavy, asphaltenic crude oils would have solubility parameters between 17.1 MPa^{1/2} and 21.84 MPa^{1/2}, which would be within 4 MPa^{1/2} of the solubility parameter of the iDMA homopolymer (17.84 MPa^{1/2}). *Id.* ¶140.

⁴ Note that the claims of the 118 patent are not limited to any particular degree of drag reduction. Instead, they recite only “that the friction loss associated with the turbulent flow through the pipeline *is reduced*.” In other words, so long as a person of ordinary skill in the art would have reasonably expected the iDMA of Holtmyer to reduce the frictional pressure loss to *any degree at all*, the claimed subject matter would have been obvious.

As explained by Prof. Epps, it was understood in 2005 that the closer the solubility parameters of two materials, the more likely they are to form a homogenous solution. *Id.* ¶42. It was also already well-known at that time that the more soluble a drag reducing polymer is in a target fluid, the greater the drag reducing effect that can be achieved by that polymer. *Id.* ¶29; *see also* Ex.1015, p.1550 (referring to solubility in the fluid being treated as “the most important requirement” of a drag reducing polymer). Therefore, by reciting that the solubility parameters of the drag reducing agent and the liquid hydrocarbon are close to one another, e.g., within about $4 \text{ MPa}^{1/2}$, the 118 patent does no more than apply solubility parameters (in a conventional manner) to describe the already well-known relationship between the solubility of a drag reducing polymer in a fluid and the expected effectiveness of the drag reducing polymer in that fluid. Ex.1041 ¶144.

In general, it would have been obvious for a person of ordinary skill in the art to select a drag reducing polymer for use in a crude oil in which the drag reducing polymer was expected to be most effective, i.e., to provide the highest degree of drag reduction. Accordingly, it would have been obvious for a person of ordinary skill in the art to have selected the iDMA of Holtmyer for use in a crude oil having a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of that iDMA drag reducing polymer. Indeed, selecting a polymer that would be expected

to produce the greatest drag reducing effect because of its predicted solubility in such a crude oil would have been a matter of routine optimization. *Id.* ¶¶142-143.

For the above reasons, the method recited in claim 1 would have been obvious over the Holtmyer Publication in view of the Holtmyer Patent and Strausz.

VIII. Ground 2: Claim 1 is unpatentable as obvious over Inaoka in view of Strausz

1. A method comprising:

introducing a drag reducing polymer, into a pipeline, such that such that the friction loss associated with the turbulent flow through the pipeline is reduced by suppressing the growth of turbulent eddies, 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 MPa^{1/2} of the solubility parameter of the liquid hydrocarbon and the drag reducing polymer is added to the liquid hydrocarbon in the range from about 0.1 to about 500 ppmw.

Ex.1001, 19:32-48.

1. Inaoka describes a 2EHMA drag reducing polymer that is suitable for use in crude oil.

Inaoka discloses most of the limitations of claim 1. Specifically, Inaoka discloses introducing a 2EHMA drag reducing polymer into a pipeline containing crude oil to achieve drag reduction, i.e., a reduction in frictional pressure loss.

A person of ordinary skill in the art would have understood that introducing the 2EHMA polymer into crude oil flowing through a pipeline would reduce drag by suppressing the growth of turbulent eddies, as recited in claim 1. As explained by Prof. Epps:

While Inaoka does not describe the exact mechanism by which the drag reducing polymers function when added to crude oil flowing through a pipeline, a person of ordinary skill in the art would have understood that the drag reducing polymers of Inaoka achieve a reduction in frictional pressure losses associated with turbulent flow by suppressing the growth of turbulent eddies, that suppression being the mechanism by which drag reducing polymers were (and are) understood to function in turbulent flow by persons of ordinary skill in the art.

Ex.1041 ¶167 (citing the Holtmyer Patent, which is described by Inaoka as conveying the state of the art). Indeed, the 118 patent itself admits that this was the manner by which drag reducing polymers were understood to function. *See supra*, VII.A.1 (citing Ex.1001, 1:30-37).

Prof. Epps also explains that a person of ordinary skill in the art would have understood that adding the high molecular weight 2EHMA polymer of Inaoka to a crude oil would “produce a treated liquid hydrocarbon in which 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,” as recited in claim 1. Ex.1041 ¶¶169-171. As noted by Prof. Epps, for instance, the Holtmyer Patent referenced by Inaoka demonstrates that adding increasing amounts of a high molecular weight polymer to kerosene actually results in an *increase* in the viscosity of the treated kerosene. *Id.* ¶170 (citing Ex.1006, Table VI). Similarly, Patent Owner’s 30(b)(6) witness testified in concurrent litigation involving the 118 patent that a drag reducing polymer itself, when dissolved in a hydrocarbon, would never decrease the viscosity of the hydrocarbon. Instead, it would only increase the viscosity of the hydrocarbon. *See* Ex.1039, 5:15-6:25.

Further, as explained by Prof. Epps, Inaoka would have directed a person of ordinary skill in the art to add the 2EHMA polymer to a liquid hydrocarbon at a concentration within the “about 0.1 ppmw to about 500 ppmw” range recited by claim 1 of the 118 patent. Ex.1041 ¶168. In particular, Inaoka discloses that the amount of polymeric drag reducer added to a crude oil is “preferably in a range of 0.1 ppm to 100 ppm, more preferably in a range of 0.5 ppm to 50 ppm.” Ex.1007, 8:18-20.

According to Inaoka, the drag reducing polymer “can be suitably adopted in transporting of an organic liquid such as crude oil through a conduit, such as a pipeline.” Ex.1007, 17:1-5. Inaoka, however, does not explicitly disclose introducing the 2EHMA drag reducing polymer into a crude oil having the following properties: (i) an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° and (ii) a solubility parameter that is within 4 MPa^{1/2} of the solubility parameter of the 2EHMA polymer.

2. It would have been obvious to introduce the 2EHMA drag reducing polymer into a crude oil having the claimed properties.

Although Inaoka does not disclose introducing the 2EHMA drag reducing polymer into a crude oil having (i) an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° and (ii) a solubility parameter that is within 4 MPa^{1/2} of the solubility parameter of the 2EHMA polymer, it would have been obvious to a person of ordinary skill in the art to do so.

i. Crude oils having the claimed properties were well known.

Crude oils having an asphaltene content of at least 3 weight percent and an API gravity of less than 26° were well known in 2005 and earlier, as acknowledged in the 118 patent itself. Ex.1001, Table 1 (spanning cols. 13-16); *see also* Ex.1017, p.12 (identifying Alaska-93, Alaska-95, Schuricht, and Heavy California crude oils meeting the asphaltene content and API gravity claim limitations); Ex.1018,

pp.557-558 (identifying Prudhoe Bay Alaskan crude oil meeting the asphaltene content and API gravity claim limitations).

ii. One of ordinary skill would have been motivated by the known economic benefits associated with drag reduction to introduce the 2EHMA polymer into a crude oil having the claimed properties.

There was a clear motivation to utilize drag reducing polymers, such as the 2EHMA polymer disclosed by Inaoka, in crude oils having the claimed properties in order to alleviate the adverse effects of frictional pressure loss during pipeline flow. The 118 patent itself acknowledges the known benefits of drag reducing polymers. *See supra*, VII.A.2.ii. (citing Ex.1001, 1:15-40). The Holtmyer Patent cited by Inaoka as conveying the state of the art also describes the significant economic advantage brought about by reducing frictional pressure loss during the transport of crude oils through pipelines. For instance, the Holtmyer Patent explains that “reduction of the frictional pressure loss in the flow of [] hydrocarbon liquids brings about an advantageous reduction in horsepower requirements, or alternatively, an increased flow rate of the hydrocarbon liquids under the same pumping conditions.” Ex.1006, 1:59-65.

According to Prof. Epps, a “person of ordinary skill in the art would have recognized that these advantages would be realized in the transport of crude oil in general, which would include the ‘heavy’ crude oil recited in the claims of the

[118] patent.” Ex.1041 ¶¶195-196. Therefore, Prof. Epps concludes that “a person of ordinary skill in the art would have been motivated to introduce the 2EHMA drag reducing polymer disclosed by Inaoka into a pipeline containing a flow of crude oil having the claimed asphaltene content and API gravity properties to obtain the well-known economic benefits associated with drag reduction.” *Id.* ¶197. Thus, at a minimum, it would have been obvious to try using 2EHMA as a drag reducer in heavy crude oil. *See KSR*, 550 U.S. at 421.

iii. One of ordinary skill would have had a reasonable expectation that the 2EHMA polymer would be effective at reducing drag in a crude oil having the claimed properties.

A person of ordinary skill in the art would have had a reasonable expectation that the 2EHMA drag reducing polymer of Inaoka would be effective at reducing frictional pressure loss when introduced into a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°.

Specifically, Inaoka discloses that the 2EHMA polymer has each of the properties that were generally understood to be required for effective drag reduction; namely, a high molecular weight, a straight-chain structure with minimal branching, and solubility. Ex.1041 ¶199; *see also id.* at ¶¶24-30 (explaining that a person of ordinary skill in the art would have understood these as being the required properties). However, though Inaoka’s testing shows solubility

in an organic solvent (specifically tetrahydrofuran), *see* Ex.1007, 9:10-14 and Table 1, Inaoka does not provide any test results demonstrating the solubility (or effectiveness) of the 2EHMA polymer in a crude oil, such as a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than 26°. Ex.1041 ¶199.

As explained by Prof. Epps, “[b]ecause the effectiveness of a drag reducing agent in a liquid hydrocarbon was known to be heavily dependent on the solubility of the drag reducing agent in that liquid hydrocarbon, a person of ordinary skill in the art would have understood that the effectiveness of the 2EHMA drag reducing polymer in a target crude oil, such as a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than 26°, would depend on the solubility of the 2EHMA drag reducing polymer in that crude oil.” *Id.* ¶200 (internal citations omitted). Therefore, one of ordinary skill in the art contemplating using the 2EHMA polymer of Inaoka in a target crude oil, such as a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than 26°, would have evaluated the solubility of the 2EHMA polymer in that crude oil. *Id.*

To evaluate the solubility of a polymer in a crude oil containing at least 3 weight percent asphaltene and an API gravity less than about 26°, a person of ordinary skill in the art would have understood that the solubility could either be

tested by experimental methods or be predicted by comparing the solubility parameters of the two materials. *Id.* ¶201. Solubility parameters were (and are) commonly consulted in order to predict solubility of one compound in another without the need for time-consuming, and sometimes expensive experimentation. *Id.*

Prof. Epps states, therefore, that “to easily evaluate the solubility of the 2EHMA drag reducing polymer in a crude oil containing at least 3 weight percent asphaltene and an API gravity of less than about 26°, a person of ordinary skill in the art would have sought to compare the solubility parameters of the drag reducing polymer and the crude oil.” *Id.*

A person of ordinary skill in the art would have easily been able to identify the solubility parameter of the 2EHMA drag reducing polymer disclosed by Inaoka, such as by using well-known group contribution methods. Indeed, Prof. Epps calculated the solubility parameter of the 2EHMA polymer and arrived at a value of about 18.04 MPa^{1/2}. *Id.* ¶¶202-204. This corresponds exactly with the value provided by the 118 patent for the same polymer, identified as Polymer A. *See* Ex.1001, 13:35-36.

A person of ordinary skill in the art also would have been able to identify a range of solubility parameters for a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26°. A person of

ordinary skill in the art would have recognized that, due to the complexity of crude oil, it would be very difficult to calculate the solubility parameter of a crude oil using group contribution methods. Therefore, a person of ordinary skill in the art would have looked to calculate the solubility parameter of a crude oil by other methods. Ex.1041 ¶205.

Crude oil is a complex fluid containing many components. When faced with calculating its solubility parameter, a person of ordinary skill in the art would have examined the solubility characteristics of the individual components of the crude oil to determine a range within which the solubility parameter of the crude oil falls. *Id.* ¶206. In particular, as explained by Prof. Epps, a person of ordinary skill in the art would have considered the solubility characteristics of the high molecular weight components of the fluid, which for an asphaltenic crude oil would include asphaltene. *Id.* ¶207-209, 211.

For example, a person of ordinary skill in the art would have consulted a book such as Strausz. Ex.1009. Strausz addresses a number of topics related to the composition and properties of crude oils. In particular, chapter 14 describes the properties of asphaltene, including its solubility characteristics. According to Prof. Epps, “[b]ecause of its subject matter and its publication prior to 2005, a person of ordinary skill in the art looking to determine the solubility parameter of a heavy, asphaltenic crude oil would have been led to Strausz.” Ex.1041 ¶210.

Strausz describes a study of the correlation between the solubility of asphaltene in a variety of test solvents and the solubility parameter of each of those test solvents. Ex.1009, p.467-468. The results of the study demonstrate that “the solvation energy of the solvents with [a solubility parameter] in the 17.1-22.1 MPa^{1/2} range is sufficiently large to overcome the cohesion energy of asphaltene and cause solubilization.” *Id.*, p.467. Therefore, according to Prof. Epps, “[a] person of ordinary skill in the art would have understood from Strausz that, generally, in order for a heavy crude oil flowing through a pipeline to have had an asphaltene content of at least 3 weight percent, that crude oil would have a solubility parameter within the disclosed range of about 17.1 MPa^{1/2} to about 22.1 MPa^{1/2}.” Ex.1041 ¶¶213-214.

Because the solubility parameter of the 2EHMA polymer (18.04 MPa^{1/2}) falls squarely within the range disclosed by Strausz, a person of ordinary skill in the art would have expected that the 2EHMA drag reducing polymer would be soluble in a heavy crude oil, such as one having an asphaltene content of at least 3 weight percent and an API gravity less than about 26°. *Id.* ¶215; *see also supra*, VII.A.2.iii at fn.3 (explaining why a person of ordinary skill in the art would have expected that methacrylate-based drag reducing polymers, such as 2EHMA, may be soluble in heavy, asphaltenic crude oils).

Because (a) Inaoka discloses that the 2EHMA polymer has a straight-chain structure with minimal branching and a sufficiently high molecular weight to be suitable as a drag reducer and (b) a person of ordinary skill in the art would have expected that the 2EHMA polymer would be soluble in heavy, asphaltenic crude oil, such a person would have had a reasonable expectation that the 2EHMA drag reducing polymer of Inaoka would be effective at achieving drag reduction in a crude oil having an asphaltene content of at least 3 weight percent and an API gravity of less than about 26° undergoing turbulent flow through a pipeline. *Id.* ¶216.

iv. One of ordinary skill would have been motivated to utilize the 2EHMA polymer in crude oils in which it was expected to be most effective.

Claim 1 also recites that the drag reducing polymer has a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of a liquid hydrocarbon. Based on the disclosure of Strausz, a person of ordinary skill in the art would have understood that at least some, and likely a fairly large proportion, of heavy, asphaltenic crude oils would have solubility parameters between $17.1 \text{ MPa}^{1/2}$ and $22.04 \text{ MPa}^{1/2}$, which would be within $4 \text{ MPa}^{1/2}$ of the solubility parameter of the 2EHMA polymer ($18.04 \text{ MPa}^{1/2}$). Ex.1041 ¶217.

As explained by Prof. Epps, it was understood in 2005 that the closer the solubility parameters of two materials, the more likely they are to form a

homogenous solution. *Id.* ¶42. It was also already well-known at that time that the more soluble a drag reducing polymer is in a target fluid, the greater the drag reducing effect that can be achieved by that polymer. *Id.* ¶29; *see also* Ex.1015, p.1550 (referring to solubility in the fluid being treated as “the most important requirement” of a drag reducing polymer). Therefore, by claiming that the solubility parameters of the drag reducing agent and the liquid hydrocarbon are close to one another, e.g. within about $4 \text{ MPa}^{1/2}$, the 118 patent does no more than apply solubility parameters (in a conventional manner) to describe the already well-known relationship between the solubility of a drag reducing polymer in a fluid and the expected effectiveness of the drag reducing polymer in that fluid. Ex.1041 ¶221.

In general, it would have been obvious for a person of ordinary skill in the art to select a drag reducing polymer for use in a crude oil in which the drag reducing polymer was expected to be most effective, i.e., to provide the highest degree of drag reduction. Accordingly, it would have been obvious for such a person to have selected the 2EHMA polymer of Inaoka for use in a crude oil having a solubility parameter within $4 \text{ MPa}^{1/2}$ of the solubility parameter of that 2EHMA polymer. Indeed, selecting a polymer that would be expected to produce the greatest drag reducing effect because of its predicted solubility in such a crude oil would have been a matter of routine optimization. *Id.* ¶¶219-220.

For the above reasons, the method recited in claim 1 of the 118 patent would have been obvious over Inaoka in view of Strausz.

IX. Petitioner is not aware of any secondary considerations that would be sufficient to overcome the strong showing of obviousness

Petitioner cannot predict with certainty whether Patent Owner will allege any secondary considerations of nonobviousness. In the event that Patent Owner does so, Petitioner calls special attention to these two requirements: (1) any evidence of secondary considerations “must be reasonably commensurate with the scope of the claims,” *In re Huai-Hung Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011); and (2) “a patentee must demonstrate a nexus between the patented features and the particular evidence of secondary considerations.” *Apple Inc. v. Samsung Elecs. Co.*, 816 F.3d 788, 798 (Fed. Cir. 2016).

In this case, the scope of the claims is extremely broad—encompassing the use of virtually any effective drag reducing polymer in virtually any heavy crude oil. Thus, any alleged evidence of secondary considerations must be commensurate with the breadth of the claims. Moreover, with respect to the nexus requirement, “[w]here the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention.” *In re Kao*, 639 F.3d at 1068 (emphasis in

original). Here, as explained above, drag reducing polymers falling within the scope of the claims were known in the prior art.

Finally, “weak secondary considerations generally do not overcome a strong *prima facie* case of obviousness.” *Apple v. Samsung*, 816 F.3d at 804. As the Federal Circuit has instructed, “[t]his is particularly true when an invention involves nothing more than ‘the predictable use of prior art elements according to their established functions.’” *Id.* (quoting *KSR*, 550 U.S. at 417). Petitioner submits, therefore, that any allegations of secondary considerations by Patent Owner cannot, as a matter of law, overcome the strong showing of obviousness in this case.

X. Claims 2-11 are also unpatentable as obvious over both (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz (Ground 1) and (b) Inaoka in view of Strausz (Ground 2)

A. Claim 2

2. The method of claim 1, wherein the solubility parameter of the drag reducing polymer is at least about 17 MPa^{1/2}.

Ex.1001, 19:48-49.

As explained above, a person of ordinary skill in the art would readily have been able to calculate the solubility parameters of the iDMA drag reducing polymer disclosed by the Holtmyer Publication and the 2EHMA drag reducing polymer disclosed by Inaoka. For instance, using a well-known group contribution

method, Prof. Epps calculated the solubility parameter of the iDMA drag reducing polymer and arrived at a value of about $17.84 \text{ MPa}^{1/2}$. Ex.1041 ¶¶125-127. Using the same method, Prof. Epps calculated the solubility parameter of the 2EHMA drag reducing polymer and arrived at a value of about $18.04 \text{ MPa}^{1/2}$. *Id.* ¶¶202-204.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 2 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

B. Claim 3

3. The method of claim 1, wherein the drag reducing polymer comprises at least about 25,000 repeating units.
Ex.1001, 19:50-51.

A person of ordinary skill in the art would have understood that the iDMA homopolymer of Holtmyer and the 2EHMA polymer of Inaoka each has well above 25,000 repeating units.

Specifically, Prof. Epps concluded that the iDMA sample disclosed by the Holtmyer Publication as having a weight average molecular weight of approximately 26 million g/mol contains between at least about 57,000 and about 104,000 repeat units, which is well above the “at least about 25,000 repeating

units” recited by claim 3 of the 118 patent. Ex.1041 ¶¶64-67. Similarly, according to Prof. Epps, a person of ordinary skill in the art would have understood that a 2EHMA polymer having a limiting viscosity number of not less than 12, as disclosed by Inaoka, contains between about 35,000 and about 68,000 repeat units, which is well above the “at least about 25,000 repeating units,” as recited by claim 3. *Id.* ¶¶162-165.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 3 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

C. Claim 4

4. The method of claim 1, wherein the drag reducing polymer has a weight average molecular weight of at least 1×10^6 g/mol.
Ex.1001, 19:52-54.

According to Prof. Epps, a person of ordinary skill in the art would have understood that the iDMA homopolymer of Holtmyer has a weight average molecular weight of at least 1×10^6 g/mol. Ex.1041 ¶61. The Holtmyer Publication describes a sample of iDMA having a viscosity average molecular weight of about 26×10^6 g/mol, which Holtmyer describes as being “close to the optimum molecular weight for maximum performance.” Ex.1005, pp.475-476. As

Prof. Epps explains, a person of ordinary skill in the art would have understood that the iDMA sample having a viscosity average molecular weight of 26×10^6 g/mol also has a weight average molecular weight of at least 26×10^6 g/mol, which is well above the “at least 1×10^6 g/mol” recited by claim 4. Ex.1041 ¶¶62-63.

According to Prof. Epps, a person of ordinary skill in the art would have also understood that the polymers disclosed by Inaoka as being preferred for drag reduction have molecular weights well above “at least 1×10^6 g/mol” as recited in claim 4. Ex.1041 ¶160. Specifically, Inaoka states that when adopting the polymer as a drag reducer, it is preferable that the polymer have a limiting viscosity number (represented by $[\eta]$) not less than 12. Ex.1007, 8:5-12. As explained by Prof. Epps, a person of ordinary skill in the art would have calculated that a polymer of Inaoka having a limiting viscosity of 12 has a molecular weight between about 14.9 million g/mol and 28.8 million g/mol. Ex.1041 ¶¶157-159. Although Inaoka does not identify the molecular weight in terms of weight average, viscosity average, or number average, Prof. Epps was nevertheless able to conclude that “the minimum weight average molecular weight would be greater than 14.9 million g/mol,” which is well above the “at least 1×10^6 g/mol” recited by claim 4 of the 118 patent. *Id.* ¶¶160-161. Accordingly, as explained by Prof. Epps, Inaoka would have led a person of ordinary skill in the art to prepare a 2EHMA polymer having a limiting viscosity number of not less than 12, and thus a

weight average molecular weight of greater than 14.9×10^6 g/mol, for use as a drag reducer. *Id.* ¶¶157-161.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 4 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

D. Claim 5

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

Ex.1001, 19:55-57.

Based on the disclosure of Strausz, a person of ordinary skill in the art would have understood that at least some, and likely a fairly large proportion, of heavy, asphaltenic crude oils would have solubility parameters between $17.1 \text{ MPa}^{1/2}$ and $20.34 \text{ MPa}^{1/2}$, which would be within $2.5 \text{ MPa}^{1/2}$ of the solubility parameter of the iDMA homopolymer ($17.84 \text{ MPa}^{1/2}$). Ex.1041 ¶141. Similarly, a person of ordinary skill in the art would have understood that at least some, and likely a fairly large proportion, of heavy, asphaltenic crude oils would have solubility parameters between $17.1 \text{ MPa}^{1/2}$ and $20.54 \text{ MPa}^{1/2}$, which would be within $2.5 \text{ MPa}^{1/2}$ of the solubility parameter of the 2EHMA polymer ($18.04 \text{ MPa}^{1/2}$). *Id.* ¶218.

As explained above, by claiming that the solubility parameters of the drag reducing agent and the liquid hydrocarbon are close to one another, e.g. within about $2.5 \text{ MPa}^{1/2}$, the 118 patent does no more than apply solubility parameters (in a conventional manner) to describe the already well-known relationship between the solubility of a drag reducing polymer in a fluid and the expected effectiveness of the drag reducing polymer in that fluid. *Id.* ¶¶144, 221.

In general, it would have been obvious for a person of ordinary skill in the art to select a drag reducing polymer for use in a crude oil in which the polymer was expected to be most effective, i.e., to provide the highest degree of drag reduction. Accordingly, it would have been obvious for such a person to have utilized the iDMA polymer of Holtmyer and/or the 2EHMA polymer of Inaoka in a crude oil having a solubility parameter within $2.5 \text{ MPa}^{1/2}$ of the solubility parameter of the drag reducing polymer. Indeed, selecting a drag reducing polymer that would be expected to produce the greatest drag reducing effect (based on its predicted solubility in such a crude oil) would have been a matter of routine optimization. *Id.* ¶¶142-143, 219-220.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 5 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

E. Claim 6

6. The method of claim 1, 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.

Ex.1001, 19:58-65.

As recited in the 118 patent itself, the solubility parameter range for the crude oils was determined from the study, in Strausz, of the correlation between the solubility of asphaltene in a variety of test solvents and the solubility parameter of each of those test solvents. *See* Ex.1001, 4:28-33. That study used the equation recited in claim 6; namely, $\delta_2 = [(\Delta H_v - RT)/V]^{1/2}$, for calculating the solubility parameters of the test solvents. Ex.1009, pp.467-468. Accordingly, a person of ordinary skill in the art would have determined the solubility parameter range for heavy, asphaltenic crude oils by the equation recited in claim 6. Ex.1041 ¶¶128-137, 205-214.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 6 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

F. Claim 7

7. The method of claim 1, 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, $\delta_d = \Sigma F_{di}/V$, $\delta_h = (\Sigma F_{hi}/V)^{1/2}$,
 $\delta_p = (\Sigma F_{pi}^2)^{1/2}/V$.

Ex.1001, 20:1-6.

As Prof. Epps confirms, the recited equation for determining the solubility parameter of the drag reducing polymer is that prescribed by the well-known group contribution method presented in Brandrup at B11 and C30. Ex.1041 ¶¶126, 203. Accordingly, a person of ordinary skill in the art would have determined the solubility parameter for a drag reducing polymer by the well-known equation recited in claim 7. *Id.* ¶¶125-127, 202-204.

For these reasons, and those explained above with respect to claim 1, the method recited in claim 7 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

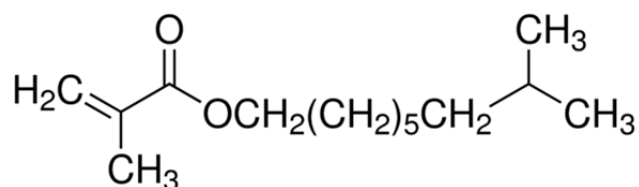
G. Claim 8

8. The method of claim 1, wherein a plurality of the repeating units comprise a heteroatom.

Ex.1001, 20:7-8.

A person of ordinary skill in the art would have known that a plurality of the repeating units of the iDMA polymer of the Holtmyer Publication comprise oxygen heteroatoms. As Prof. Epps testifies:

Isodecyl methacrylate – the monomeric constituent of the iDMA homopolymer – was known to contain oxygen heteroatoms. The chemical structure of the isodecyl methacrylate monomer is shown below:

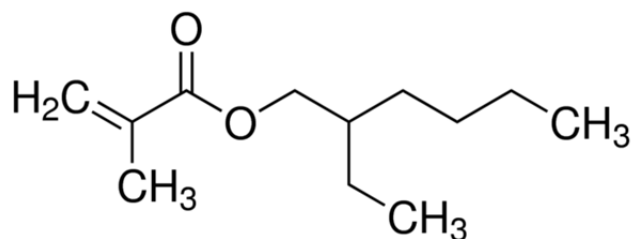


Ex.1041 ¶57. Accordingly, as Prof. Epps explains, “because iDMA is a homopolymer that is made up solely of isodecyl methacrylate monomer segments, all of the repeat units of the iDMA homopolymer contain oxygen heteroatoms.”

Id.

A person of ordinary skill in the art also would have known that a plurality of the repeating units of the 2EHMA polymer of Inaoka comprise oxygen heteroatoms. As Prof. Epps testifies:

2-ethylhexyl methacrylate – the monomeric constituent of the 2EHMA homopolymer – was known to contain oxygen heteroatoms. The chemical structure of the 2-ethylhexyl methacrylate monomer is shown below:



Ex.1041 ¶156. Accordingly, as Prof. Epps explains, “because 2EHMA is a homopolymer that is made up solely of 2-ethylhexyl methacrylate monomer segments, all of the repeat units of the 2EHMA homopolymer contain oxygen heteroatoms.” *Id.*

For these reasons, and those explained above with respect to claim 1, the method recited in claim 8 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

H. Claim 9

9. The method of claim 8, wherein the heteroatom is selected from the group consisting of an oxygen atom, a nitrogen atom, a sulfur atom and/or a phosphorous atom.

Ex.1001, 20:9-12.

As explained above with respect to claim 8, each repeating unit of the iDMA polymer disclosed by the Holtmyer Publication and each repeating unit of the 2EHMA polymer disclosed by Inaoka contains oxygen heteroatoms. *See, e.g.,* Ex.1041 ¶¶157, 156. For these reasons, and those explained above with respect to

claim 1, the method recited in claim 9 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz.

I. Claim 10

10. A method comprising:

introducing a drag reducing polymer having a solubility parameter of at least about $17 \text{ MPa}^{1/2}$, into a pipeline, such that the friction loss associated with the turbulent flow through the pipeline is reduced by suppressing the growth of turbulent eddies, 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 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 $1 \times 10^6 \text{ g/mol}$ and

the drag reducing polymer is added to the liquid hydrocarbon in the range from about 0.1 to about 500 ppmw.

Ex.1001, 20:13-36.

Claim 10 differs from claim 1 in that it additionally includes the limitations of claims 2-4 and 8-9. Therefore, the method recited in claim 10 would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz for the same reasons set forth above concerning claims 1, 2-4, and 8-9.

J. Claim 11

11. A method comprising:

introducing a drag reducing polymer, into a pipeline, such that such that the friction loss associated with the turbulent flow through the pipeline is reduced by suppressing the growth of turbulent eddies, into a liquid hydrocarbon;

wherein the drag reducing polymer has a solubility parameter within 4 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, $\delta_d = \Sigma F_{di}/V$, $\delta_h = (\Sigma F_{hi}/V)^{1/2}$, $\delta_p = (\Sigma F_{pi}^2)^{1/2}/V$ and

the drag reducing polymer is added to the liquid hydrocarbon in the range from about 0.1 to about 500 ppmw.

Ex.1001, 20:37-64.

Claim 11 differs from claim 1 in that it additionally includes the limitations of claims 6-7. Therefore, the method recited in claim 11 of the 118 patent would have been obvious over each of (a) the Holtmyer Publication in view of the Holtmyer Patent and Strausz and (b) Inaoka in view of Strausz for the same reasons set forth above concerning claims 1 and 6-7.

XI. Conclusion

Petitioner has established a reasonable likelihood of prevailing as to each of claims 1-11 of the 118 patent, and it therefore respectfully requests that the Board institute *inter partes* review of those claims.

*Petition for Inter Partes Review of
U.S. Patent No. 8,022,118*

Respectfully submitted,

McANDREWS, HELD & MALLOY, LTD.

Dated: October 6, 2016

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CERTIFICATE OF WORD COUNT

I hereby certify, pursuant to 37 CFR § 42.24, that this **PETITION FOR
INTER PARTES REVIEW** contains fewer than 14,000 words, as determined by
Microsoft Word.

/Herbert D. Hart III/
Herbert D. Hart III
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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e)(4) and 42.105, the undersigned certifies on this date, a true and correct copy of this Petition for *Inter Partes* Review and all supporting exhibits were served by Federal Express to the Patent Owner at the following correspondence address of record for U.S. Patent No. 8,450,118:

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