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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ENERCORP SAND SOLUTIONS INC.
Petitioner

v.

SPECIALIZED DESANDERS INC.
Patent Owner

Inter Partes Review No. 2018-01748
U.S. Patent No. 8,945,256

PATENT OWNER'S RESPONSE TO PETITION FOR *INTER PARTES* REVIEW

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Patent Owner Ex. 2001	Declaration of Harold E. McGowen III, P.E.
Patent Owner Ex. 2002	*Curriculum Vitae* of Harold E. McGowen III, P.E.
Patent Owner Ex. 2003	*Engineering Data Book, FPS Version*, vols. I&II, 12th ed., Gas Processors Suppliers Association, 2004
Patent Owner Ex. 2004	Rhinesmith, R. Bret, Kimmitt, Russell P., and Root, Chris R., "*Proven Methods for Design and Operation of Gas Plant Liquid Slug Catching Equipment*", 80th Annual Gas Processors Convention, San Antonio, Texas, March 12-14, 2001
Patent Owner Ex. 2005	Deposition Transcript of David A. Simpson dated May 8, 2019
Patent Owner Ex. 2006	*The American Heritage Dictionary of Science* (1986) (definition of "suspension")
Patent Owner Ex. 2007	*McGraw-Hill Dictionary of Scientific and Technical Terms* (4th ed. 1989) (definition of "suspension")

I. INTRODUCTION

The Board instituted *inter partes* review ("IPR") of U.S. Patent No. 8,945,256 (the "'256 Patent," Ex. 1001) on four grounds: (1) obviousness of claims 1-7, 9-11, 13 and 16 based on U.S. Patent No. 6,983,852 ("Hemstock," Ex. 1004) and Robert H. Davis, *Sedimentation of Noncolloidal Particles at Low Reynolds Numbers*, 17 Annual Review of Fluid Mechanics, 91-118 (1985) ("Davis," Ex. 1005); (2) obviousness of claims 1-13 and 16 based on Hemstock and Engineering Data Book §§ 7 and 17 Gas Processors Suppliers Ass'n, Rev. 10th ed. 1994 ("Data Book," Ex. 1008); (3) obviousness of claims 8, 12, 14 and 15 based on Hemstock, Davis, and U.S. Patent No. 1,458,234 ("Miller," Ex. 1007); and (4) obviousness of claims 14 and 15 based on Hemstock, the Data Book, and Miller. Petitioner fails to show that any of its Grounds render any challenged claim obvious.

None of Petitioner's prior art references disclose a gas/liquid interface that is formed at the fluid outlet, one of the key innovations of the '256 Patent that allows the liquid level of the vessel to be controlled without a flow barrier. Instead, Hemstock (Petitioner's primary reference) makes use of a flow barrier to maintain a gas/liquid interface that is below the fluid outlet so that desanded fluid can escape the vessel. None of Petitioner's other prior art references disclose a gas/liquid interface, the location of any gas/liquid interface, or any motivation for a person of ordinary skill in the art ("POSITA") to include such an interface formed at a fluid

outlet in an inclined vessel. Because a gas/liquid interface formed at the fluid outlet is a requirement of every challenged claim, Petitioner has not and cannot show that that any claim of the '256 Patent would have been obvious to a POSITA.

Additionally, Petitioner's motivation to modify Hemstock in each of its Grounds is flawed. In each Ground, Petitioner starts with the problem addressed by a secondary reference that shows inclination, and attempts to work backwards to find motivation to incline Hemstock where there is none. To wit, Petitioner's alleged motivation for Grounds 1 and 2 is based on alleged "problems" with Hemstock that are contradicted by Hemstock's disclosure. In modifying Hemstock in view of Davis, Petitioner argues that a POSITA would want to improve the rate at which sand settles out of the liquid portion of Hemstock so that liquid exiting the device will be free of sand. But Petitioner ignores that Hemstock expressly discloses that the liquid exiting the device is already "particulate free." As such, the problem is illusory and not supported by the evidence on which Petitioner relies.

In modifying Hemstock in view of the Data Book, Petitioner argues that a POSITA would want to improve Hemstock's ability to handle slug flow. But Hemstock teaches that slug flow was a problem with even older desanders that use filters, which Hemstock overcame by eliminating filters. Indeed, Petitioner's expert concedes that Hemstock is already able to handle slug flow. Here again, the identified problem is illusory and without proper foundation.

Even if Petitioner's illusory with problems Hemstock were to be addressed by a POSITA, neither Davis nor the Data Book would motivate a POSITA to incline the Hemstock vessel to solve those problems. Davis discloses a method for improving the rate at which solids are separated from liquids in a suspension in a narrow vertical channel: incline the narrow vertical channel. Davis discloses that in vessels (as opposed to narrow channels) such as Hemstock, inclined plates should be used rather than inclining the vessel itself, and further teaches that horizontal (as opposed to vertical) channels are often made worse through inclination. Further, Davis expressly teaches that its inclination strategy will not work in a turbulent flow environment, which both parties' experts agree is the environment of Hemstock. The Data Book teaches that slug flow capacity is improved in horizontal vessels like Hemstock, not through inclining the vessel, but by raising the liquid level in the vessel. Indeed, the Data Book does not disclose any inclined vessel, nor does it teach that inclining a vessel will improve slug capacity. Petitioner relies on the sole inclined object in the entire reference—a slug catcher consisting of inclined pipes, that has nothing to do with pressure vessels such as Hemstock.

Finally, Petitioner's Grounds 3 and 4 merely repeat Grounds 1 and 2, respectively, with the addition of Miller (a patent that issued in 1922), and are directed only to certain dependent claims. Not only does Miller not remedy any of

the issues identified above, but Petitioner's expert concedes that Miller does not even disclose the relevant limitations.

All of Petitioner's Grounds should be rejected, and the Board should find that Petitioner fails to establish the unpatentability of any challenged claim.

II. THE '256 PATENT

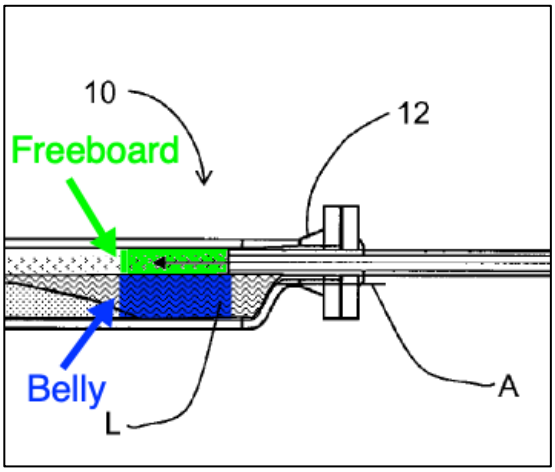
The '256 Patent is directed to "a system and apparatus for the removal of particulates, such as sand, from fluid streams produced from a well, while minimizing the abrasion of the involved equipment." Ex. 1001, 1:5-8. Production from oil wells often contains sand, and this sand, in combination with the high velocity fluid flow of the oil and gas, can cause multitudes of problems for downstream oil and gas gathering systems and refining facilities, including most importantly erosion. Such erosion can lead to high-pressure release of oil and gas into the environment, damaging the environment and causing significant cleanup costs. Ex. 1001, 1:12-39.

The desander of the '256 Patent is designed to be placed adjacent to a well's wellhead, receiving the wellhead's high velocity fluid flow, and is meant to be used prior to other oil and gas systems, such as piping, separators, vales, chokes, and downstream equipment to prevent sand from damaging these downstream systems. Ex. 1001, 2:33-36.

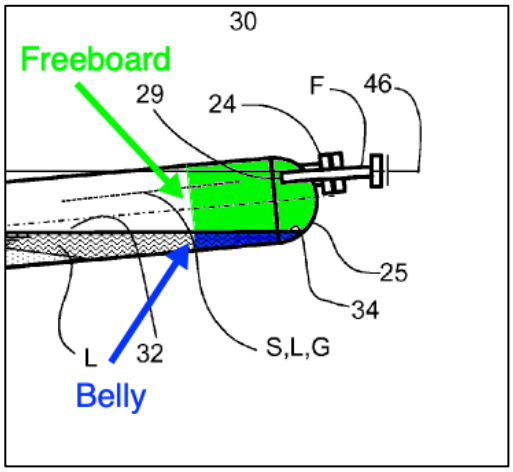
SDI first provided a solution to this problem in its Canadian Patent 2,433,741, which issued in 2004, that discloses a horizontal desander placed immediately adjacent to an oil well in an environment where pressures and flow velocities are substantial and offer unique challenges for designing systems able to separate sand from the fluid streams. Ex. 1001, 2:7-29. This patent, and its U.S. counterpart Hemstock (Ex. 1004), provided the novel solution of a desander making use of a horizontal, elongated vessel with an input at one end and an output at the other end. *Id.* Hemstock relies on, among other things, slowing down the high velocity of the fluid flow enough to allow sand to fall out of the fluid by the effects of gravity. *Id.* This process directs the fluid to enter an upper portion of the vessel that has a cross-sectional area larger than the input piping, which slows down the fluid enough for sand, oil and water to fall out of the fluid. *Id.* The sand and liquids collect in the lower, or belly, portion of the vessel, while the fluid stream remains in an upper, freeboard portion. In order to maintain the larger cross-sectional area of the freeboard region Hemstock relies on a downcomer flow barrier that limits the depth of collected liquids and solids in the belly portion of the vessel. *Id.* The desander disclosed in Hemstock remained the industry standard for approximately 8 years. *Id.*

Although the Hemstock vessel was a commercially successful vessel for almost a decade, the ‘256 Patent sought to improve upon the design of Hemstock in

two important ways: by increasing the separation efficiency of the solids from the fluid flow, and by improving the ease by which the vessel could be cleaned. Ex. 1001, 2:22-29; Ex. 2001 ¶¶24-26. The inventor of the '256 Patent recognized that by increasing the cross-sectional area of the freeboard portion of the vessel near the fluid inlet as compared to Hemstock, the velocity of the incoming fluid could be further reduced, causing solids to fall more efficiently from the fluid stream. Ex. 1001, 5:27-30. The '256 Patent teaches an innovative way to increase the cross-sectional area of the freeboard portion of the vessel near the fluid inlet: incline the vessel such that the fluid outlet is lower than the fluid inlet. Ex. 1001, 4:21-26 ("through tilting or inclination of the vessel, maximize freeboard upon entry of the flow stream"). This increase in freeboard area can be seen by comparing Figure 1 of the '256 Patent (the Hemstock vessel) to Figure 2 of the '256 Patent:



Annotated Hemstock Vessel

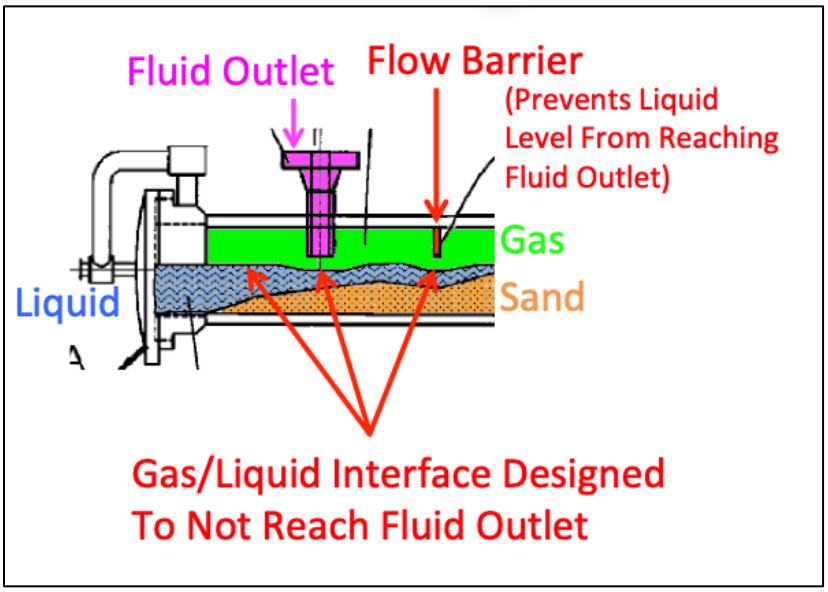


Annotated '256 Vessel

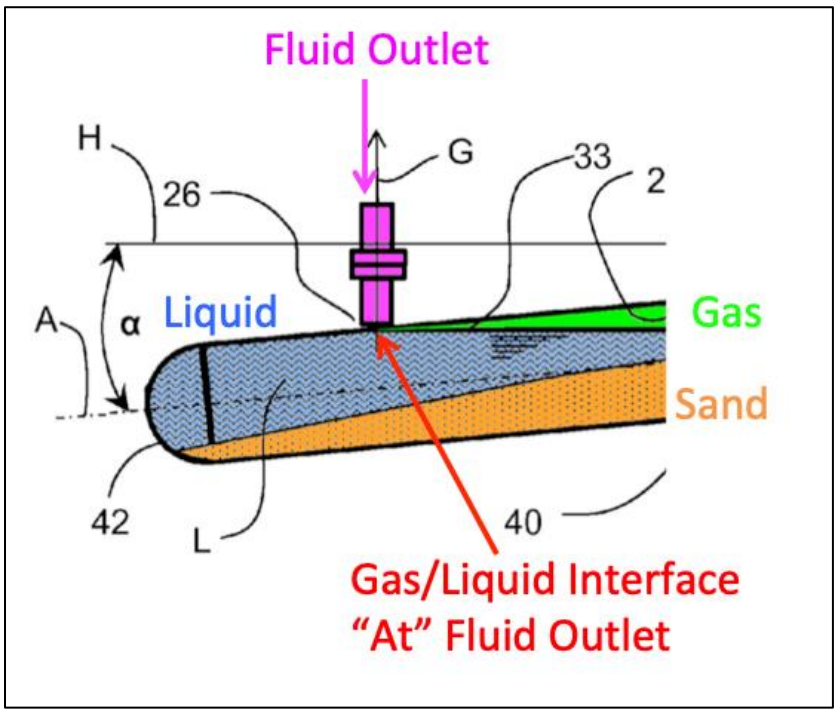
Not only does the inclination of the vessel of the '256 Patent provide increased drop-out efficiency by increasing the cross-sectional area of the freeboard portion of the vessel, but it also results in the fluid from the inlet being aimed at the belly portion of the vessel rather than parallel to it. This results in a shorter trajectory for the sand to fall to enter the belly portion, also increasing drop out efficiency. Ex. 1001, 4:57-59 ("The trajectory for dropping sand S and liquid L into the belly portion 40 is foreshortened, reducing drop out time.").

The '256 Patent also teaches that by inclining the vessel, the desander can be further improved in such a way that the flow barrier of Hemstock is no longer necessary. Ex. 1001, 6:38-52. The purpose of the flow barrier of Hemstock is to place it before the fluid outlet and force gas to travel beneath it to increase the gas velocity so that that the liquid level in the vessel never reaches the flow barrier (the high velocity gas causes excess liquid to rejoin the fluid flow), and in turn never reaches the fluid outlet. *Id.* The '256 Patent teaches another innovation: allow the fluid outlet itself—rather than the flow barrier—to maintain the freeboard portion of the vessel by setting the gas/liquid interface at, rather than below, the fluid outlet. Ex. 1001, 4:45-5:5; Ex. 2001 ¶25. This is achieved, because when the liquid level is at the fluid outlet, both liquid and gas exit the vessel via the fluid outlet together. Ex. 1001, 4:65-5:5; Ex. 2001 ¶25. By allowing the liquid level to match the height of the fluid outlet, excess liquid will not cause the liquid level to rise, instead the

liquid will simply exit the vessel with the fluid. A comparison of the '256 design and the Hemstock design is depicted below. Ex. 1001, Figs. 1, 2 (annotations added).

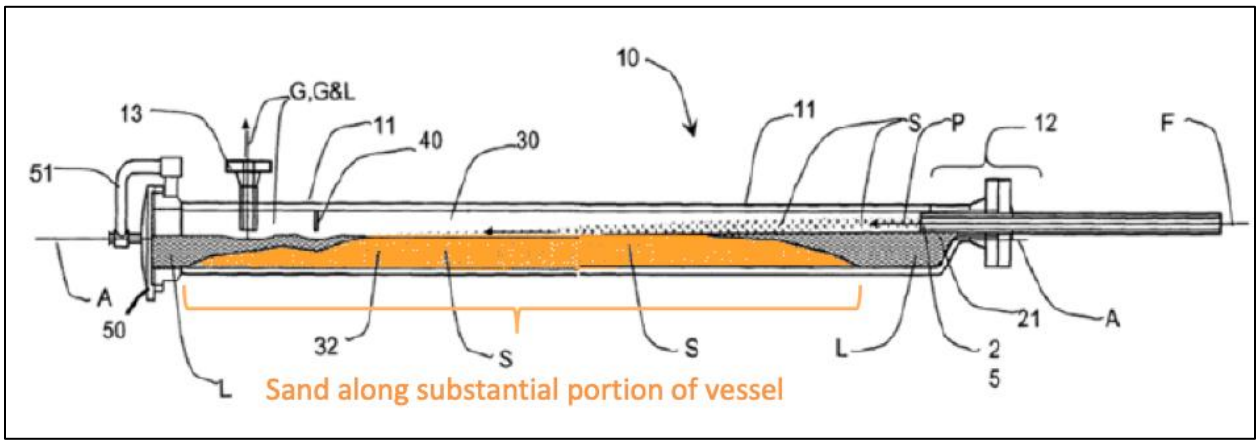


'256 Patent Fig. 1 (annotated)

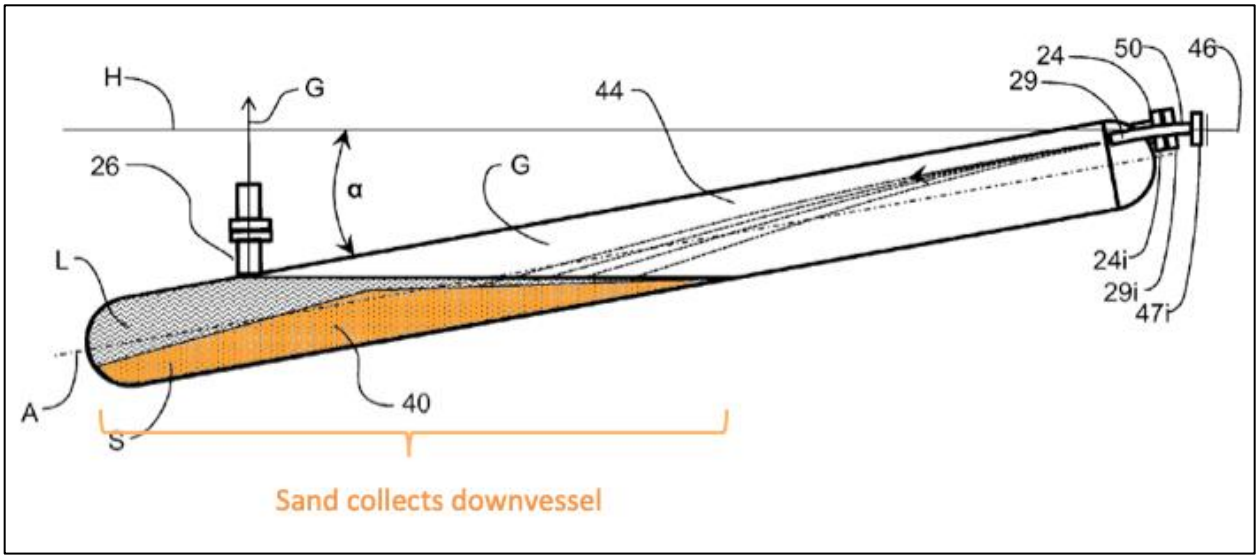


'256 Patent Fig. 2 (annotated)

The inclination of the vessel of the '256 Patent also provides the benefit of making the vessel easier to clean. In the prior art Hemstock vessel, the accumulation of particles "is along a substantial length of the elongate vessel increasing the difficulty of periodic manual removal of such accumulating [particles.]" Ex. 1001, 2:18-21. In contrast, the angle of inclination of the vessel of the '256 Patent allows the liquids and solids of the belly portion of the vessel to flow downvessel. Ex. 1001, 5:45-51. Moreover, as sand begins to accumulate in the belly portion of the vessel, the amount of liquid necessarily decreases. *Id*. This decrease in liquid level causes the velocity of the liquid level to increase, dragging more sand to the lowest portion of the vessel. *Id.* Conveniently, the access closure of the pressure vessel for the removal of particles is located at this bottom-most portion of the vessel. Ex. 1001, 7:14-27. The inclination of the vessel thus causes the sand and other particles to collect at this bottom-most portion of the vessel, making cleaning much more convenient than the Hemstock vessel. *Id.*; *see also* figures below (annotations added).



Annotated Prior Art Hemstock Vessel



Annotated Figure 4 of '256 Patent

III. CLAIM CONSTRUCTION

Petitioner only proposes a construction for "freeboard" and "replaceable." The Board construed "freeboard" to mean "the substantially gas-filled portion of the desanding vessel above the gas/liquid interface," and Patent Owner does not object to this construction. Dec. 8. The Board also recognized that "replaceable" does not require construction, and Patent Owner agrees. *Id*. However, the claim limitations

"gas/liquid interface formed at the fluid outlet having a belly storage portion formed therebelow" and "a freeboard above the fluid outlet…establishing a liquid interface in a belly portion of the vessel, the belly portion being formed below the fluid outlet" (the "Interface Limitations") require construction for the purposes of the instituted grounds.

Independent claim 1 recites a "gas/liquid interface formed at the fluid outlet having a belly storage portion formed therebelow" and Independent claim 9 recites and "a freeboard above the fluid outlet…establishing a liquid interface in a belly portion of the vessel, the belly portion being formed below the fluid outlet." The plain and ordinary meaning of the Interface Limitations is that the gas/liquid interface level is the boundary between the gas-filled freeboard portion of the vessel and the solid-and-liquid-filled belly portion of the vessel; and that this interface must be at the same level as the fluid outlet, not above or below the fluid outlet. Ex. 2001 ¶¶28-29. Petitioner did not construe this term, but appears to agree with this construction, arguing that this term is met by "a gas/liquid interface, which is formed at the vapor outlet and extends horizontally from the vapor outlet in the same manner as disclosed, for example, in Figure 7 of the '256 Patent." Pet. 35.

The claims themselves support this construction. Ex. 2001 ¶30. For example, claim 1 requires a "belly storage portion formed therebelow [the gas/liquid interface]" and a freeboard portion formed "above the interface." Ex. 1001, 7:58-

61; Ex. 2001 ¶30. Claim 1 further requires that this interface be "formed at the fluid outlet." Ex. 1001, 7:58. These claim elements, taken together, demonstrate that the gas/liquid interface is the interface between the belly and freeboard portion of the vessel, and that this interface is located at the fluid outlet. Ex. 2001 ¶30. Similarly, claim 9 requires that the "belly portion being formed below the fluid outlet" and "forming a freeboard portion above the fluid outlet." Ex. 1001, 8:49, 8:53-54. Further, claim 9 requires that there be a "liquid interface in a belly portion" of the vessel. Ex. 1001, 8:53. A POSITA would understand that these limitations together require that the gas/liquid interface form the interface separating the belly portion from the freeboard portion, and that this interface is located at the fluid outlet. Ex. 2001 ¶30.

The specification also supports this construction. Ex. 2001 ¶¶31-33. For example, the specification teaches that the gas/liquid interface is element 32. Ex. 1001, 4:38-40 ("In an operating state, a gas/liquid interface 32 forms"). The patent further teaches that the gas/liquid interface 32 is between the belly and freeboard portions of the vessel. Ex. 1001, 4:50-52 ("The interface 32 is a generally obround, gas/liquid interface between the belly and freeboard portions 40,44"); Ex. 2001 ¶¶23-31. Moreover, the specification teaches that the liquid/gas interface is "adjacent" and "extending horizontally from" the fluid outlet. Ex. 1001, 4:50-55 ("32 has a distal end 33 adjacent the fluid outlet 26"); Ex. 1001, 4:38-40 ("In an

operating state, a gas/liquid interface 32 forms extending horizontally from about the fluid outlet 26.”). The specification additionally limits the angle of the vessel based on the interface being at the outlet, teaching “[t]he minimum inclination angle would be the condition where…the gas phase at the discharge is of zero height.” Ex. 1001, 5:67-6:3. A POSITA would understand this statement to be teaching that the gas/liquid interface is at the same level as the fluid outlet, because the interface is between the gas and liquid states, so having a gas height of zero at the outlet means the interface forms at the outlet. Ex. 2001 ¶31.

Further, the ‘256 Patent teaches that having the gas/liquid interface at the fluid outlet is an improvement over its prior art Hemstock vessel. Ex. 1001, 2:7-17, 2:44-47. The prior art Hemstock design required a flow barrier, such a weir, in order to maintain the freeboard portion of the vessel. Ex. 1001, 2:7-17, 6:38-46. As Hemstock teaches, the weir prevents the gas/liquid interface from getting too high, by forcing fluid flow to go below the flow barrier such that it collects below the fluid outlet so that it can leave the vessel via the outlet. Ex. 1004, 4:44-47, 5:28-39; Ex. 2001 ¶33. If the liquid level were to reach the level of the fluid outlet, the flow would become unstable and the vessel could no longer be able to prevent sand from exiting the vessel as intended. Ex. 1004, 2:37-39, 5:9-27; Ex. 2001 ¶¶33, 39.

The ‘256 Patent teaches that by placing the gas/liquid interface at the fluid outlet, the flow barrier (weir) of the prior art Hemstock vessel is no longer required.

Ex. 1001; Ex. 2001 ¶¶25, 33. Instead, the freeboard portion of the vessel is maintained by the outlet itself. Ex. 1001, 6:47-52; Ex. 2001 ¶¶25, 33. Once the liquid level raises to the level of the outlet (i.e., the gas/liquid interface is at the fluid outlet), any excess liquid will simply exit via the fluid outlet. Ex. 1001, 5:1-4; Ex. 2001 ¶¶25, 33. Therefore the liquid level is inhibited to rise above the level of the fluid outlet, ensuring that the desanding process can continue. Ex. 1001, 5:1-4; Ex. 2001 ¶¶25, 33. Where having the gas/liquid interface at the fluid outlet was a problem to be avoided in the prior art Hemstock design, the '256 Patent benefits from having the gas/liquid interface at the fluid outlet. Ex. 2001 ¶¶25, 33.

The Board briefly addressed this limitation in the Institution Decision, stating that "the identified gas/liquid interface is at the fluid outlet portion of Hemstock's vessel… in Figure 3." Dec. 19. Figure 3 of Hemstock is reproduced in Figure 1 of the '256 Patent, and is labelled "prior art." Ex. 1001, Fig. 1. The gas/liquid interface in Figure 1 of the '256 Patent is below the outlet, not adjacent the outlet. *Compare* Ex. 1001, Fig. 1 (showing the liquid/gas interface below, rather than adjacent, the outlet 13) with Ex. 1001, Fig. 2 (showing the liquid/gas interface 33 adjacent outlet 26); *see* Ex. 2001 ¶32. Indeed, the Board's initial statements regarding the interface in Hemstock do not align with the actual design and apparently misapprehend its operation and purpose of the flow barrier. Both experts agree that the purpose of the flow barrier (element 14 of Figure 1) is to maintain the freeboard portion of the

vessel, or in other words to keep the gas/liquid interface in the vessel at a constant level below the fluid outlet. Ex. 1001, 6:38-46; Ex. 1002 ¶143; Ex. 2001 ¶¶25, 33. The '256 Patent teaches that, unlike in the prior art vessel, the flow barrier is not necessary in the improved '256 Patent vessel, because when the vessel is inclined, the fluid outlet, rather than the flow barrier, maintains the freeboard portion of the vessel. Ex. 1001, 4:67-5:5, 6:47-53; Ex. 2001 ¶¶25, 33. The fluid outlet maintains the freeboard portion of the vessel because the gas/liquid interface is formed at the fluid outlet. Ex. 1001, 6:47-53 ("Herein, in the inclined desander 20, the prior art downcomer flow barrier, such as a weir, can be eliminated by [inclining the vessel] so as to form the interface 32 at the fluid outlet 26"). Thus, while the operation of the prior art vessel in Figure 1 of the '256 Patent maintains a gas/liquid interface that is below the fluid outlet, the design of the '256 Patent is to set the gas/liquid interface at, rather than below, the fluid outlet. SDI's construction clarifies where the interface must occur, consistent with both parties' interpretation and the claims and specification of the '256 Patent.

IV. GROUND 1: PETITIONER FAILS TO ESTABLISH THAT THE COMBINATION OF HEMSTOCK AND DAVIS RENDERS OBVIOUS ANY CHALLENGED CLAIM

Under 35 U.S.C. § 103, a patent may not issue when "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention was made to

a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (quoting 35 U.S.C. § 103 (pre-AIA)).[1] The framework for applying this statutory analysis includes: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) any secondary considerations of non-obviousness. *See id*. (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)).

Obviousness requires more than merely demonstrating that each claimed element was, independently, known in the art. *Id.* at 418. Rather, a party asserting that a patent is obvious must demonstrate that "a skilled artisan would have had reason to combine the teaching of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so." *PAR Pharm., Inc. v. TWI Pharm, Inc.*, 773 F.3d 1186, 1193 (Fed. Cir. 2014) (citation omitted).

[1] The pre-America Invents Act ("AIA") version of § 103 applies because the application of the '256 Patent was filed before March 16, 2013. *See* AIA, Pub. L. No. 112-29, § 3(n)(1), 125 Stat. 284, 293 (2011).

In performing an obviousness analysis, "[c]are must be taken to avoid hindsight reconstruction by using the 'patent in suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit.'" *In re NTP*, 654 F.3d 1279, 1299 (Fed. Cir. 2011) (citation omitted). Moreover, "[r]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. at 418 (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

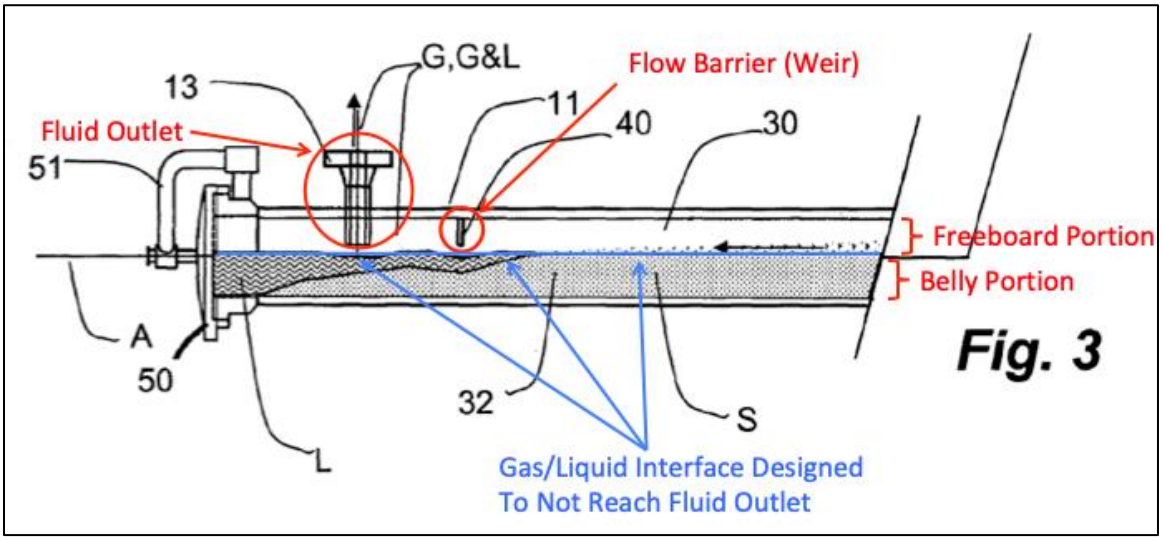
A. Overview of Hemstock

Hemstock is Patent Owner's original desander pressure vessel. Prior to the inventions disclosed by Hemstock, desanding equipment came in two varieties: (1) very large pressurized tanks that were designed to hold all of the fluid that is output from a wellsite, allowing the sand to slowly settle out of the fluid; and (2) pressure vessels containing fiber-mesh filters to filter the sand out of the fluid stream. Ex. 1004, 1:51-2:21. The pressurized tanks were only a temporary solution and were prohibitively expensive if a well continued to produce sand. Ex. 1004, 1:62-65. The pressure vessels containing filters were prone to failure because slugs—large amounts of fluid followed by a gas mist—would cause pressure drops that cause the filters to fail. Ex. 1004, 2:1-19; Ex. 2001 ¶36.

Hemstock overcomes the disadvantages of these prior art designs. Ex. 2001 ¶37. Hemstock improves over the giant pressurized tanks by allowing for continuous fluid flow while removing the sand particles from the fluid. *Id*. Hemstock improves over the filter design by removing the filters, thus removing the hazard caused by liquid slugs. *Id*.

The innovative design of Hemstock includes an elongated horizontal pressure vessel with a fluid inlet that is connected to a wellhead. The fluid inlet provides a fluid stream consisting of gas, some liquids and some solids such as sand. The Hemstock design also includes a fluid outlet that provides gas and liquid, but that has had all of its solids removed, to downstream equipment such as multiphase separators. Ex. 1004, 3:32-47; Ex. 2001 ¶34. When the fluid enters the Hemstock vessel, it transitions from a narrow inlet pipe to a wide vessel. This increase in space (known as the cross-sectional area) causes the velocity of the fluid to slow down dramatically. Ex. 1004, 4:15-21; Ex. 2001 ¶39. The decrease in velocity allows the sand particles and the liquid to fall out of the fluid to the bottom of the vessel. Ex. 1004, 4:21-31; Ex. 2001 ¶39. Within the vessel, the solids and the liquids collect in the bottom of the vessel which is called the belly portion of the vessel, while the remaining area where the fluid travels, in the top of the vessel, is known as the freeboard portion of the vessel. Ex. 1004, 4:29-43; Ex. 2001 ¶39.

Hemstock makes use of a flow barrier to make sure that the belly portion of the vessel remains below the fluid outlet to the vessel, thus ensuring that the gas/liquid interface does not reach the fluid outlet. Ex. 1004, 4:44-54; Ex. 2001 ¶39. Below is Figure 3 of Hemstock which has been annotated to highlight these features:



'852 Patent (Hemstock) Fig. 3 (annotated)

This arrangement is in stark contrast to the '256 Patent, which requires that the gas/liquid interface be "at the fluid outlet." Ex. 1001, cls. 1, 9. Hemstock requires the gas/liquid interface is below the fluid outlet in order to properly function; if the liquid level were to rise to the level of the fluid outlet, the flow would become unstable and sand would no longer be removed from the fluid stream. Ex. 2001 ¶39.

Hemstock includes two embodiments relating to its fluid outlet, both which disclose a fluid inlet that is below the fluid outlet. Ex. 2001 ¶40. The first embodiment includes an outlet protruding into the vessel, but above the lower edge

of the fluid inlet; the second embodiment includes an outlet that is at the top of the vessel, above the entire fluid inlet. Ex. 1004, Figs 4a, 4b; Ex. 2001 ¶40.

B. Overview of Davis

Davis is a research paper from 1985 that purports to review developments in the field of "sedimentation"—which Davis defines as when "particles fall under the action of gravity through a fluid in which they are suspended." Ex. 1005 at 4; Ex. 2001 ¶41. Specifically, Davis focuses on solids in a suspension within a liquid, and the rates at which those solids settle out of suspension. Ex. 1005 at 4. Petitioner relies only on one section of Davis, a section directed to "Enhanced Sedimentation in Inclined Channels." *Id.* at 17-26. This section of Davis discloses that solids in suspension can be caused to settle at a faster rate in an inclined vessel than a vertical. Ex. 1005 at 17; Ex. 2001 ¶45. Davis clarifies that these vertical vessels "may be composed either of a narrow tube or channel inclined from the vertical or of a large tank containing several closely spaced tilted plates." Ex. 1005 at 17; Ex. 2001 ¶52. Davis provides an example of a narrow tube or channel, a test tube. Ex. 1005 at 17. Below are examples of a large tank settler that includes inclined plates as described in Davis. Ex. 2001 ¶105.

Example of a large tank with inclined plates for sedimentation

Example of parallel plates for sedimentation

Davis explains that this phenomenon results "from the fact that whereas particles can only settle onto the bottom in a channel with vertical walls, such particles can also settle onto the upward-facing wall in a tilted channel, as shown in Figure 4." Ex. 1005 at 17; Ex. 2001 ¶¶45-46. In mathematical terms, this enhancement is "equal to the velocity of the particles multiplied by the horizontal projection of the channel area available for settling." Ex. 1005 at 18. Davis discloses a formula (Equation 4.1) for computing the settling efficiency of a solid in suspension as a function of the angle of inclination from the vertical. Ex. 1005 at 19 (Equation 4.1); Ex. 2001 ¶46.

A POSITA would understand that Equation 4-1 is only applicable to a vertical channel, and would not be applied to a horizontal vessel. SDI's expert, Mr. McGowen, explains that a vertical channel inclined at 25 degrees will increase settling efficiency by over 100% compared to a non-inclined vertical channel. Ex. 2001 ¶51. He also explains that if this formula is applied to a horizontal channel (which it is not meant to describe), an inclination of 25 degrees will decrease its settling efficiency by over 3%. Ex. 2001 ¶¶49-57. This is why Davis teaches that its enhanced sedimentation is for "vertical" settlers as opposed to all settlers. Ex. 2001 ¶52.

Davis also discloses that the enhanced sedimentation it describes for vessels inclined from the vertical "holds true only so long as the flow in the channel remains

laminar." Ex. 1005 at 19; Ex. 2001 ¶77. A POSITA would understand that laminar flow is a type of fluid flow where the fluid flows smoothly, with little or no mixing, and is usually found in slow moving fluids. Ex. 1008 at 22; Ex. 2001 ¶66. This is contrasted to turbulent flow, which is a less orderly flow regime that contains random motion, such as eddies or swirls of fluid, and typically applies to higher velocity fluids. Ex. 1008 at 22; Ex. 2001 ¶67. Turbulent flow has a negative effect on settling efficiency, because the swirling of the fluid causes the solids to remix with the suspension. Ex. 1005 at 19; Ex. 2001 ¶77. Davis further explains that even tiny waves caused by particles settling from the suspension can be destabilizing enough to remix the solid particles into the suspension, limiting any effectiveness allowed by inclining the channel. Ex. 1005 at 19; Ex. 2001 ¶77. Davis does not disclose any gases, any gas/liquid interface, any inlets, or any outlets. Ex. 2001 ¶45.

C. The Combined Teachings of Hemstock and Davis Do Not Disclose the Interface Limitations

Claim 1 of the '256 Patent requires a "gas/liquid interface formed at the fluid outlet having a belly storage portion formed therebelow," and claim 9 of the '256 Patent requires "establishing a liquid interface in a belly portion of the vessel, the belly portion being formed below the fluid outlet." Ex. 1001, cls. 1, 9. As explained above, a POSITA would understand that the Interface Limitations require a gas/liquid interface that is located at, rather than below, the fluid outlet. *See* Section

III; Ex. 2001 ¶28-33, 89. This gas/liquid interface exists at the boundary between the freeboard portion and belly portion of the vessel. Ex. 2001 ¶¶33, 89; Ex. 1001, 4:50-51 ("The interface 32 is a generally obround, gas/liquid interface between the belly and freeboard portions 40,44"). Neither Hemstock nor Davis teach or suggest the Interface Limitations. Ex. 2001 ¶¶89-93.

Hemstock does not teach the Interface Limitations because Hemstock discloses a design where the gas/liquid interface is below the fluid outlet, rather than at the fluid outlet. Ex. 2001 ¶¶89-93; Ex. 1004, Fig. 3; Ex. 1001, Fig. 1; *cf.* Pet. 32 (describing Hemstock as teaching a freeboard portion that "exists both below and above the fluid outlet 13"). In fact, Petitioner does not even allege that the gas/liquid interface is at the fluid outlet in Hemstock; it merely alleges that a gas/liquid interface exists in Hemstock. Pet. 34-35. And Petitioner's expert concedes that the gas/liquid interface in Hemstock is below the fluid outlet. Ex. 2005, 15:24-16:6.

Davis also does not teach the Interface Limitations, because Davis does not teach a gas/liquid interface, and because Davis does not even teach a fluid outlet. Ex. 2001 ¶91. While Davis discloses a liquid suspension, it does not disclose any gas, and therefore cannot teach a gas/liquid interface. *Id.* Moreover, as Petitioner's expert concedes, Davis does not disclose a fluid outlet. Ex. 2005, 26:8-16. And Petitioner does not argue that Davis meets this claim limitation at all. Pet. 34-35. Even Petitioner's motivation to combine Hemstock and Davis contains no

description as to where any alleged gas/liquid interface would be located. Pet. 48-49. Indeed, as discussed further below, even if a POSITA would be motivated to incline Hemstock based on Davis (which he would not), he would be motivated to raise the outlet and lower the inlet, which would result in the gas/liquid interface being located farther below the fluid outlet than disclosed in Hemstock. Ex. 2001 ¶¶94-99. Therefore, the combination of Hemstock and Davis does not teach the Interface Limitations.

D. The Combined Teachings of Hemstock and Davis Do Not Disclose "said vessel being inclined…such that the fluid outlet is lower than the fluid inlet"

Neither Hemstock nor Davis, nor their combination teach "said vessel being inclined…such that the fluid outlet is lower than the fluid inlet" as required by claim 1 of the '256 Patent or "inclining the vessel…so that the fluid outlet is lower than the fluid inlet" as required by claim 9. Ex. 1001, cls. 1, 9.

Hemstock does not teach an inclined vessel and therefore cannot teach a fluid outlet that is lower than the fluid inlet because of that inclination. Ex. 1001, cls 1,9 ("inclined…***such that*** the fluid outlet is lower") (emphasis added). Further, Hemstock discloses a fluid outlet that is above—not lower than—the fluid inlet. As Petitioner's expert admits, Hemstock discloses in its main embodiment that the fluid inlet has a bottom that is below the bottom of the fluid outlet. Ex. 2005, 15:18-17:18; Ex. 1004, Fig. 3; Ex. 2001 ¶40. Because the fluid inlet extends below the

fluid outlet, the fluid outlet cannot be described as "lower than" the fluid inlet. In another embodiment of Hemstock, the fluid outlet is coextensive with the top of the vessel, and thus is completely above the fluid inlet. Ex. 1004, Fig. 4b. Although Petitioner's expert stated that the outlet is lower than the inlet in Hemstock in his Declaration, when cross examined, he abandoned that position and admitted that the bottom of the inlet is below the bottom of the outlet, according to Hemstock. Ex. 2005, 17:12-18.

Similarly, Davis nowhere discloses a fluid outlet that is lower than a fluid inlet. Ex. 2001 ¶¶45, 94. Indeed, it is undisputed that Davis does not disclose either a fluid inlet or a fluid outlet. Ex. 2005, 26:8-16; Ex. 2001 ¶¶45, 94.

To the extent a POSITA would be motivated to tilt Hemstock based on Davis (which he would not), he would be motivated to tilt Hemstock such that the outlet were ***higher*** than the outlet, not lower as the claims of the '256 Patent require. Ex. 2001 ¶¶94-99. This is because Davis teaches that separation efficiency of solids suspended in a liquid is increased if additional surface area is provided for the suspension to settle on. Ex. 2001 ¶96. Hemstock has two side walls that could be provided as additional surface area: the wall past the fluid outlet, and the wall adjacent the fluid inlet. Ex. 2001 ¶96. Since Hemstock teaches that liquid is particulate free by the time it reaches the fluid outlet, there is no sand in the liquid adjacent the wall past the fluid outlet. *Id.* The only place where sand is ever in the

liquid of the Hemstock vessel is where sand is falling through the liquid, i.e., prior to the fluid outlet. Ex. 2001 ¶¶96-97; Ex. 1004, 5:34-36. This means that only the side wall adjacent the fluid inlet could possibly be used to increase the settling rate of the sand in the liquid. Thus, in order to provide a side-wall for settling, as taught by Davis, a POSITA would understand that after tilting, the wall of the vessel closest to the inlet would need to be under the liquid. Ex. 2001 ¶98. This can only be achieved by tilting the Hemstock vessel such that the fluid outlet is ***higher*** than the fluid inlet. Ex. 2001 ¶99. Therefore, the combination of Hemstock and Davis does not teach a fluid outlet that is below the fluid inlet, as required by the claims of the '256 Patent.

E. The Combined Teachings of Hemstock and Davis Lack a Motivation to Modify Hemstock to Arrive at the Claimed Invention

Even if Hemstock and Davis taught all of the limitations of the asserted claims, there is no motivation to modify Hemstock to arrive at the claimed invention. Indeed, as explained above, Petitioner does not even assert that the Interface Limitations will be met by modifying Hemstock based on Davis. Pet. 48-49. Moreover, Petitioner's alleged motivations to modify fall well short of supporting obviousness.

1. Petitioner relies on a non-existent problem

Petitioner's main argument relies on the faulty assumption that a POSITA would have desired "more rapid sand settling in the liquid" in Hemstock to prevent "re-entrainment of the solid particulates with the liquid stream leaving via outlet 13." Pet. 48. As Petitioner's expert admits, Hemstock does not disclose anything about "sand settling in the liquid." Ex. 2005, 19:25-20:7. Moreover, Hemstock discloses that the fluid leaving via outlet 13 is already particulate-free. Ex. 2001 ¶101; Ex. 1004, 5:34-36. Because the fluid leaving the Hemstock vessel is already particulate-free, there is no further need to prevent particulates from re-entrainment with the liquid stream leaving the vessel. Therefore, it is factually incorrect that a POSITA would have desired more rapid sand settling in the liquid of Hemstock, and therefore Petitioner's motivation to combine theory must fail.

Petitioner's argument is no different than the argument that was rejected in *Broadcom Corp. v. Emulex Corp.*, 732 F.3d 1325 (Fed. Cir. 2013). There, the patent claim alleged to be obvious required a master timing generator that included a number of limitations, including a "data path." *Id.* at 1329-30. The prior art reference disclosed each limitation of the challenged claim, except for the "data path." *Id.* at 1330 ("The record shows that Pickering discloses each limitation of claim 8 except for a 'data path'"). Emulex argued that a POSITA would have been motivated to broaden Pickering to include a data path, but the Federal Circuit

affirmed that there was no such motivation, in part because "Pickering's system accomplished its objective and provided no suggestion to broaden that objective." *Id.* at 1334. Like in *Broadcom*, Hemstock is a system that accomplished its objective—i.e., the objective of providing sand-free liquid at its fluid outlet. Like in Broadcom, Hemstock does not provide any suggestion that it must broaden its objective by further increasing sand settling efficiency. Thus, as in *Broadcom*, no motivation exists to improve Hemstock's sand settling efficiency where that objective was already accomplished.

2. The teachings of Davis do not apply to Hemstock

Petitioner is incorrect that the principles of settling described in Davis are applicable to Hemstock. Ex. 2001 ¶¶102-106. As Petitioner concedes, Davis discloses how to improve the settling of a solid that is ***in suspension*** with a liquid. Pet. 26-27; Ex. 2005, 25:2-8; Ex. 2001 ¶103. However, as Petitioner's expert concedes, the sand is not described as being in suspension with the liquid in Hemstock. Ex. 2005, 19:25-20:7; Ex. 2001 ¶103. Instead, sand that falls out of the fluid flow simply falls through the liquid to the bottom of the vessel, and does not become suspended. Ex. 2001 ¶103; Ex. 1004, 4:40-43. A POSITA would not be motivated to apply Davis's method for improving settling efficiency of a solid suspended in a liquid to Hemstock, which does not have a solid suspended in a liquid. *See Broadcom Corp. v. Emulex Corp.*, 732 F.3d 1325, 1334 (Fed. Cir. 2013) ("While

a prior art reference may support any finding apparent to a person of ordinary skill in the art, prior art references that address different problems may not, depending on the art and circumstances, support an inference that the skilled artisan would consult both of them simultaneously.").

Moreover, Davis teaches away from applying its teachings to non-laminar flows, like those present in Hemstock. Ex. 2001 ¶104. Davis specifically teaches that the efficiency in settling that it discloses will not work if flows are not laminar. Ex. 2001 ¶77; Ex. 1005 at 19 ("The enhancement in the settling rate predicted by (4.1) holds true only ***so long as the flow in the channel remains laminar***") (emphasis added). This is because turbulent flow will cause solids that were in suspension with a liquid to resuspend into the liquid. Ex. 2001 ¶104. It is undisputed that the high velocity flows in Hemstock will not be laminar. Ex. 2001 ¶104; Ex. 2005, 50:19-23, 51:8-11. Indeed, Petitioner's expert testified that he "almost never sees laminar flows in real systems" (Ex. 2005, 50:16-23), further evidencing that the teachings of Davis are not applicable to the turbulent fluid flows from a wellhead. Therefore, a POSITA would be discouraged from applying the teachings regarding the laminar flow of Davis to the turbulent flows of Hemstock. *Tec Air, Inc. v. Denso Mfg. Michigan Inc.*, 192 F.3d 1353, 1360 (Fed. Cir. 1999) ("There is no suggestion to combine, however, if a reference teaches away from its combination with another source.").

Further, Davis teaches that its inclination method is applicable in two situations: 1) narrow vertical channels, and 2) plates within a large tank. Ex. 1005 at 17 ("These settlers may be composed either of a narrow tube or channel inclined from the vertical or of a large tank containing several closely spaced tilted plates."). Importantly, in the second situation, it is the plates within the vessel, and not the vessel itself, which are tilted. *Id.* A POSITA would not consider the vessels disclosed in Hemstock—12 inches high by 10 or 20 feet long—to be a "narrow vertical channel;" instead it would consider the Hemstock vessel to be a "large tank," rendering the second situation the only potentially applicable one here. Ex. 2001 ¶105. Therefore, to the extent a POSITA would apply the teachings of Davis to Hemstock, the POSITA would at best be motivated to insert tilted plates into the vessel rather than be motivated to incline the vessel itself. *Id.*

Finally, Davis teaches that, compared to a vertical vessel, a vessel inclined from the vertical will have increased settling efficiency "by an order of magnitude or more." Ex. 1005 at 17. In other words, Davis teaches that by providing the sidewalls of a vessel for solids to settle on through inclination, solids will settle at an increased rate, compared to a vertical vessel where solids can only settle on the bottom of the vessel. Ex. 1005 at 17; Ex. 2001 ¶106. However, this phenomenon only applies to vertical vessels—vessels that are higher than they are wide; it does not apply to horizontal vessels—vessels that are wider than they are tall. Ex. 2001

¶106. Therefore, a POSITA would understand that the teachings of Davis are to be applied to a vertical settler, but not to a horizontal settler. Ex. 2001 ¶106. Indeed, as fully explained by Mr. McGowen, laminar flows in a channel inclined from the vertical at 25 degrees will have more than double the settling efficiency as a vertical vessel, while laminar flows in a horizontal channel inclined from the horizontal at 25 degrees will reduce, rather than increase the settling efficiency. Ex. 2001 ¶106.[2] Thus, Petitioner is incorrect when it asserts that "it was well known that an inclined channel improved solid-liquid separation times," as the method of improving separation times only applies to vertical channels, while the Hemstock vessel is indisputably horizontal. Ex. 2001 ¶106; Ex. 1004, 3:32-36; Pet. at 32 ("Hemstock teaches a horizontal (non-inclined) vessel"). Therefore, a POSITA would not be

[2] As Mr. McGowen further explains, in theory a horizontal channel at small angles will have a very small (less than 0.5%) increase in settling efficiency. However, this insubstantial improvement will not apply to Hemstock unless Hemstock is tilted such that the output is higher than the input. *See supra* Section IV.D. Thus, to the extent Petitioner intends to rely on this insubstantial increase in settling efficiency—which it did not in its Petition—it still does not result in the claimed invention, and therefore does not qualify as a motivation to combine.

motivated to incline the horizontal vessel of Hemstock based on the teachings of Davis.

F. Davis Is Unavailable as Prior Art in Support of Obviousness

A reference may be used as prior art for purposes only if it is analogous to the claimed invention. *Circuit Check Inc. v. QXQ Inc.*, 795 F.3d 1331, 1335 (Fed. Cir. 2015). "Prior art is analogous if it is from the same field of endeavor or if it is reasonably pertinent to the particular problem the inventor is trying to solve." *Id.* Davis is not in the same field of endeavor—the removal of particulates, such as sand, from fluid steams produced from a well—or reasonably pertinent to the particular problem facing the '256 inventor—improving the separation efficiency of sand from the fluid stream of the Hemstock desander and improving its ease of cleaning. Petitioner erroneously claims Davis is analogous art.

1. Davis is not from the same field of endeavor as the claimed invention

The field of endeavor disclosed by the '256 Patent is "the removal of particulates, such as sand, from fluid streams produced from a well." Ex. 1001, 1:5-7. A POSITA having read the '256 Patent would understand that the entire written description is directed at removing solids from a fluid stream produced from a wellhead. Ex. 2001 ¶74. A fluid stream, as that term is used in the '256 Patent, is a

gas with some liquid and some entrained particulates such as sand. Ex. 1001, 4:30:35. Thus, the '256 Patent is not teaching the settling of a solid out of a liquid.

Petitioner's expert concedes that Davis is not directed to a fluid stream produced from an oil well. Ex. 2005, 31:12-18. Instead, as Petitioner concedes, Davis is directed at particles settling out of a liquid (and not a fluid stream) in which they are suspended. Pet. 24 ("Davis…teaches a method…which can greatly reduce settling times for solids settling out of a liquid); Ex. 2005, 31:12-15. Moreover, Davis teaches applying its sedimentation method only to laminar flows, and teaches away from applying its sedimentation method to turbulent flows. Ex. 2001 ¶77; Ex. 1005 at 19 ("such an instability limits the efficiency of the inclined settling process"). Furthermore, Petitioner concedes that the flow of the fluid inside the desander of the '256 Patent will be turbulent, not laminar. Ex. 2005, 50:18-23, 51:8-11.

A POSITA working in the field of removing particulates from fluid streams produced from a well would not consider a paper discussing settling of solids in a laminar flow liquid suspension to be at all relevant to removing sand from a fluid stream produced from a well. Ex. 2001 ¶77. This is because a POSITA would never expect laminar flows to be found in a pressure vessel like Hemstock that is situated next to an oil well; rather a POSITA would expect highly turbulent, high velocity fluids. Ex. 2001 ¶77. Additionally, as described above, when dealing with solids

settling in a suspension, any swirling of the fluid, which is present in a turbulent fluid flow, will cause solids to mix back into the suspension and not settle out. Ex. 1005 at 19.

Further, Davis is limited to a very specific application: suspensions. Ex. 1005 at 3; Ex. 2001 ¶41. A POSITA would understand that a suspension is "a mixture of solids and liquids, where the solids do not immediately fall to the bottom of the liquid, but rather they stay suspended within the liquid for a period of time." Ex. 2001 ¶42; Ex. 2007 at 3; Ex. 2008 at 3. The portion of Davis that Petitioner relies on, Section 4, is titled "Enhanced ***Sedimentation*** in Inclined Channels." Ex. 1005 at 17 (emphasis added). Davis defines sedimentation as only applying to particles suspended in a liquid—a suspension. Indeed, as Petitioner's expert concedes, sedimentation in Davis is accurately defined as "particles falling under an action of gravity through a liquid in which they are ***suspended***." Ex. 2005, 25:2-8; Ex. 1005 at 3 (emphasis added).

However, sedimentation is inapplicable to the '256 Patent, because the '256 Patent does not teach that, in the belly portion of the vessel, any solids are in suspension with the liquid, and instead shows the sand and liquid as completely separated. Ex. 1001, Figs. 2, 4; Ex. 2001 ¶75. Further, Petitioner's expert concedes that the '256 Patent does not anywhere teach sand being in suspension with the liquid in the belly portion of the vessel. Ex. 2005, 13:22-24. Thus, while "sedimentation"

may take place in the chemical and petroleum industries as Davis describes (Petitioner's sole argument regarding field of endeavor, *see* Pet. 34), sedimentation is not taking place in the '256 Patent. Thus Davis, which is directed to "sedimentation," is not in the same field of endeavor as the '256 Patent, where no sedimentation is taking place. Ex. 2001 ¶76.

To the extent Petitioner relies on both Davis and the '256 Patent as both being in the "chemical and petroleum industries" (Pet. 24), or that both relate to "phase separation," such broad categories of the field of endeavor are not enough to establish analogous art. *Wang Laboratories, Inc. v. Toshiba Corp.*, 993 F.2d 858, 864 (Fed. Cir. 1993) ("The Allen–Bradley art is not in the same field of endeavor as the claimed subject matter merely because it relates to memories" where the art and patent were directed to different types of memory.). Here, the '256 Patent and Davis are directed toward two very different types of phase separation. Ex. 2001 ¶76. The '256 Patent teaches slowing down the velocity of a fluid flow in a vessel to allow solids to very quickly fall from that fluid into a liquid. Ex. 2001 ¶23. Conversely, Davis discloses a solid that is in suspension with a liquid, and a method for allowing that solid to very slowly separate from that liquid through sedimentation. Ex. 1005 at 3.

2. Davis is not pertinent to the particular problem of the '256 Patent

Davis does not have any relevance to the two problems addressed by the '256 Patent: increasing the settling efficiency of sand falling from a fluid stream and increasing the cleaning efficiency of a desander. Ex. 1001, 2:22:26; Ex. 2001 ¶¶26, 84; *see supra* Section II. A reference is only "reasonably pertinent" if it "logically would have commended itself to an inventor's attention in considering his problem." *Innovation Toys, LLC v. MGA Entm't, Inc.*, 637 F.3d 1314, 1321 (Fed. Cir. 2011) (citation omitted). Davis does not teach increasing the settling efficiency of sand falling from a fluid stream. Ex. 2001 ¶84. Indeed, the fluid stream in the '256 Patent is both turbulent and consists of gas, while Davis does not include any description of gas and teaches away from turbulent flow. Ex. 2001 ¶¶84-85. Nor does Davis include any description of improving the cleaning efficiency of a vessel.

The Board in its Institution Decision noted that both the '256 Patent and Davis "involve fluid mechanics with similar objectives of efficiently separating out solids in a vessel." Dec. 13. While at the highest level this may be true, the mechanics at play are vastly different. The '256 Patent relies on slowing down the velocity of a fluid stream so that solids will fall out of the fluid by the force of gravity. Ex. 2001 ¶84. By inclining the vessel, the '256 Patent provides a larger freeboard portion, which slows the fluid down more, increasing the settling efficiency. Ex. 2001 ¶¶23-

24; Ex. 1001, 5:17-39. Conversely, Davis does not change the velocity of its liquid, it simply provides more surface area for a solid in suspension to come in contact with, and thus settle on. Ex. 2001 ¶86. In fact, for systems that use vessels to perform phase separation, Davis teaches using additional special-purpose plates to increase sedimentation, not inclining the vessel (which wouldn't work anyways, Ex. 2001 ¶86):

Example of plates for sedimentation in a vessel

Additionally, the Board in its Institution Decision noted that both the '256 Patent and Davis "refer to the orientation of a vessel for improving the separation of solids from a fluid stream." Dec. 12. However, as discussed above, Davis focuses on solids in a suspension with a liquid, and the rates at which those solids settle out of **suspension**, not a fluid stream, which is not present in Davis.

Because the '256 Patent involves a completely different process of separation, Davis is not pertinent to the problem of improving separation efficiency of its desander. Ex. 2001 ¶88.

V. GROUND 2: PETITIONER FAILS TO ESTABLISH THAT THE COMBINATION OF HEMSTOCK AND THE DATA BOOK RENDERS OBVIOUS ANY CHALLENGED CLAIM

A. Overview of the Data Book

The Data Book is the 10th Edition of a general reference manual periodically put out by the Gas Processors Suppliers Association, copyrighted in 1987, and revised in 1994. Ex. 1008 at 2. Petitioner includes two sections of the Data Book in its exhibit 1008: Section 7 directed to "Separators and Filters" and Section 17 directed to "Fluid Flow and Piping." Ex. 1008 at 3, 21.

According to the Data Book, a "separator" is a "vessel used to separate a mixed-phase stream into gas and liquid phases that are 'relatively' free of each other." Ex. 1008 at 3. Section 7 of the Data Book includes design information relating to separator vessels, including horizontal and vertical separators. Ex. 2001 ¶59. This section includes information regarding how to modify the vessels to handle slugs for both horizontal and vertical vessels—with no discussion of inclining the vessel. Ex. 2001 ¶¶59, 64. None of the vessels disclosed in Section 7 of the Data Book are inclined in any way. Ex. 2001 ¶60.

Section 17 of the Data Book is directed to fluid flow in pipelines. Ex. 2001 ¶61. Section 17 also acknowledges a device known as a "slug catcher," which the Data Book defines as "a particular ***separator*** design able to absorb sustained in-flow of large liquid volumes at irregular intervals." Ex. 1008 at 3 (emphasis added); Ex. 2001 ¶63. In other words, slug catchers are designed to "separate a mixed-phase stream into gas and liquid phases that are 'relatively' free of each other," especially when large volumes of liquid (slugs) are present in the mixed-phase flow. Ex. 1008 at 3; Ex. 2001 ¶63. The Data Book discloses that there are two types of slug catchers, pipe-type slug catchers (also called a "harp-type slug catchers") and vessel-type slug catchers. Ex. 1008 at 41-42; Ex. 2001 ¶63. For the vessel-type slug catcher, the Data Book depicts the gas and liquid phases in Figure 17-22. Ex. 1008 at 42. However, the Data Book does not provide information about the liquid and gas phases for the pipe-type slug catcher in Figure 17-21. Ex. 1008 at 41.

B. The Combined Teachings of Hemstock and the Data Book Do Not Disclose the Interface Limitations

As described above in Section III, the Interface Limitations[3] of claims 1 and

[3] "gas/liquid interface formed at the fluid outlet having a belly storage portion formed therebelow" of claim 1, and "establishing a liquid interface in a belly portion of the vessel, the belly portion being formed below the fluid outlet" of claim 9.

9 require a gas/liquid interface that is at, rather than below, the fluid outlet. This gas/liquid interface exists at the boundary between the freeboard portion of the vessel and the belly portion of the vessel. Ex. 2001 ¶¶28-29, 33, 89; Ex. 1001, 4:50-51. Neither Hemstock nor the Data Book teach or suggest the Interface Limitations. Ex. 2001 ¶¶113-115.

Hemstock does not teach the Interface Limitations, because Hemstock discloses a gas/liquid interface that is below the fluid outlet, rather than at the fluid outlet. Ex. 2001 ¶113; Ex. 1004, Fig. 3; Ex. 1001, Fig. 1; Pet. 32 (describing Hemstock as teaching a freeboard portion that "exists both below and above the fluid outlet 13"). Petitioner does not allege that the gas/liquid interface is at the fluid outlet in Hemstock, it only alleges that a gas/liquid interface exists in Hemstock. Pet. 34-35. Moreover, Petitioner's expert concedes that the gas/liquid interface in Hemstock is below the fluid outlet. Ex. 2005, 15:24-16:6. Therefore, Hemstock does not teach the Interface Limitations.

The Data Book also does not teach the Interface Limitations, because the Data Book does not teach a gas/liquid interface in relation to the only embodiment that Petitioner relies on for its obviousness combination: Figure 17-21 and its

accompanying description.[4] Petitioner argues that a POSITA would understand from the description of Figure 17-21 that such slug catchers "necessarily have a gas/liquid interface, which is formed at the vapor outlet and extends horizontally from the vapor outlet." Pet. 35. But this assertion is contradicted by Petitioner's own expert. Petitioner's expert describes three different "modes of operation" for the Figure 17-21 slug catcher (descriptions that are not based on any disclosure in the Data Book): (1) liquid starved, where the gas/liquid interface is below the vapor outlet; (2) steady state, where the gas/liquid interface is at the vapor outlet; and (3) liquid flooded, where the gas/liquid interface is above the vapor outlet. Ex. 1002 ¶104. Thus, according to Petitioner's expert, the gas/liquid interface is not "necessarily" at the vapor outlet, because in modes (1) and (3), the gas/liquid interface is above and below the vapor outlet, respectively. Moreover, Petitioner's expert testified that during normal operation, the slug catcher is designed to have a

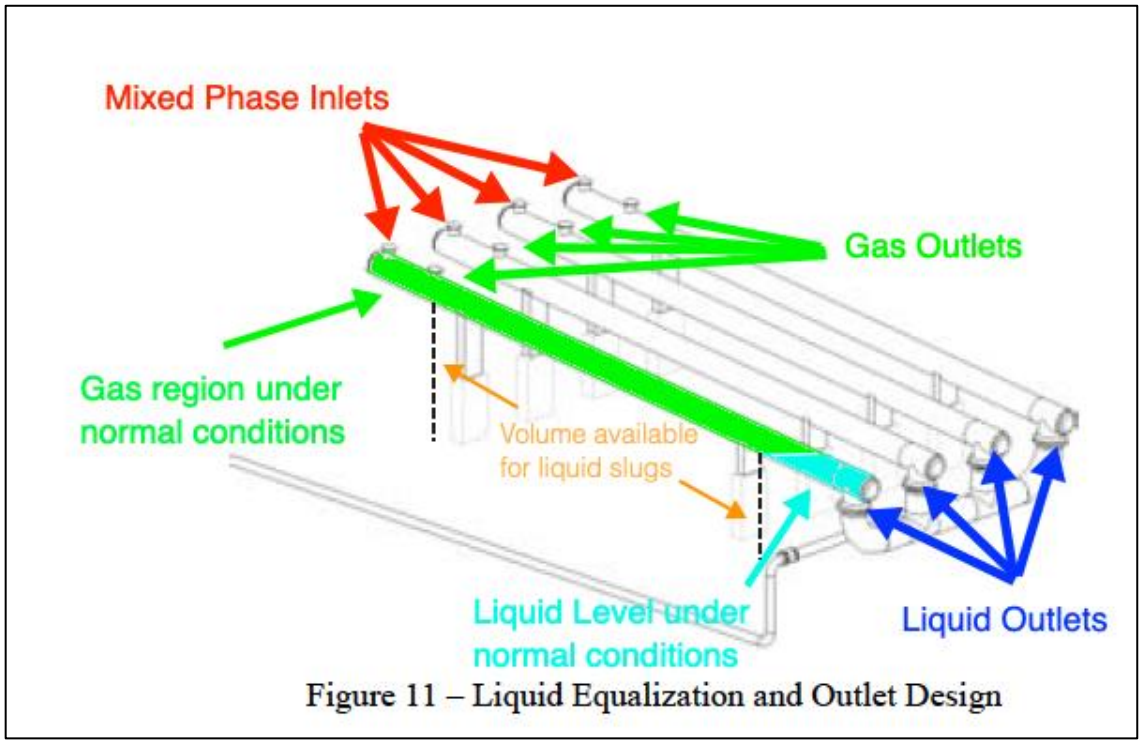
[4] Petitioner's obviousness theory relies solely on a POSITA inclining the Hemstock desander (Pet. 49-51). As Petitioner's expert admits, the only disclosure of an inclined vessel in the Data Book is the pipe-type slug catcher of Figure 17-21. Ex. 2005, 49:12-22; Ex. 1005 at 41. Petitioner does not allege that any other disclosure in the Data Book would motivate a POSITA to incline Hemstock. Pet. 49-51.

gas/liquid interface that is below the vapor outlet. Ex. 2005, 48:24-49:7 (testifying that when a slug catcher is working as intended, the only time liquid is above not below the outlet is during a slug). Thus, by the admissions of Petitioner's own expert, the Data Book does not disclose a slug catcher which ***necessarily*** has a gas/liquid interface at the vapor outlet.

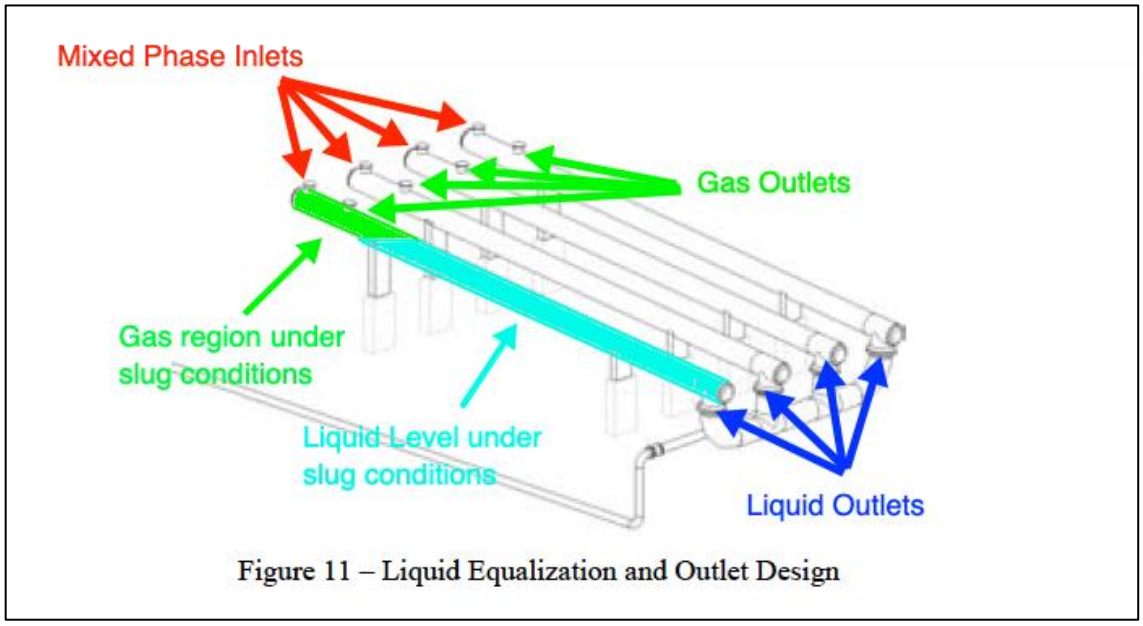
Worse yet, Mr. Simpson's testimony about his "modes of operation" is inconsistent with what a POSITA would have understood from the disclosures in the Data Book at the time of the invention. Ex. 2001 ¶¶108-112. The 12th Edition of the Data Book, dated 2004,[5] indicates that a paper by Rhinesmith provides design details of slug catchers. Ex. 2001 ¶109; Ex. 2003 at 20; Ex. 2004. Rhinesmith teaches that a slug catcher should have sufficient volume beyond its vapor outlet such that it can contain the entirety of the liquid of an anticipated slug. Ex. 2001 ¶110. This design allows a slug catcher to "catch" a slug of liquid, but continue to send liquid-free vapor out of the vapor outlet. Ex. 2001 ¶110. Indeed, the Data Book calls a slug catcher a "separator," which it defines as separating liquid and gas such that each is free of the other. Ex. 1008 at 3. To a POSITA, this indicates that

[5] 8 years prior to the priority date of the '256 Patent; 9 years after Petitioner's version of the Data Book.

the slug catchers described by the Data Book operate in a manner such that the gas/liquid interface is ***always below*** the vapor outlet—i.e., they always allow liquid-free gas to flow out of the vapor outlet. Ex. 2001 ¶110. Annotated images from Rhinesmith depicting the liquid and gas regions before and after a slug event are shown below. Ex. 2001 ¶110.



Rhinesmith Fig. 11 (annotated):
Slug Catcher During "Normal" Operation



Rhinesmith Fig. 11 (annotated):
Slug Catcher During "Slug" Conditions

Petitioner does not provide any reason that either Hemstock or the Data Book teaches that the gas/liquid interface should be at the fluid outlet, especially given that the gas/liquid interface is below the fluid outlet in Hemstock, and a POSITA would understand that the gas/liquid interface is below the fluid outlet in the Data Book as well. Pet. 34-35, 49-51, 51-52. Therefore, none of Hemstock, the Data Book, or the combination of Hemstock and the Data Book teach the Interface Limitations as required by the asserted claims of the '256 Patent. As a result, the Board must find that the asserted claims are not obvious. *See St. Jude Medical, Inc. v. Access Closure, Inc.*, 729 F.3d 1369, 1381 (Fed. Cir. 2013) (affirming finding that claims were nonobvious where neither of the prior art references disclosed a certain

claim limitation, and there is no explanation for why that limitation would be met by the combination of references).

C. The Combined Teachings of Hemstock and the Data Book Lack a Motivation to Combine the References to Arrive at the Claimed Invention

1. Petitioner relies on a non-existent problem

Like with Davis, Petitioner must invent a problem in Hemstock in order to argue that a POSITA would modify Hemstock based on the Data Book. Here, Petitioner improperly relies on "maximizing the device's ability to handle liquid slugs" in Hemstock as the motivating factor to look to disclosures of slug catchers in the Data Book. Pet. 49-51. Petitioner's theory is nonsensical. Hemstock is not a slug catcher, it is a desander, and therefore is not designed to "handle liquid slugs." Ex. 2001 ¶117. Indeed, Hemstock does not disclose any way to "handle liquid slugs," much less maximize the devices ability to handle liquid slugs. Ex. 1004; Ex. 2001 ¶117; Ex. 2005, 18:13-15. Petitioner's sole rationale for wanting to handle liquid slugs in Hemstock is a single disclosure that slugs of fluid are common in the expected multiphase flow of Hemstock. Pet. 50. However, this disclosure in Hemstock describes a problem with ***prior art desanding vessels that rely on filters***, not a problem with Hemstock's vessel. Ex. 1004, 2:1-19; Ex. 2005, 18:2-23; Ex. 2001 ¶118. Specifically, Hemstock discloses that filters in desander vessels often fail due to liquid slugs, and that there is "a need for more versatile and cost-effective

system of particulate handling." Ex. 1004, 2:8-21. There is no dispute that Hemstock does not make use of filters; indeed, the desander vessel in Hemstock was specifically designed to remove solids without the use of a filter. Ex. 2001 ¶118; Ex. 2005, 18:16-23. As Petitioner's expert concedes, Hemstock discloses that its filter-less design can handle the expected multiphase flow, which, as Petitioner argues, includes liquid slugs. Ex. 2005, 82:21-83:10; Ex. 2001 ¶118; Pet. 50. Therefore, it is factually incorrect that a POSITA would have desired to maximize Hemstock's ability to "handle liquid slugs," and Petitioner's motivation to modify theory must fail.

2. A POSITA modifying Hemstock based on the Data Book would not incline the Hemstock vessel

Even if a POSITA were motivated to maximize Hemstock's ability to handle liquid slugs (which he would not), the Data Book would not motivate a POSITA to modify the vessel of Hemstock by inclining it. Ex. 2001 ¶¶119-122. Without inclining the vessel of Hemstock, it is undisputed that the claims of the '256 Patent are not obvious. Pet. 48. It is also undisputed that Hemstock discloses a pressure vessel, not a pipe. Pet. 31 ("Hemstock discloses a cylindrical pressure vessel"); Ex. 2001 ¶121. It is further undisputed that the Data Book includes two separate sections, Section 7 dealing with pressure vessel separators, and Section 17 dealing with fluid flow in pipes. Pet. 28 ("[Section 7 of the Data Book] discusses the various

parts and types of separator vessels, including horizontal pressure vessels (such as those discussed in Hemstock."), *id.* ("Section 17 of the Data Book relates to fluid flow and piping"); Ex. 2001 ¶121. Therefore, a POSITA who wanted to learn how to handle liquid slugs in a horizontal vessel like Hemstock would look to Section 7 of the Data Book, not Section 17. Ex. 2001 ¶119.

Section 7 of the Data Book discloses increasing slug capacity of a horizontal pressure vessel like Hemstock "through shortened retention time and increased liquid level." Ex. 1008 at 7; Ex. 2001 ¶119. Section 7 of the Data Book does not teach to increase slug capacity in any type of vessel through inclining the vessel. Ex. 2001 ¶119. Indeed, Section 7 of the Data Book does not teach that a pressure vessel of any kind should be inclined for any reason. Ex. 2001 ¶60; Ex. 2005, 49:19-22. Thus a POSITA, seeking to increase the slug capacity of a horizontal pressure vessel like Hemstock, relying on the teaching of the Data Book, would not incline the vessel, it would shorten retention time and/or increase the liquid level. Ex. 2001 ¶119. Therefore, a POSITA would not be motivated to combine Hemstock and the Data Book to arrive at the claimed invention.

Further, even if a POSITA were motivated to maximize Hemstock's ability to handle liquid slugs (which he would not be), and even if a POSITA were to ignore the teachings of Section 7 related to pressure vessels and instead turn to Section 17 related to fluid flow and piping (which he would not), the Data Book still would not

motivate a POSITA to incline the vessel of Hemstock. Ex. 2001 ¶¶121-122. Section 17 of the Data Book teaches two types of slug catchers, a pipe-type slug catcher and a vessel-type slug catcher. Ex. 1008 at 41; Ex. 2001 ¶121. Given that Hemstock is a vessel, and not a pipe, a POSITA would, at best, apply the vessel-type slug catcher to Hemstock, and not the pipe-type slug catcher. Ex. 2001 ¶122. As Petitioner's expert concedes, the vessel-type slug catcher is not inclined. Ex. 2005, 49:12-18; Ex. 2001 ¶63. Instead, it places a vessel under the gas flow, so that the liquid slugs can drain to the bottom while the gas stays on the top. Ex. 2001 ¶122; Ex. 1008 at 41-42. Indeed, as Petitioner's expert also concedes, the Data Book does not disclose a single pressure vessel in any Section that is inclined. Ex. 2005, 49:12-18; Ex. 2001 ¶121. Thus a POSITA, seeking to increase the slug capacity of a pressure vessel like Hemstock based on Section 17 of the Data Book would, at best, be motivated to attach a second vessel to collect liquid, not incline the vessel. Therefore, a POSITA would not be motivated to combine Hemstock and the Data Book to derive the claimed invention.

Finally, even if a POSITA were motivated to maximize Hemstock's ability to handle liquid slugs (which he would not), and even if a POSITA were to ignore both Section 7 and Section 17 of the Data Book's teaching for how to improve the slug capacity of a pressure vessel like Hemstock (which he would not), a POSITA would understand that the pipe-type slug catcher of Figure 17-21 teaches a gas/liquid

interface that is well below the gas outlet. Ex. 2001 ¶¶122-125. This lower level gas/liquid interface is necessary for a pipe-type slug catcher to be able to handle slugs, because it provides a buffer volume for extra liquid to be stored while still allowing gas to exit the gas outlet free of liquid. Ex. 2001 ¶¶108-112, 124; Ex. 1008 at 3, 41. Hemstock, on the other hand, teaches that it is not a "separator" of gas and liquid, as "separator" is defined by the Data Book, because both gas and liquid are designed to exit the fluid outlet. Ex. 2001 ¶125; Ex. 1008 at 3; Ex. 1004, 4:55-59; Pet. 48 ("explaining that liquids are re-entrained with the gas leaving the vessel during typical operation") (citing Hemstock). Thus a POSITA would understand that the principles of slug catching at play in the pipe-type slug catcher would not be applicable to the vessel of Hemstock. Ex. 2001 ¶123. Additionally, even if a POSITA were to incline Hemstock based on this teaching (which he would not), he would be motivated to set the gas/liquid well below the fluid outlet to provide a buffer volume to catch slugs, as a POSITA would understand is taught by the Data Book. Ex. 2001 ¶126. Therefore, a POSITA would not be motivated to incline the horizontal vessel of Hemstock based on the teachings of the Data Book to arrive at the claims of the '256 Patent.

VI. GROUNDS 3 AND 4: THE PETITION FAILS TO ESTABLISH THAT HEMSTOCK, MILLER AND EITHER DAVIS OR THE DATA BOOK RENDER OBVIOUS ANY CHALLENGED CLAIM

In Ground 3, Petitioner alleges that claims 8, 12, 14 and 15 are obvious over Hemstock, Miller and Davis. Pet. 3. In Ground 4, Petitioner alleges that claims 14 and 15 are obvious over Hemstock, Miller and the Data Book. Pet. 3. Claims 8, 12, 14 and 15 all depend, either directly, or indirectly, from claim 1. Ex. 1001, 7:46-9:10. Because Petitioner does not apply Miller in any way to cure the deficiencies of either the combination of Hemstock and Davis or Hemstock and the Data Book, Petitioner fails on Ground 3 with respect to all challenged claims for the same reasons as Ground 1, and on Ground 4 with respect to all challenged claims for the same reasons as Ground 2. *See supra* Sections V, VI; Ex. 2001 ¶127.

A. Overview of Miller

Miller is a 97-year-old patent that does not relate to separating solids from a fluid flow. Instead, Miller teaches how to remove the heaviest solids from a flow, while allowing mud to remain in the fluid. Ex. 2001 ¶68. Miller does not relate to fluid flow from a wellhead; rather, Miller relates to mud-laden water used to clean drill bits at a drill site. Ex. 2001 ¶68. Miller does not disclose anything about gas, and therefore does not include a gas/liquid interface. Ex. 1007. The inlet of Miller is towards the bottom of an inclined vessel, with the heavy solids to be removed from the flow sinking further to an outlet pipe at the bottom of the vessel, and the

mud-laden liquid travelling in the opposite direction up the inclined vessel. Ex. 2001 ¶¶68-70.

B. Miller Does Not Disclose the Limitations of Claims 14 or 15

Claim 14 of the '256 Patent requires "said vessel has a smaller diameter downstream of the fluid outlet." Ex. 1001, 9:6-8. Likewise, claim 15 depends from claim 14, and therefore also requires this limitation. Ex. 1001, 9:9-10. Petitioner does not allege that any reference discloses this limitation other than Miller. Pet. 46. In Miller, Petitioner points only to outlet pipe 8. Pet. 46. As Petitioner's expert admits, outlet pipe 8 is not "downstream of the fluid outlet." Ex. 2005, 62:10-63:24. Instead, outlet pipe 8 is to the right of the inlet of the Miller device, while the fluid outlet 13 is to the left of the inlet. Ex. 2005, 64:10-19; Ex. 2001 ¶128. Therefore, Miller does not disclose this limitation, and the combination of either Miller, Hemstock and Davis, or Miller, Hemstock, and the Data Book does not teach this limitation. Ex. 2001 ¶128.

Further, Petitioner argues that a disclosure of a pipe as an outlet meets the claim limitation "said vessel has a smaller diameter." Pet. 46. Petitioner cites no evidence that an outlet pipe can be considered part of a pressure vessel in the context of the '256 Patent. Pet. 46. Further, a POSITA would not understand an outlet pipe to be disclosure of a smaller diameter portion of a pressure vessel. Ex. 2001 ¶129.

Therefore, Miller does not provide any motivation to modify Hemstock, Davis or the Data Book to incline a vessel that includes a smaller diameter downstream of the fluid outlet.

VII. CONCLUSION

For the foregoing reasons, the Board should find that Petitioner fails to establish the unpatentability of any challenged claim.

Respectfully submitted,

Date: May 22, 2019

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CERTIFICATION UNDER 37 C.F.R. §42.24

The undersigned certifies that the foregoing **PATENT OWNER'S RESPONSE TO PETITION FOR *INTER PARTES* REVIEW** complies with the type-volume limitation in 37 C.F.R. § 42.24(b)(1). According to the word-processing system's word count, the brief contains 11,814 words, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a).

Date: May 22, 2019

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CERTIFICATE OF SERVICE

I hereby certify that on May 22, 2019, a copy of the foregoing:

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