United States Court of Appeals for the Federal Circuit

05-1105, -1325, -1366, -1399

LIQUID DYNAMICS CORPORATION,

Plaintiff-Appellee,

v.

VAUGHAN COMPANY, INC.,

Defendant-Appellant.

Steven C. Schroer, Fitch, Even, Tabin & Flannery, of Chicago, Illinois, argue for plaintiff-appellee. With him on the brief were Mark W. Hetzler and Jon A. Birmingham.

Robert J. Carlson, Christensen O'Connor Johnson Kindness PLLC, of Seattle, Washington, argued for defendant-appellant. With him on the brief was Mark P. Walters. Of counsel was Ward Brown.

Appealed from: United States District Court for the Northern District of Illinois

Senior Judge Suzanne B. Conlon

United States Court of Appeals for the Federal Circuit

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LIQUID DYNAMICS CORPORATION,

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Defendant-Appellant.

DECIDED: June 1, 2006

Before GAJARSA, DYK, and PROST, Circuit Judges.

GAJARSA, Circuit Judge.

This is the second time we have heard an appeal in this case. In the previous appeal, Liquid Dynamics ("LD") contested the claim construction and summary judgment of non-infringement entered against it. Liquid Dynamics Corp. v. Vaughan Co., 355 F.3d 1361 (Fed. Cir. 2004) ("LD I"). In that decision, we found error in the

district court's claim construction, vacated the grant of summary judgment, and remanded for proceedings based on the revised claim construction. Id.

On remand, the district court held a six-day jury trial to determine whether Vaughan Company, Inc. ("Vaughan") infringed claims 1 and 8 of U.S. Patent No. 5,458,414 ("the '414 patent") and whether the '414 patent was valid. On October 25, 2004, the jury returned a verdict that Vaughan had infringed the '414 patent, that the infringement was willful, and that Vaughan failed to prove that the '414 patent was invalid. The jury awarded damages to LD in the amount of $1,183,722.

Subsequently, the district court held a bench trial on Vaughan's allegation of inequitable conduct, but granted LD's motion for judgment as a matter of law on that issue at the close of evidence. Final judgment was entered on November 15, 2004, and the district court subsequently denied Vaughan's judgment-as-a-matter-of-law ("JMOL") and new-trial motions on the issues of invalidity, infringement, and willfulness. Thereafter, the district court granted, in part, LD's motions for enhanced damages and attorney's fees. The court trebled the jury's damage award based upon the jury's willfulness finding and "Vaughan's behavior as a litigant." Separately, the court awarded attorney's fees amounting to $1,501,239. The court also entered a permanent injunction on February 25, 2005.

Vaughan now appeals the district court's denial of its JMOL motion for non-infringement, invalidity, no willful infringement, and unenforceability due to inequitable conduct. Further, Vaughan appeals the district court's orders for a permanent injunction, enhanced damages, and attorney's fees. For the reasons stated below, we affirm the judgment of the district court.

I. BACKGROUND

The '414 patent involves a system of pumps that stir mixtures of solids and liquids in large 1,000,000-gallon tanks. The invention is primarily directed to applications for mixing wastewater and manure. Because we have already detailed the invention and its background in LD I, we reproduce only a summary of the relevant facts below:

> This case involves the structure of slurry tanks. Slurry tanks are used to store and process chemicals and organic waste products (e.g., manure) that retain value as useful inputs (e.g., fertilizer) into other processes. Large storage tanks house these waste compounds in liquid or semisolid form between their production and their subsequent use. The liquid and solid components of these waste compounds tend to separate when stored, with solid particles either forming a crust on the top of the tank and/or falling to the bottom of the tank. Productive use of the stored compound requires remixing both to suspend the heavy solid particles within the liquid and to ensure that the resulting suspension is uniform. One standard approach has been to stir the mix continuously to avoid settling. Because continuous mixing can be expensive, however, tank designers sought ways to store the mixtures in a still tank, to allow the settling to occur, and to remix only when necessary for use. The '414 patent addressed these concerns.

LD I, 355 F.3d at 1363.

A. The '414 Patent

Claims 1 and 8 are the contested claims in this case. The patent recites a method and apparatus for handling wastewater slurries: a storage tank equipped with submerged agitators capable of generating a flow of liquid throughout the tank. With the relevant language underlined, claim 1 reads:

> 1. Apparatus for storing a slurry having solid and liquid components, comprising:
>
> a storage tank defining a volume for holding a body of liquid and solid slurry components, including a floor of generally circular configuration and having a center, said storage tank further including an

outer surrounding wall positioned generally at a radial distance from the center;

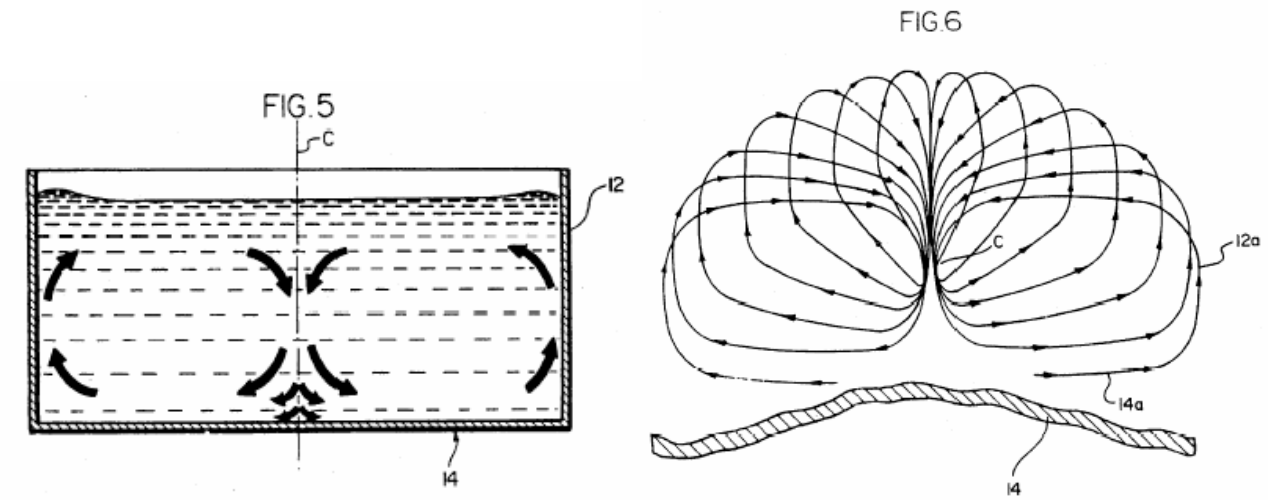
at least two flow generating means positioned to be submerged within the liquid and solid slurry components for generating flow of at least one of the slurry components along a rotational direction, each of said flow generating means being disposed at distances from the center ranging between approximately 30 percent and 70 percent of said radial distance;

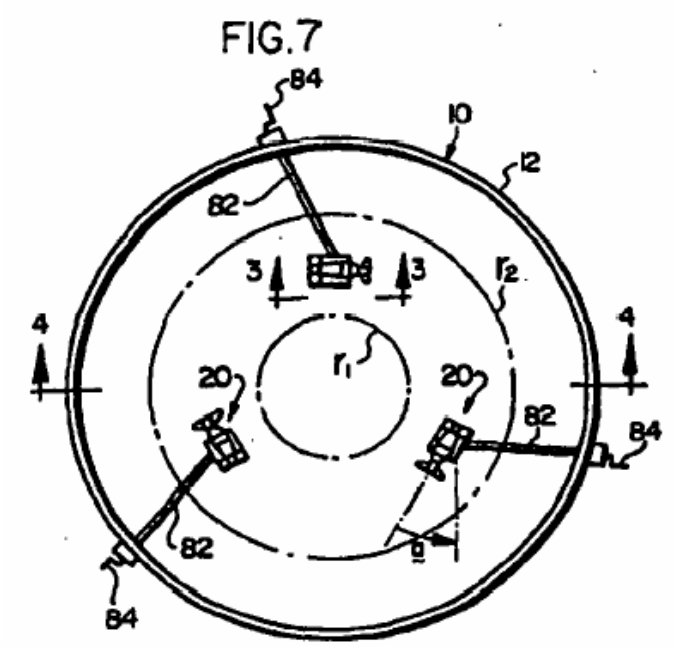
each of said first and second flow generating means being pointed toward the outer surrounding wall for generating a substantial helical flow path of the liquid and solid components therein with the liquid and solid components traveling outwardly, across the tank floor from the center portion of the tank toward the tank wall and then upwardly along the tank outer surrounding wall to a first point and then inwardly along an upper portion of the body toward the center of the tank and then downwardly toward the tank floor, and then outwardly to a second point spaced circumferentially in the direction of rotation of the entire body of liquid, the liquid and solid components continuing to travel in the helical path as the entire body of liquid and solid components continues to rotate;

a pressure source coupled to the first and second flow generating means to generate directed streams from the flow generating means to rotate the body of liquid and solid components and to cause the flow in the helical path; and

said flow generating means creating a substantially volume filling flow of at least one of the slurry components within said storage tank which mixes the liquid and solid slurry components to form a substantially homogeneous slurry suitable for unloading from said storage tank using liquid handling devices.

'414 Patent, col. 8, l. 56 – col. 9, l. 39 (emphases added). In LD I, we construed the term "substantial helical flow" to be "all flow patterns that are generally, though not necessarily perfectly, spiral, and that fill much, though not necessarily all, of the tank's volume." LD I, 355 F.3d at 1369. Claim 8 includes the relevant terms from claim 1. The written description includes the following examples of tank arrangement and helical flow path.





In Figure 7, impellers or pumps 20 that are placed within the claimed radii of r_1 and r_2 create the substantial helical flow as shown in Figures 5 and 6.

B. Prior Art and Pre-filing Activities

The inventors named in the '414 patent, James M. Crump and Bruce K. Doyle, Jr., were dealers for the A.O. Smith Corporation ("A.O. Smith") and sold A.O. Smith's tank agitation system containing a single, center-mounted, rotatable agitator nozzle, known as the Slurrystore system. According to Crump, in 1990 the inventors first

became involved with the Slurrystore system when A.O. Smith asked them to help move a tank from a farm to a wastewater treatment plant in Plymouth, Indiana.

Commonwealth Engineering, Plymouth's engineering firm, redesigned the tank for use in the wastewater plant by moving the original agitator away from the tank center and adding a second agitator that was placed on the same radial line on the same side of the tank. The first and second agitators were placed at a distance of approximately 25 and 75 percent respectively, from the tank's center to the wall. The nozzles were designed to rotate in position so that the workers could agitate different sections and clean out the tank when needed. According to Crump, this new design did not help the mixing because the tank slurry was still only agitated in zones and not throughout the whole tank. At startup, the Plymouth tank did not operate properly until flow reducers were installed on the nozzles to impart more energy into the liquid volume. LD presented a video tape made in January of 1992 showing that flow occurred in only one section of the Plymouth tank and not the entire tank.

In the summer and fall of 1991, Crump and Doyle designed and sold the next relevant tank system to a hog processing plant called Indiana Packers. LD claims the Indiana Packers tank was the same as the Plymouth tank and did not embody the invention claimed by the '414 patent. Crump's diagrams and testimony suggest that the Indiana Packers tank was similar in layout to Plymouth and, like Plymouth, only mixed the liquid in zones.

In April of 1991, the inventors submitted a proposal to A.O. Smith asking that a patent application be filed for their invention for zone mixing within the Indiana Packers and Plymouth tanks. A.O. Smith declined to develop the proposal because it appeared

that the invention, as described, was not patentable. Crump testified that in February of 1992, he and Doyle began to develop the idea for mixing throughout the entire tank volume instead of just mixing in one zone at a time, as the Plymouth and Indiana Packers designs provided. The '414 patent, incorporating the concept of volume-filling flow, was filed on May 7, 1992. Although the original application did not claim a substantially helical flow path, it was later amended to claim such a flow path.

Crump further testified that on May 20, 1991 he offered to sell another system for antibiotic industrial waste to Eli Lilly just after the critical date. According to Crump, the Eli Lilly system was not only offered after the critical date, its nozzle placement was not even within the limitations of the patent. At the time the patent was filed, the Plymouth, Indiana Packers, and Eli Lilly tanks had been installed.

C. Infringement Evidence

1. Vaughan's Business History

Vaughan designs and manufactures "chopper pumps," which are used to mix solid materials in large tanks. It claims to have supplied LD with pumps for many years. Vaughan also claims that it was in the business of large-tank mixing designs, decades before the '414 patent, with its roof-mounted chopper pump design called "Scumbuster."

Vaughan and LD's relationship soured when Vaughan began manufacturing floor mounted systems and bid on a tank for the city of Augusta, Georgia. LD claims to have been negotiating with Augusta in late 1999 to supply Augusta with its Jetmix system, the commercial product covered by the '414 patent. In December of 1999, LD terminated Richard Behnke, a sales engineer who had been "intimately involved" with the Augusta design and negotiations. Soon thereafter, Behnke was hired by Vaughan and submitted

engineering drawings for nozzle layouts to Augusta, which Vaughan presented as its Rotamix System. LD claims these drawings were directly copied by Behnke from LD's previous engineering drawings. LD also includes statements from Glenn Dorsch, Vaughan's Chief Engineer and Vice President, stating:

> What is planned and requested is for us to remove the [LD] JetMix nozzles from the drawings and put in our own floor mounts. . . . This should be very easy for Wade to do, once we get final orientations from Rich Behnke.

Vaughan notes that even though the nozzles were located in the same place, they constituted a special dual-nozzle design. Thus, whereas the LD Jetmix design had six nozzles, Vaughan's design had twelve.

2. Vaughan's Business Records as Infringement Evidence.

LD confronted Vaughan with allegations of infringement of the '414 patent, and in June of 2000, Vaughan consulted with patent counsel to evaluate the '414 patent and Vaughan's potentially infringing Rotamix design. At about the same time, Vaughan commissioned AEA Technology to perform two different computational fluid dynamics ("CFD") studies to analyze the flow patterns in its tanks. The first study, labeled PX20, evaluated a generic 50-foot-diameter tank that was 30-feet high. The second, labeled PX19, was a study conducted for a proposed tank at Merced, California that demonstrated the tank's mixing capabilities to the city's engineer. Dorsch testified that these studies were representative of the flow patterns generated by Vaughan's Rotamix systems.

Vaughan provided patent counsel with these studies to assist in forming an opinion relative to infringement. Based on the CFD studies and the tank designs, patent

counsel rendered an opinion for Vaughan concluding that its Rotamix design did not infringe the '414 patent because it did not produce substantially helical flow.

LD relies on Vaughan's CFD studies as evidence of both infringement and willfulness. The report not only shows toroidial[1] flow in the vertical plane with downward velocity in the center of the tank and upward velocity at the walls of the tank, but it also indicates there was a "concern over terrodial [sic] flow." Moreover, as LD notes, the author of the PX20 report explained that "the momentum from the nozzles pushes the fluid to the side walls of the tank" and "then changes direction and heads up the side walls." LD's own expert, Lueptow, relied on these same vertical vector plots to express a similar opinion that Vaughan's tanks generate helical flow.

3. Structure Evidence

Next, LD relies on testimony regarding the structure of Vaughan's designs and their similarity to the '414 patent claims. Dorsch, Vaughan's chief engineer and its technical expert at trial, testified that the Vaughan engineering manual included specifications and drawings showing Vaughan's regular method of installation. Vaughan did not keep accurate records of each of the 47 allegedly infringing installations. LD's technical expert Gillette, a wastewater treatment engineer, reviewed the engineering records for all of the accused systems, prepared a report establishing the parameters of each installation, and testified regarding the systems and any missing installation data.

[1] Webster's defines "toroidal" as "of, relating to, or shaped like a torus or toroid: doughnut-shaped." Webster's Ninth New Collegiate Dictionary 1245 (1985). The meaning of torodial is similar, if not identical, to helical flow for our purposes.

Vaughan correctly points out that Gillette's report lacks nozzle placement and/or nozzle angle data for 11 of the 47 systems. However, Dorsch testified that if records on construction were missing it would be reasonable to assume that the installation was in accordance with the standard procedure described in Vaughan's engineering manual.

4. LD's CFD Analysis

LD contends that 47 Vaughan installations infringe the '414 patent. Since some installations are duplicates, there are 34 unique tank designs. Of these, Vaughan argues that there is insufficient evidence to prove that two contested claim elements are present in the accused tanks, namely "substantial helical flow" and "rotation of the entire body." In addition to Vaughan's business records and its own CFD analysis, LD relies heavily on Lueptow's expert opinion. His opinion concludes that each of the 47 installments infringe by recreating the substantially helical flow path. LD supports Lueptow's conclusions with the following evidence in the record: (1) Vaughan's two CFD studies for the generic 50-foot and Merced tanks; (2) LD's prelitigation CFD study modeling the Merced tank; (3) observation of a tank in Argos, Indiana; and (4) Lueptow's own CFD analysis of nine tank configurations representative of various Vaughan installations.

Lueptow performed his own CFD analysis of the Vaughan systems using the same software Vaughan had used in its own CFD studies; however, he did not recreate each of the 47 tanks at issue in this case because CFDs are very time intensive. Instead, he modeled the flows in nine representative tanks with various tank sizes and nozzle configurations depending on different Vaughan designs. Lueptow based these models on the Vaughan Engineering Manual and Gillette's testimony. Gillette had

testified that there was information missing in the record detailing some tank characteristics but that he nonetheless had sufficient information to summarize the tank characteristics for flow modeling.

Lueptow's CFD work resulted in 116 different graphical plots consisting of path-line and vector plots. The vector plots detailed the overall flow path and magnitude in the horizontal and vertical planes. The path-line plots estimated the path an individual particle travels within the tank. Lueptow concluded that the Vaughan systems were very robust and would produce the helical flow despite small changes to each tank. He opined that his representative systems and tanks allowed him to render an opinion on all 47 tanks. This opinion, based on the nine CFD models Lueptow created, the Vaughan data from Merced and a generic 50-foot tank, and LD's Merced Model, was that infringing helical and volume-filling flow is present in all 47 models.

During trial, Vaughan challenged Lueptow's analysis maintaining that the plots simulated conditions just mere seconds after pump startup and that this could not be sufficient evidence of helical and rotational flow during steady-state flow. Lueptow, however, testified that his models were sufficient to determine that helical and rotational flow existed despite the fact that only 40 to 50 iterations were performed.

II. DISCUSSION

A. Standard of Review

We review the denial of a JMOL de novo. Juicy Whip, Inc. v. Orange Bang, Inc., 292 F.3d 728, 736 (Fed. Cir. 2002). Upon review, we consider whether the jury verdict is supported by substantial evidence. Id. In other words, we ask whether the record taken as a whole would support the verdict in the mind of a reasonable person. Id. It is

not our duty, however, to reevaluate the weight or credibility of the evidence. Comark Commc'ns, Inc. v. Harris Corp., 156 F.3d 1182, 1192 (Fed. Cir. 1998).

Evidentiary rulings by the district court are reviewed under regional circuit law. Advanced Cardiovascular Sys., Inc. v. Medtronic, Inc., 265 F.3d 1294, 1308 (Fed. Cir. 2001). Thus, we review decisions to admit expert testimony for abuse of discretion under Seventh Circuit law. Kumho Tire Co. v. Carmichael, 526 U.S. 137, 152 (1999); United States v. Allen, 390 F.3d 944, 949 (7th Cir. 2004).

Inequitable conduct pertains to and arises under the patent laws; we therefore review it pursuant to Federal Circuit law. In re Spalding Sports Worldwide, Inc., 203 F.3d 800, 803-04 (Fed. Cir. 2000). We review an inequitable conduct determination under an abuse of discretion standard and the underlying factual issues of materiality and intent for clear error. Bristol-Myers Squibb Co. v. Rhone-Poulenc Rorer, Inc., 326 F.3d 1226, 1234 (Fed. Cir. 2003).

B. Infringement Evidence

Vaughan's first alleged error is that LD presented insufficient evidence that each of the 47 accused installations infringed. First, it explains that LD did not present sufficient evidence that 11 of the 47 installations met the required nozzle placement and nozzle angle limitations required by claims 1 and 8. Second, Vaughan argues that LD's computer simulations presented at trial were inaccurate and therefore did not provide evidence of infringement. Third, Vaughan contends that there is no evidence Vaughan knew or intended that 11 of its systems, which are located outside the United States, indirectly infringe.

1. Tank Structure Limitations

The ‘414 patent requires that the tank nozzles be placed within 25 to 75 percent of the tank’s annular radius and that the nozzle angle be sufficient to “generate flows . . . [that] impart a rotational movement of the entire body of liquid.” ‘414 patent, col. 9, ll. 4-12. Vaughan explains that the structural data compiled by Gillette do not provide nozzle angles for 11 installations and do not provide radial distances and relative nozzle placements for 8 of those 11 installations. Further, it points out that Dorsch testified to his knowledge of four installations with nozzles located outside the annular regions claimed by the patent.

LD agrees that 11 of the tanks had some missing structural information; however, it submits Dorsch’s testimony stating that even where there is missing information, one could generally reconstruct a tank using the specification in the Vaughan engineering manual. Moreover, it contends that the Vaughan engineering manual shows nozzle placement within the claim limitations and that one drawing is almost an exact duplicate of the Augusta installation.

Our task on appeal is to determine whether the jury could reasonably have inferred from the engineering manual and Dorsch’s testimony that 11 installations infringe even though some structural data is missing from Vaughan’s records. LD argues this was a reasonable weighing of the evidence that is exclusively within the province of the jury. We agree.

A patentee may prove direct infringement or inducement of infringement by either direct or circumstantial evidence. Moleculon Research Corp. v. CBS, Inc., 793 F.2d 1261, 1272 (Fed. Cir. 1986). There is no requirement that direct evidence be

introduced, nor is a jury's preference for circumstantial evidence over direct evidence unreasonable per se. See Fuji Photo Film Co. v. Jazz Photo Corp., 394 F.3d 1368, 1374 (Fed. Cir. 2005); Moleculon Research, 793 F.2d at 1272 (noting "it is hornbook law that direct evidence of a fact is not necessary"); see also Michalic v. Cleveland Tankers, Inc., 364 U.S. 325, 330 (1960) ("Circumstantial evidence is not only sufficient, but may also be more certain, satisfying and persuasive than direct evidence."). Though Dorsch testified that four tanks were outside the scope of the patent claims, the jury could reasonably have discredited that evidence and given more weight to the circumstantial evidence of the Vaughan engineering manual, which was created before litigation began. Similarly, the jury could reasonably rely on the engineering manual and complete records for the remaining Vaughan designs to infer that the missing information on 11 tanks also had infringing structural components.

Both parties argue that the other should have submitted additional evidence regarding the tank parameters. Though it is LD's burden to prove infringement, it chose to rely on circumstantial evidence for some installations. While direct evidence may have made LD's case of infringement stronger, it does not render the case presented to the jury unreasonable as a matter of law. Indeed, the jury could have reasonably inferred from the evidence submitted that each of the tanks infringed the claims. Thus, we hold that there is substantial evidence that all 47 accused tanks met the structural limitations of the '414 patent.

2. Computer Simulations

Next, Vaughan challenges the computer simulations used to establish the helical- and rotational-flow claim limitations. Vaughan maintains that Lueptow's simulations

were insufficient for two reasons: (1) because the parameters used to run the nine different modeled simulations were inaccurate and (2) because the simulations do not show the required helical flow and general body rotation.

a. Lueptow's Model Parameters

First, Vaughan argues that the modeling parameters were inaccurate. It notes specifically that the simulated Tank A and Tank G groupings in Lueptow's CFDs did not match or approximate many of the known tank parameters such as the height, flow rate, and nozzle diameter. Lueptow admitted that these parameters did not match the real-world parameters as Vaughan points out, but he also testified that the changes in the nozzle design would do little to disrupt the robust helical flow in the tanks. Furthermore, Lueptow performed a simulation of the Tank D parameters with different nozzle spacing and concluded that even though the parameters changed and some aspects of the flow changed, the helical flow was still present.

Vaughan appears to challenge the admissibility and reliability of Lueptow's expert scientific analysis and opinion. LD argues that our previous opinion reversing the district court's grant of summary judgment based on the genuine issue of material fact presented by the vector plots makes the evidence admissible under the law-of-the-case doctrine. Our previous opinion, LD I, did not directly consider the admissibility of the evidence, only that such evidence would be sufficient to create a genuine issue of material fact for trial. 355 F.3d at 1371. Issues not decided by the court in a prior proceeding are not covered by the law-of-the-case doctrine. Stearns v. Beckman Instruments, Inc., 737 F.2d 1565, 1568 (Fed. Cir. 1984). Therefore, the admissibility of Lueptow's testimony had not been previously resolved.

Vaughan's challenges to expert testimony and scientific evidence are analyzed under the Supreme Court's Daubert factors. See Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 589 (1993). When faced with expert scientific testimony, a district court must first determine "whether the expert is proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact at issue." Id. at 592. This requires an assessment of the reasoning and methodology underlying the testimony to determine whether it is scientifically valid. Id. In Daubert, the Supreme Court set forth four factors for district courts to consider when evaluating the validity and relevance of scientific evidence pursuant to Rule 702 of the Federal Rules of Evidence. Id. at 592-93. These factors include (1) whether the methodology can and has been tested, (2) whether the methodology is subject to peer review, (3) the potential rate of error, and (4) the general acceptance of the methodology. Id. at 593-94. The court further noted that the focus of a court's inquiry into the relevance and reliability of scientific evidence "must be solely on principles and methodology, not on the conclusions that they generate." Id. at 595.

Here, Vaughan's argument focuses on the parameters Lueptow applied, not on the reliability of CFD analysis in general. Indeed, CFD analysis has been previously recognized in the scientific community and has been recognized as reliable by at least one circuit. See Quiet Tech. DC-8, Inc. v. Hurel-Dubois UK Ltd., 326 F.3d 1333, 1343-44 (11th Cir. 2003). In Quiet Tech., the appellant challenged the credibility of CFD analysis for modeling aerodynamic properties in a jet engine. Id. at 1344. The appellant argued that the expert used incorrect data or was missing data to run the CFD software and used the wrong equations to run his CFD analysis of the engine's

aerodynamic properties. Id. Such a flawed analysis, it argued, made the testimony and evidence unreliable. Id. at 1344-45. The court held that such an attack goes more to the weight of the evidence than to its admissibility. "The identification of such flaws in generally reliable scientific evidence is precisely the role of cross-examination." Id. at 1345; see also In re TMI Litig., 193 F.3d 613, 692 (3d Cir. 1999) ("'So long as the expert's testimony rests upon "good grounds," it should be tested by the adversary process—competing expert testimony and active cross-examination—rather than excluded from jurors['] scrutiny for fear that they will not grasp its complexities or satisfactory [sic] weigh its inadequacies.'" (quoting Ruiz-Troche v. Pepsi Cola of Puerto Rico Bottling Co., 161 F.3d 77, 85 (1st Cir. 1998))); Wilmington v. J.I. Case Co., 793 F.2d 909, 920 (8th Cir. 1986) ("Virtually all the inadequacies in the expert's testimony urged here by [the defendant] were brought out forcefully at trial . . . . These matters go to the weight of the expert's testimony rather than to its admissibility.").

Here, Vaughan's challenge goes to the weight of the evidence rather than the admissibility of Lueptow's testimony and analysis. Though he admitted that his models did not exactly match the various accused tanks, this fact was fully discussed on cross examination. As in Quiet Tech., his models were not the perfect models of each individual tank, but they were based on reliable scientific methodology and subject to cross examination and the proffering of further scientific analysis by Vaughan. We conclude that a reasonable juror could consider Lueptow's testimony explaining the very robust, helical flow in the models and infer that the similar accused tanks will produce flow similar to the modeled flow. Therefore, we will not contravene the province of the jury by reweighing Lueptow's testimony.

b. Alleged Flows

Vaughan's challenges do not end with allegations of inaccurate data. It also challenges the relevance of Lueptow's testimony regarding general rotation of the fluid in combination with the helical flow. Vaughan argues that Lueptow's analysis performed only 40 to 50 iterations, a time frame that it suggests is only a few seconds after pump startup and, therefore, was not enough time to rotate the entire body of fluid.

However, such arguments do not overcome Lueptow's testimony that there was helical flow and general body rotation in his simulation even after 50 iterations. Furthermore, Lueptow did not rely solely on his CFD plots, but also on those that were admittedly continued for longer periods of time by Vaughan and LD when they simulated the Merced and generic tanks at AEA Technologies. Any fault within Lueptow's opinion was properly covered during cross examination. But, sufficient evidence still existed for a reasonable juror to find infringement.

Vaughan's last contention with the CFD analysis counters LD's reliance on the vertical vector plots from the PX19 and PX20 reports by presenting an argument that they are unreliable. Basically, Vaughan argues that movement shown in the vector plots represents the single-plane movement of a particle flowing in two planes: vertical and horizontal. For purposes of determining helical flow, the vertical-plane vector plot is critical. Vaughan explains that the vertical plot shows particles with very little movement in the vertical plane, but much more substantial movement in the horizontal plane. It contends that the vertical vector plot in the PX19 report is consistent with a rotational vortex, as in the prior art, rather than helical flow. Essentially, it maintains that even though the vertical vector plots look helical, the actual particles are moving like a

whirlpool around a common center and that even in that configuration there will be flow upward and downward somewhere in the tank.

While Vaughan's interpretation could be correct, the evidence presented suggests that the vertical vector plot is subject to different interpretations. There was substantial evidence presented to the jury to suggest that this plot represents a helical pattern. The plot appears to show two vortices on either side of the tank center. While these vortices may be aided by the fluid intake sump in the tank center, it appears clear in this figure that the downward speeds increase towards the pumps. Furthermore, for both the PX19 and PX20 reports, their authors acknowledge that flow vortices do exist in the vertical plane. Upon consideration of the evidence, the jury may have had a different interpretation than that postulated by Vaughan. There is certainly substantial evidence to support this jury's findings.

3. Foreign Infringement

Vaughan makes one final argument with respect to infringement under 35 U.S.C. § 271(f) by six tanks located outside of the United States. It argues that under § 271(f) there was insufficient evidence that it intended for the foreign purchasers to infringe the '414 patent. Pursuant to § 271(f)(1), a party may be an infringer if it

> supplies . . . in or from the United States all or a substantial portion of the components of a patented invention, where such components are uncombined in whole or in part, in such manner as to actively induce the combination of such components outside of the United States in a manner that would infringe the patent if such combination occurred within the United States. . .

"A finding of inducement requires both an underlying instance of direct infringement and a requisite showing of intent." Fuji Photo Film Co., 394 F.3d at 1377. Here, although

Vaughan contends that the requisite intent showing is missing, "[a] patentee may prove intent through circumstantial evidence." Id.

Accordingly, LD identifies evidence in the record that Vaughan knew of the '414 patent after its first sale to Augusta. Moreover, Vaughan's hiring of Behnke, a former LD employee with knowledge of the patented design, and Dorsch's statements indicating that Vaughan was relying on nozzle orientations from Behnke, support the proposition that Vaughan intended for its Augusta design to infringe the claims of the '414 patent. Furthermore, Vaughan's engineering manual was sent to its customers and is replete with examples that are similar to the Augusta designs. This constitutes circumstantial evidence that Vaughan intended for its subsequent buyers, including foreign buyers, to install systems that infringe the claims of the '414 patent. Vaughan argues that the engineering manual itself expresses an intent to mix by rotation, such that Vaughan's dissemination of the manual did not intend its customers to create the infringing helical flow. Vaughan's arguments ask us to reweigh the evidence, a task reserved for the jury, not this court. See Teleflex, Inc. v. Ficosa N. Am. Corp., 299 F.3d 1313, 1335 (Fed. Cir. 2002). Thus, we hold that there is substantial evidence to support the jury's verdict under § 271(f).

C. Invalidity of the '414 Patent

Vaughan's second allegation of error is that the court should have found the '414 patent invalid because the specification did not disclose the inventor's best mode of practicing the invention and did not enable the claims. See BJ Servs. Co. v. Halliburton Energy Servs., 338 F.3d 1368, 1371-72 (Fed. Cir. 2003); Eli Lilly & Co. v. Barr Labs., 251 F.3d 955, 963 (Fed. Cir. 2001). It argues that the inventors failed to disclose the

need for reducers on the tank nozzles and that the specification failed to enable the creation of helical flow in the tank.

1. Best Mode

Vaughan argues that the use of reducers on the tank nozzles was the best mode of practicing the invention, that it was known to the inventors, and that they failed to disclose it in their patent application. Vaughan presented evidence that the inventors installed reducers on the Plymouth and Indiana Packers tanks in order to increase flow velocity and impart more momentum into the large tanks.

Inventors are required by 35 U.S.C. § 112, ¶ 1 to disclose the best mode for practicing their claimed inventions. A finding of patent invalidity based on best mode "requires clear and convincing evidence that the inventor both knew of and concealed a better mode of carrying out the claimed invention than that set forth in the specification." Teleflex, 299 F.3d at 1330. This is a two-part factual test inquiring into (1) whether the inventor subjectively "considered a particular mode of practicing the invention to be superior to all other modes at the time of filing" the application and (2) whether the inventor adequately disclosed that superior mode. Id.; accord Eli Lilly & Co., 251 F.3d at 963. The best mode requirement does not require the disclosure of "routine details" that would be apparent to one of ordinary skill in the art practicing the invention. Teleflex, 299 F.3d at 1331-32. "Known ways of performing a known operation cannot be deemed intentionally concealed absent evidence of intent to deliberately withhold that information." High Concrete Structures, Inc. v. New Enter. Stone & Lime Co., 377 F.3d 1379, 1384 (Fed. Cir. 2004).

In light of all the evidence presented on this issue, a reasonable jury could conclude that Vaughan failed to demonstrate by clear and convincing evidence that LD did not disclose the best mode. First, the '414 patent states that "[t]he jet nozzle units 20 are preferably of a type disclosed in U.S. Pat. No. 4,332,484 (herein incorporated by reference) [("the '484 patent")] and commercially available from A.O. Smith, as part of its Slurrystore . . . systems." '414 patent, col. 4, ll. 52-55. The '484 patent describes a nozzle that discharges "a high velocity high volume jet," col. 3, ll. 50-51, and a nozzle which is "concentrically reduced in diameter in its upward extend . . . ," col. 3, ll. 65-68. Second, Crump testified that the Plymouth and Indiana Packers installations did not incorporate the invention and were used to achieve zone mixing instead of helical flow. Third, LD presented evidence that adding reducers is a routine detail and did not need to be disclosed to a person of ordinary skill in the art. Fourth, Lueptow testified that a particular flow velocity did not matter given that the fluid flow began to dissipate further from the nozzle.

Admittedly, the '414 patent does not disclose a particular size of reducer, but Vaughan failed to demonstrate by clear and convincing evidence that it must. Ideal flow rates and flow velocities depend on the nature of the tank to be mixed. Moreover, Vaughan has not made a sufficient showing to overcome the jury determination that the best mode requirement was satisfied.

2. Enablement

Vaughan argues that the '414 specification fails to enable the claimed helical flow. It contends that Crump's testimony that he did not discover helical flow until after

his patent application was filed is proof that the specification does not enable the claim to such flow.[2]

In order to enable the claims of a patent pursuant to § 112, the patent specification must teach those of ordinary skill in the art "how to make and use the full scope of the claimed invention without undue experimentation." Bruning v. Hirose, 161 F.3d 681, 686 (Fed. Cir. 1998). Some experimentation is permissible although it cannot be unduly excessive. Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1384 (Fed. Cir. 1986). Enablement is a question of law which we ultimately review de novo, but it is based on factual findings that are reviewed for clear error. Bruning, 161 F.3d at 686. Here, because the underlying inquiry was inherently factual, "we look to whether a reasonable jury could have made the underlying factual findings necessary to provide substantial evidence in support of its conclusion." BJ Servs. Co., 338 F.3d at 1371-72.

First, LD submitted Gillette's testimony to establish that even though the patent does not discuss a specific combination of elements to create helical flow, it could be produced by a person of ordinary skill in the art without undue experimentation. Second, Crump's testimony indicates that he conceived of the idea of producing helical flow in late 1991 or early 1992, constructively reduced his idea to practice in the patent application, then confirmed that the helical flow could be produced in his later tank

[2] Vaughan also argues that the district court improperly excluded expert testimony regarding enablement. The district court excluded the expert opinion evidence as irrelevant because it was based on an impermissible claim construction and relied heavily on Figure 6 of the patent specification that shows perfect helical flow instead of substantial helical flow. Furthermore, the court found that the evidence could prejudice and confuse the jury. Since the enablement inquiry necessarily depends on

designs. This testimony, along with Lueptow's indication that helical flow is robust, provides substantial evidence that helical flow could be generated by following the '414 patent written description.

D. Willful Infringement

Vaughan also argues that there was not clear and convincing evidence to support the jury's verdict of willful infringement. Vaughan's only contentions are that there was no basis on which the jury could disregard Vaughan's reliance on counsel's opinion of non-infringement and that there was insufficient evidence that Vaughan copied the Augusta system.

A finding of willful infringement is made after considering the totality of the circumstances. See Knorr-Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp., 383 F.3d 1337, 1342-43 (Fed. Cir. 2004) (en banc). The evidence is weighed and evaluated by the trier of fact. Id. at 1343. "The drawing of inferences, particularly in respect of an intent-implicating question such as willfulness, is peculiarly within the province of the fact finder that observed the witnesses." Rolls-Royce, Ltd. v. GTE Valeron Corp., 800 F.2d 1101, 1110 (Fed. Cir. 1986).

Courts consider several factors when determining whether an infringer has acted in bad faith and whether damages should be increased. They include: "(1) whether the infringer deliberately copied the ideas or design of another; (2) whether the infringer, when he knew of the other's patent protection, investigated the scope of the patent and formed a good-faith belief that it was invalid or that it was not infringed; . . . (3) the infringer's behavior as a party to the litigation;" (4) "defendant's size and financial

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an interpretation of the claims, we conclude that the district court did not abuse its

condition;" (5) "closeness of the case;" (6) "duration of defendant's misconduct;" (7) "remedial action by the defendant;" (8) "defendant's motivation for harm;" and (9) "whether defendant attempted to conceal its misconduct." Read Corp. v. Portec, Inc., 970 F.2d 816, 826-27 (Fed. Cir. 1992) (superseded on other grounds as recognized in Hoechst Celanese Corp. v. BP Chems. Ltd., 78 F.3d 1575, 1578 (Fed. Cir. 1996)). Good faith may normally be shown by obtaining the advice of legal counsel as to infringement or patent validity. See id. at 828. If counsel's opinion is found to be incompetent, however, a fact finder may discount its usefulness in determining a party's good faith. See id. at 828-29; see also Goodwall Constr. Co. v. Beers Constr. Co., 991 F.2d 751, 758 (Fed. Cir. 1993) (holding that a jury could have concluded that the infringing party concealed incriminating evidence from its opinion counsel).

Here, LD cites to several pieces of evidence the jury may have relied on to find copying. One of the most persuasive pieces of evidence appears to be Vaughan's competing bid on the Augusta tank. Though the engineering drawings are virtually duplicates of LD's job proposal, that is not the most persuasive evidence that the jury may have relied upon to infer copying. LD presented evidence that Vaughan used Behnke, a former LD employee with intimate knowledge of the Augusta tank and LD's Jetmix system, to establish a nozzle angle of its own Rotamix system. While Vaughan discounts this evidence because it used a different nozzle height and a dual-nozzle design instead of the single-nozzle design LD proposed to Augusta, the jury could reasonably infer that Vaughan was deliberately trying to create the same flow pattern as LD's Jetmix system in violation of the '414 patent. There is no limitation in the '414

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discretion in excluding the expert's testimony pertaining to enablement.

patent requiring single-nozzle systems. In fact, the '414 patent contemplates the use of "various flow devices of a system [that] may be installed at differing heights, if desired . . . and may be combined in pairs." Col. 8, ll. 35-44. Thus, Vaughan's argument that the jury could not find copying because its Augusta proposal made insubstantial changes to a patented invention does not overcome the substantial evidence to the contrary. Furthermore, the Vaughan engineering manual includes a drawing similar in detail to the Augusta tank layout, a fact the jurors could have used to infer copying.

Though Vaughan relies heavily on its opinion of counsel, LD presented flaws in that opinion's factual basis. LD explains that patent counsel was not given the complete CFD analysis because he was not provided with the vertical vector plots of fluid flow. Patent counsel was advised that the vertical plots did not show anything of significance. In fact, the report on the Merced and generic 50-foot tanks explained that the vertical plots indicated vertical flow and secondary flow vortices. The jury could use such a concealment of evidence from the attorney to discount the opinion. See Goodwall Constr., 991 F.2d at 758. Although Vaughan asserts that the district court's enhancement of damages should be reversed, the primary basis for this position is that the jury's finding of willfulness should be reversed, an argument we have already rejected. Vaughan's only other argument is that litigation misconduct did not justify enhancement but that argument was made only in a footnote in the opening brief and therefore was not sufficiently preserved. SmithKline Beecham Corp. v. Apotex Corp., 439 F.3d 1312, 1320 (Fed. Cir. 2006).

E. Inequitable Conduct

Finally, Vaughan argues that the district court improperly granted LD's JMOL for its inequitable conduct claim. Vaughan maintains that the court committed clear error by finding that the Plymouth and Indiana Packers installations were not prior art that should have been disclosed to the patent examiner.

Patent applicants are required to prosecute patents "with candor, good faith, and honesty." See Bristol-Myers Squibb Co., 326 F.3d at 1233 (citation omitted). "A breach of this duty can take several forms: 'affirmative misrepresentation of a material fact, failure to disclose material information, or submission of false material information.' Further, a breach of this duty, when coupled with an intent to deceive or mislead the PTO, constitutes inequitable conduct, which, when proven, renders the patent unenforceable." Id. (citations omitted). In order to establish inequitable conduct, Vaughan must present clear and convincing evidence that the inventors "failed to disclose material information with an intent to mislead the PTO." Id. at 1233-34.

The district court found that Crump's testimony regarding the process of invention was credible and believed that the Plymouth and Indiana Packers installations were not material information because they were "very different configurations" from the claimed invention and were part of an "evolving process of experimentation by the inventors." The court also found that even if the previous installations had been material, Crump's testimony that he did not intend to deceive the patent office was credible and his extensive prior art disclosures during prosecution strongly suggested good faith.

Our inquiry into materiality is an objective one. "Materiality is not limited to prior art but embraces any information that a reasonable examiner would be substantially likely to consider important in deciding whether to allow an application to issue as a patent." Bristol-Myers Squibb Co., 326 F.3d at 1234 (citation omitted). Here, the district court erred in its analysis of materiality. The court focused on whether the prior installations actually embody the invention, when the correct analysis asks whether a reasonable examiner would find it important. In this case, the inventors explain how they developed the invention and their use of the Plymouth and Indiana Packers tanks to do so. They certainly used the previous tanks to assist in developing the invention and the tanks were part of a sale, not an experiment. A reasonable patent examiner would find such information important to his consideration of the patent application.

However, Vaughan fails to establish that the inventors had the requisite intent to deceive. Intent is a subjective inquiry into whether the inventor knew the information was material and chose not to disclose it. See id. at 1239. Here, Vaughan asks us to reweigh the credibility of the evidence and testimony, something we cannot do. See LNP Eng'g Plastics, Inc. v. Miller Waste Mills, Inc., 275 F.3d 1347, 1361 (Fed. Cir. 2001). The trial court relied on the evidence that Crump did not believe the prior installations were necessary disclosures because they were not embodiments of the invention and were similar to other disclosures. Furthermore, Crump testified that he did inform the examiner of the prior tanks. We see no reversible error in the district court's analysis of intent. Thus, the court's finding of no inequitable conduct was not clearly erroneous.

III. CONCLUSION

In this appeal, Vaughan asks us to review the district court's denial of their JMOL motion for non-infringement, invalidity, no willful infringement, and unenforceability due to inequitable conduct. For the reasons stated in this opinion, we find no reversible error. Accordingly, we affirm.

AFFIRMED