

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

UNION CARBIDE CHEMS. &)
PLASTICS TECH. CORP. and)
UNION CARBIDE CORP.,)
)
Plaintiffs,)
Counter-Defendants,)
v.) Civ. No. 99-CV-274-SLR
) (Consolidated)
SHELL OIL CO.,)
SHELL CHEMICAL CO., and)
CRI CATALYST CO.,)
)
Defendants,)
Counter-Plaintiffs.)
)
)
SHELL OIL CO.,)
)
Plaintiff,)
)
v.) Civ. No. 99-846-SLR
)
)
UNION CARBIDE CHEMS. &)
PLASTICS TECH. CORP. and)
UNION CARBIDE CORP.,)
)
)
Defendants.)

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MEMORANDUM OPINION

Dated: June 9, 2004
Wilmington, Delaware

ROBINSON, Chief Judge

I. INTRODUCTION

On May 3, 1999 plaintiffs Union Carbide Chemicals & Plastics Technology Corporation ("UCC/PTC") and Union Carbide Corporation ("UCC" and collectively "Union Carbide")¹ filed this action against defendants Shell Oil Company, Shell Chemical Company, and CRI Catalyst Company (collectively "Shell"), alleging infringement of three United States patents owned by plaintiff.² In early 2001, the case was tried by a jury who found in favor of defendants on the issues of infringement and invalidity. Following the verdict, the court considered numerous motions by the parties for judgment as a matter of law. Union Carbide v. Shell Oil Co., 163 F. Supp. 2d 426 (D. Del. 2001). The case was subsequently appealed and, in November 2002, the United States Court of Appeals for the Federal Circuit affirmed in part and reversed in part the judgment and remanded the case for further proceedings. Union Carbide Chemicals & Plastics Tech. Corp. v. Shell Oil Co., 308 F.3d 1167 (Fed. Cir. 2002).

Between October 27 and November 3, 2003, a jury trial was held on the remanded issues. Submitted to the jury were Union

¹The court notes that all parties in their briefs, evidence, and arguments have largely treated the two plaintiffs and the two defendants as single entities. Consequently, except in the court's discussion of damages where the separate corporate existence is relevant, the court will similarly not distinguish.

²U.S. Patent No. 4,908,343 ("the '343 patent"); U.S. Patent No. 4,916,243 ("the '243 patent"); and U.S. Patent No. 5,057,481 ("the '481 patent").

Carbide's claims that Shell infringed claim 4 of the '243 patent and Shell's affirmative defenses of invalidity. The jury returned a verdict finding that Shell directly infringed claim 4 when it used its S-880 and S-882 catalysts in the production of ethylene oxide ("EO"). The jury also found that Shell's subsidiary, CRI, contributorily infringed claim 4 by selling to third parties Shell's S-863, S-880 and S-882 catalysts. The jury found that claim 4 was not invalid due to non-enablement, anticipation by prior art, or obviousness in light of the prior art. Finally, the jury awarded damages in the amount of \$112,198,893. Presently before the court are the parties' twenty-four post-trial motions, as well as the court's findings of fact and conclusions of law with respect to Shell's equitable defenses of laches and estoppel.

II. BACKGROUND

A. The Patent-in-Suit and Asserted Claim

The '243 patent is the only patent remaining in the present case. The '243 patent was a continuation of prior U.S. application Ser. No. 763,273 filed August 7, 1985, which was a continuation of application Ser. No. 497,231 filed May 23, 1983, now abandoned, which was a continuation of application Ser. No. 116,292 filed February 13, 1980, now abandoned, which was a continuation-in-part of Ser. No. 021,727 filed March 20, 1979, now abandoned. As described in the specification, the '243

patent comprises a process for the commercial production of EO with a supported silver catalyst containing

a combination of (a) cesium and (b) at least one other alkali metal selected from the group consisting of lithium, sodium, potassium and rubidium, wherein (a) and (b) are present in amounts in relation to the amount of silver therein sufficient to increase the efficiency of the ethylene oxide manufacture to a value greater than the efficiencies obtainable under common operating conditions from respective catalysts which are the same as said catalyst except that instead of containing both (a) and (b), one contains the respective amount of (a), and the other contains the respective amount of (b).

('243 patent, col. 1, ll. 19-28) In short, this patent is directed to improved silver catalysts for the production of EO. EO is a chemical intermediate product, meaning it is a compound primarily used in the production of other chemical products.

(D.I. 624 at 199-200) In the case of EO, it is a gas used in the production of ethylene glycol which is subsequently used in the production of synthetic substances such as polyester fiber, resin and film, and it is created when ethylene reacts with oxygen.³

³While ethylene glycol has more than one form, it is most commonly and profitably used in monoethylene glycol ("MEG"). Approximately 7.2 billion pounds of EO are produced each year, most of which is converted into MEG. Union Carbide and its parent corporation, Dow Chemical, produces approximately 1.4 billion pounds or twenty-five percent of the annual MEG domestic market. The average price of MEG is approximately \$0.25 per pound although that price is not stable. MEG sales are a growth market with about six percent annual domestic growth. (D.I. 624 at 204-08) As MEG is a fungible commodity, there is incentive for MEG manufacturers to reduce their cost structures. (D.I. 626 at 606-09)

(Id. at 200-204)

EO is produced through a highly exothermic reaction between ethylene and oxygen.⁴ This process also results in the production of water and carbon dioxide. It is known in the art, however, that if certain catalysts, such as the one claimed in the patent, are present during this process, a lower reaction temperature may be employed.⁵ A lower reaction temperature reduces the amount of oxygen and water byproducts and results in greater production efficiency. Production efficiency, sometimes referred to as "selectivity", is defined by the percentage of ethylene that is converted to EO. (D.I. 624 at 245)

It was understood in the prior art that one such catalyst that enhances reaction efficiency is silver. Prior to 1971, EO reaction efficiencies using silver as a catalyst had an efficiency of no greater than 65 percent. In 1971, a Shell scientist determined that small amounts of alkali metals had a promotional effect on silver-catalyzed EO reactions. These alkali metals when present in catalyzed EO reactions are referred

⁴In the case of the EO production process described in the '243 patent, the temperature range is from 200 to 300 degrees celsius. ('243 patent, col. 29, ln. 56)

⁵A catalyst is a chemical that increases the rate of a chemical reaction without being consumed or altered. (D.I. 625 at 241-42, 381)

to as "promoters."⁶ ('243 patent, col. 3, ll. 43-61) In particular, it was learned that cesium when properly optimized could achieve an efficiency in the range of seventy-eight to eighty-two percent. (D.I. 625 at 304-06)

The '243 patent claims a process in which silver, cesium and at least one other alkali metal are combined to produce a synergistic effect, this synergistic effect being that the catalytic reaction efficiency is greater with the three materials present than with only silver and either cesium or one other alkali metal. ('243, col. 8, ll. 11-30; D.I. 625 at 270)

Claim 4, which is dependent on claim 1, is the only claim at issue in the case before the court and concerns a catalytic process in which silver, cesium and lithium are present. It claims:

1. In the continuous process for the production of ethylene oxide by the vapor phase oxidation of ethylene with molecular oxygen provided as an oxygen-containing gas at a temperature of from about 200° C. to 300° C. in the presence of at least about one mole percent of carbon dioxide and an organic chloride in the gaseous feed stream and in the presence of a supported, silver-containing catalyst in a fixed bed, tubular reactor used in commercial operations to form

⁶These promoters are not themselves catalysts but act both to increase the efficiency of the reaction and to prolong the life span of the catalyst itself. It is also understood in the art that certain materials function as "inhibitors" in the EO reaction process by serving to reduce the amount of carbon dioxide produced. (D.I. 624 at 245-46; '243 patent, col. 3, ln. 30 - col. 4, ln. 47)

ethylene oxide, wherein said supported, silver-containing catalyst contains 2 to 20 weight percent silver deposited on a support which is in a form and size for use in the reactor, wherein (i) the specific reaction conditions of the ethylene oxide process; (ii) the specific catalyst support characteristics and (iii) the specific silver deposition method comprise an ethylene oxide production system, the improvement in which the catalyst comprises silver deposited on an alpha-alumina macroporous support in a first amount having a surface area less than 10 m²/g and contains a combination of (a) cesium in a second amount and (b) at least one other alkali metal selected from the group consisting of lithium, sodium, potassium and rubidium in a third amount, which combination comprises (a) and (b) in amounts in relation to the amount of silver in the catalyst sufficient to provide an efficiency of ethylene oxide manufacture that is greater than the efficiencies obtainable in the same ethylene oxide production system, including the same conversions, than (i) a second catalyst containing silver in the first amount and cesium in the second amount, and (ii) a third catalyst containing silver in the first amount and the alkali metal in the third amount, wherein the combination of silver, cesium and alkali metal in said catalyst is characterizable by an efficiency equation:

$$\begin{aligned}
 \text{efficiency \%} = & b_0 + b_1(BG) + b_2(BCs) + \\
 & \sum_1^4 b_{3j} BA_j + b_4(BG)^2 + b_5(BCs)^2 + \\
 & \sum_1^4 b_{6j} BA_j^2 + b_7 (BG \cdot BCs) + \\
 & (BG) \sum_1^4 b_{8j} BA_j + (BCs) \sum_1^4 b_{9j} BA_j,
 \end{aligned}$$

where $BA_1 = BRb$,

BA₂=BK,

BA₃=BNa,

BA₄=BLi, and where the coefficient b₀ through b_{9j} and BG, BRb, BK, BNa, BLi and BCs are determined from a composite design set of experiments using the same ethylene oxide production system for the independent variables silver, cesium and alkali metal, and wherein BG is the difference of the average value of the silver content from the silver content used in the design set, BCs is the difference of the average value of the cesium content from the cesium content used in the design set . . . and BLi is the difference of the average value of the lithium content from the lithium content used in the design set.

4. The process of claim 1 wherein said alkali metal is lithium.

('243 patent, col. 29, ln. 53 - col. 30, ln. 54)

In summary, claim 4 has four basic limitations, each containing various requirements:⁷ (1) an EO process operated at specific reaction conditions;⁸ (2) the catalyst used in the EO process comprises silver in a first amount, cesium in a second amount, and lithium in a third amount; (3) the efficiency obtainable from the EO process using the catalyst is greater than

⁷The court notes that while claim 4 is the only claim at issue, its limitations are substantially defined by claim 1. Consequently, throughout this memorandum the court's analysis frequently refers to claim 1.

⁸The '243 patent lists ten specific commercial reaction conditions. (D.I. 625 at 410-13)

the efficiency of a process using (a) a second catalyst containing silver in the first amount and cesium in the second amount (but no lithium) and (b) a third catalyst containing silver in the first amount and lithium in the third amount (but no cesium), when operated in the same EO production system (the "comparison test"); and (4) the combination of silver, cesium and lithium is characterizable by the efficiency equation set fourth in claim 1 (the "characterizable test").⁹

B. Federal Circuit's Claim Construction

The Federal Circuit describes the equation outlined in claim 1, upon which claim 4 depends, as "not a patented process for developing a synergistic catalyst but rather a descriptive tool that defines the scope of the patented invention: silver catalysts containing cesium and lithium in a combination that provides a synergistic, rather than an antagonistic or additive, effect." Union Carbide, 308 F.3d at 1178. Consequently, the Federal Circuit construed claim 1's limitation that the catalyst be "characterizable by an efficiency equation" to mean that "the claim limitation covers those catalysts that are described by the

⁹The characterizable test is an example of a statistical approach to comprehensive catalyst optimization. (D.I. 625 at 310; PTX 1079) Union Carbide's expert explained the efficiency equation as "a mathematical relationship between the amount of cesium and the amount of lithium that predicts the efficiency, correlates, actually, the change in efficiency with variations of cesium and lithium." (D.I. 625 at 419-20; '243 patent, col. 8 ln. 65 - col. 9 ln. 5)

efficiency equation" or "capable of being described by an efficiency equation." Id. at 1178-79.

III. MOTIONS FOR JUDGMENT AS A MATTER OF LAW OR, IN THE ALTERNATIVE, FOR A NEW TRIAL.

Prior to submission of the case to the jury, Union Carbide and Shell each entered numerous motions, both oral and by written brief, for judgment as a matter of law. Where the jury's verdict was unfavorable, both parties have renewed post-trial their motions for judgment as a matter of law. These motions include the following: (1) Shell's motion for judgment as a matter of law and alternative motion for new trial on Union Carbide's claim of direct infringement (D.I. 605; D.I. 647-1; D.I. 647-2); (2) Shell's motion for judgment as a matter of law and alternative motion for new trial on Union Carbide's claim of contributory infringement (D.I. 609; D.I. 645-1; D.I. 645-2); (3) Union Carbide's motion for judgment as a matter of law on wilfulness (D.I.662); (4) Shell's renewed motion for judgment as a matter of law and alternative motion for new trial on its invalidity defenses of anticipation and obviousness (D.I. 617; D.I. 651-1; D.I. 651-2); (5) Shell's motion for judgment as a matter of law and alterative motion for new trial on Shell's invalidity defense of indefiniteness (D.I. 611; D.I. 653-1; D.I. 653-2); (6) Shell's motion for judgment as a matter of law and alternative motion for a new trial on its invalidity defense of non-enablement (D.I.

613; D.I. 657-1; D.I. 657-2); and (7) Shell's motion for judgment as a matter of law on UCCPTC's claims for damages and alternative motion for a new trial or remittitur on the jury's damages verdict (D.I. 607; D.I. 655-1; D.I. 655-2).

A. Standards of Review

1. Judgment as a Matter of Law

To prevail on a renewed motion for judgment as a matter of law following a jury trial, the moving party "must show that the jury's findings, presumed or express, are not supported by substantial evidence or, if they were, that the legal conclusions implied [by] the jury's verdict cannot in law be supported by those findings.'" Pannu v. Iolab Corp., 155 F.3d 1344, 1348 (Fed. Cir. 1998) (quoting Perkin-Elmer Corp. v. Computervision Corp., 732 F.2d 888, 893 (Fed. Cir. 1984)). "'Substantial' evidence is such relevant evidence from the record taken as a whole as might be acceptable by a reasonable mind as adequate to support the finding under review." Perkin-Elmer Corp., 732 F.2d at 893. In assessing the sufficiency of the evidence, the court must give the non-moving party, "as [the] verdict winner, the benefit of all logical inferences that could be drawn from the evidence presented, resolve all conflicts in the evidence in his favor, and in general, view the record in the light most favorable to him." Williamson v. Consol. Rail Corp., 926 F.2d 1344, 1348 (3d Cir. 1991); Perkin-Elmer Corp., 732 F.2d at 893.

The court may not determine the credibility of the witnesses nor "substitute its choice for that of the jury between conflicting elements of the evidence." Perkin-Elmer Corp., 732 F.2d at 893. In sum, the court must determine whether the evidence reasonably supports the jury's verdict. See Dawn Equip. Co. v. Ky. Farms Inc., 140 F.3d 1009, 1014 (Fed. Cir. 1998).

2. Motion for a New Trial

Federal Rule of Civil Procedure 59(a) provides, in pertinent part:

A new trial may be granted to all or any of the parties and on all or part of the issues in an action in which there has been a trial by jury, for any of the reasons for which new trials have heretofore been granted in actions at law in the courts of the United States.

Fed. R. Civ. P. 59(a). The decision to grant or deny a new trial is within the sound discretion of the trial court and, unlike the standard for determining judgment as a matter of law, the court need not view the evidence in the light most favorable to the verdict winner. See Allied Chem. Corp. v. Darflon, Inc., 449 U.S. 33, 36 (1980); Olefins Trading, Inc. v. Han Yang Chem. Corp., 9 F.3d 282 (3d Cir. 1993); LifeScan Inc. v. Home Diagnostics, Inc., 103 F. Supp. 2d 345, 350 (D. Del. 2000), aff'd per curiam, Nos. 00-1485, 00-1486, 2001 WL 345439 (Fed. Cir. Apr. 6, 2001) (citations omitted). Among the most common reasons for granting a new trial are: (1) the jury's verdict is against the

clear weight of the evidence, and a new trial must be granted to prevent a miscarriage of justice; (2) newly-discovered evidence exists that would likely alter the outcome of the trial; (3) improper conduct by an attorney or the court unfairly influenced the verdict; or (4) the jury's verdict was facially inconsistent. See Zarow-Smith v. N.J. Transit Rail Operations, 953 F. Supp. 581, 584 (D.N.J. 1997) (citations omitted). The court must proceed cautiously, mindful that it must not substitute its own judgment of the facts and the credibility of the witnesses for those of the jury. The court should grant a new trial on the basis that the verdict was against the weight of the evidence only where a miscarriage of justice would result if the verdict were to stand. See Williamson, 926 F.2d at 1352; EEOC v. Del. Dep't of Health and Soc. Servs., 865 F.2d 1408, 1413 (3d Cir. 1989).

B. Direct Infringement

Shell filed a motion for judgment as a matter of law or, in the alternative, for a new trial, contending that Union Carbide failed to provide a legally sufficient evidentiary basis for a reasonable jury to conclude that Shell literally infringed claim 4 of the '245 patent directly.¹⁰ Shell alleges the following

¹⁰Shell originally filed a motion for judgment as a matter of law on direct infringement on November 3, 2003, prior to submission of the case to the jury. (D.I. 605) Shell filed its renewed motion on December 22, 2003. (D.I. 647)

basis for its motion on direct infringement: (1) Union Carbide did not conduct its tests of Shell's catalysts at the "same conversions;" (2) Union Carbide did not vary silver in the design set of experiments; (3) Union Carbide did not conduct the characterizable test and comparison test in the "same ethylene oxide production system;" (4) Union Carbide failed to prove infringement because the differences in efficiencies are within experimental error; (5) Union Carbide did not properly prepare Shell's catalysts; and (6) Union Carbide did not properly test Shell's rhenium catalysts.

1. Same Conversion

The comparison test of claim 1 of the '243 patent requires "an efficiency of ethylene oxide manufacture that is greater than the efficiencies obtainable in the same ethylene oxide production system, including the same conversions." ('243 patent, col. 30, ll. 9-12) Union Carbide's expert testified that he maintained the same conversion by measuring EO in the outlet. (D.I. 626 at 562-569) Based upon the specification's definition of conversion, Shell contends that Union Carbide's expert should have conducted his experiment by measuring whether ethylene conversion was constant rather than measuring EO in the outlet. (D.I. 648 at 9-10) It is not disputed that the '243 patent, its prosecution history and the prior art recognize that catalyst efficiencies may be compared at constant EO in the outlet,

constant oxygen conversion, or constant ethylene conversion. ('243 patent, col. 11, ll. 14-21; JTX 4 at 112-13, 128-29; JTX 7 at 101, 113-15, 534-35; D.I. 625 at 509-10; D.I. 648 at 9) Moreover, as Union Carbide's infringement expert explained, once efficiency is determined by any of these three measurements, obtaining the conversion rate of the other two is a matter of basic stoichiometry.¹¹ (D.I. 526 at 512) Union Carbide's use of EO in the outlet was not improper and was evidence by which a reasonable jury could find direct infringement.

2. Variance of Silver

The plain language of the claim at issue requires that the combination of silver, cesium and lithium in a catalyst used in an accused process be "characterizable" by a particularly defined efficiency equation. Claim 1 further requires that the coefficients of the efficiency equation be determined by testing catalysts in a composite design set of experiments which must include, as independent variables, silver, cesium and lithium. ('243 patent, col. 30, ll. 16-54) Shell contends that claim 1 requires that the amounts of silver be varied to determine the silver-related coefficients of the efficiency equation. (D.I. 648 at 13) Shell did not seek a jury instruction that claim 1 required that silver actually be varied to prove literal

¹¹In presenting its defense, Shell itself argued the propriety of performing such calculations. (D.I. 627 at 857, 859, 917-19)

infringement. Conversely, Union Carbide contends that, as the actual amount of silver in the Shell catalysts was a known factor, it was not necessary for purposes of proving infringement to use varying amounts of silver. The plain language of claim 1 does not require silver to actually be varied. The jury heard conflicting expert testimony from both parties concerning this issue. The court finds that there was sufficient evidence by which a reasonable jury could conclude that proof of infringement did not require that silver actually be varied in order to satisfy the characterizable test limitation.

3. Appropriate Reaction Conditions

Claim 1 requires that the comparison test and characterizable test be conducted in the "same ethylene oxide production system" which, as the court instructed the jury, means "the laboratory or experimental 'conditions and parameters' which define the ethylene oxide production system which ultimately will be used commercially." ('243 patent, col. 30, ll. 4-54; D.I. 601) Shell contends that this should mean the "specific reaction conditions of each commercial ethylene oxide process." (D.I. 648 at 15) As Shell's own brief reflects, its argument rests upon its interpretation of claim 1. (D.I. 696 at 11) The plain language of claim 1 and this court's construction thereof do not require that the specific reaction conditions of each commercial process be tested, only that the laboratory conditions and

parameters define the process ultimately used. In the present case, sufficient evidence is in the record by which a reasonable jury could conclude that Union Carbide's expert's testing procedures were consistent with the requirements of "same ethylene oxide production system." (D.I. 625 at 444-57; D.I. 626 at 578-87; PTX 1101)

4. Range of Experimental Error

Shell contends that the differences in efficiency with respect to tests performed on Shell's catalysts by Union Carbide's expert were less than 1.31% and were within the range of experimental error for the comparative efficiency test. (D.I. 648 at 20) Consequently, Shell contends that the efficiency differences relied upon were not statistically significant. Statistical significance, however, is a question of fact for the jury as it is an issue of evidentiary weight. The jury heard evidence by which they could conclude that the efficiency differences achieved were statistically significant. (PTX 2227; D.I. 625 at 473) Consequently, the court finds the records reasonably supports the jury's findings.

5. Preparation of Shell Catalysts

Shell contends that the Union Carbide expert's test catalysts were not representative of Shell's cesium-optimized catalysts and, therefore, no jury could conclude that the Shell catalysts infringe the '243 patent. The jury heard evidence that

the amount of cesium used by Union Carbide's infringement expert was the optimum amount. (D.I. 625 at 438-439; PTX 331; D.I. 627 at 887-88; D.I. 628 at 1383-84) This was, therefore, an issue of disputed fact for the jury to resolve. Consequently, the court finds that there was sufficient evidence for a reasonable jury to conclude that the Union Carbide expert's tests were properly performed. Shell is not entitled to judgment as a matter of law.

6. Testing of Shell's Rhenium Catalysts

Shell contends that, with respect to the rhenium catalysts, Union Carbide's expert failed to properly optimize the chloride inhibitor and failed to properly pretreat the catalysts. (D.I. 648 at 21-22) The jury, however, heard testimony that the amount of chloride inhibitor used with the catalysts depends primarily on the amount of rhenium present. Union Carbide's expert testified that he optimized this amount consistent with the catalyst's requirements. (D.I. 628 at 1386; D.I. 625 at 450; D.I. 629 at 1387-88) Union Carbide's expert also testified that the pretreatment of rhenium catalysts with nitrogen was not required under the conditions at which his tests were performed. (D.I. 628 at 1380) Consequently, the jury heard sufficient evidence to support their finding that the Union Carbide expert's testing of the rhenium catalysts was proper and, therefore, supporting of a finding of infringement.

Accordingly, the court finds that Shell has failed to meet

its burden with respect to its judgment as a matter of law on the claim of direct infringement. For the reasons stated above, the court also declines to find that the jury's verdict was against the clear weight of the evidence such that it shocks the court's conscience and, therefore, a new trial is not warranted. Shell's motions for judgment as a matter of law, or in the alternative, for a new trial will be denied. (D.I. 605; D.I. 647-1; D.I. 647-2)

C. Contributory Infringement

The jury returned a verdict finding Shell liable for contributory infringement of the '243 patent. (D.I. 602) Shell, in its motion for judgment as a matter of law, asserts the following arguments: (1) failure of proof with respect to a predicate act of direct infringement; (2) failure of proof with respect to the absence of substantial noninfringing use; (3) failure of proof with respect to CRI's knowledge of customers infringing uses of the catalysts. Alternatively, Shell moves for a new trial on the following bases: (1) the jury verdict form was erroneous; (2) the jury instructions were erroneous; and (3) the exclusion of U.S. Patent No. 5,057,481 ("the '481 patent") was substantially prejudicial. (D.I. 646)

Section 271(c) provides for secondary liability for infringement of a United States Patent. To prove contributory infringement a plaintiff must demonstrate the following: (1) an

offer to sell, sale, or import; (2) a component or material for use in a patented process constituting a material part of the invention; (3) knowledge by the defendant that the component is especially made or especially adapted for use in an infringement of such patent; and (4) the component is not a staple or article suitable for substantial noninfringing use. 35 U.S.C. § 271(c). Further, contributory infringement generally requires proof of actual direct infringement by a customer of the defendant. See Novartis Pharmaceuticals Corp. v. Eon Labs Mfg., Inc., 363 F.3d 1306, 1308 (Fed. Cir. 2004). However, if use of the component by the defendant's customers necessarily infringes the patent, actual proof of an instance of direct infringement is not required. Dynacore Holdings Corp. v. U.S. Philips Corp., 363 F.3d 1263, 1275-76 (Fed. Cir. 2004).

1. Predicate Act of Direct Infringement

In its motion and brief related to contributory infringement, Shell renews its arguments pertaining to direct infringement of the '243 patent. For the reasons discussed above, the court finds that a reasonable jury could conclude that there was an occurrence of a predicate act of direct infringement. See infra Part IV.B.

2. Substantial Noninfringing Use

Shell contends that the tests conducted by Union Carbide's expert cannot be proof of the absence of substantial

noninfringing use, as Union Carbide's expert did not test the catalysts at the specific reaction conditions used in the commercial process at issue. (D.I. 646 at 26) Union Carbide's expert testified that his tests demonstrated that the processes actually used by CRI customers would infringe the '243 patent. (D.I. 625 at 456-57) Union Carbide's expert explained that at different process conditions than those he used, the accused catalysts would still have an increased efficiency as required by the claims and would still meet the efficiency equation. (Id. at 479-80) The testimony of Union Carbide's expert is evidence that there is not a substantial noninfringing use of the Shell catalysts. Shell asserts that there are numerous conditions under which the catalysts may be used commercially and would not infringe but offered no evidence to the jury to that effect. Substantial noninfringing use is a question of fact for the jury and the Union Carbide expert's unrefuted testimony was sufficient evidence thereof.

3. CRI's Knowledge of Customers' Infringing Uses

Shell contends that Union Carbide failed to offer proof of the requisite knowledge for liability under 34 U.S.C. § 271(c). (D.I. 646 at 27) In so arguing, Shell renews arguments previously made at trial and rejected by the court. Shell contends that to be liable for contributory infringement, the law requires that CRI knew when it sold its catalysts to customers

that the use of the catalysts in its customers' processes would infringe the '243 patent.¹² (D.I. 646 at 11)

In Hewlett-Packard Co. v. Bausch & Lomb Inc., the Federal Circuit Court of Appeals described § 271(c) as requiring "proof of a defendant's *knowledge*, not *intent*, that his activity cause[s] infringement." 909 F.2d 1464, 1469 (Fed. Cir. 1990) (emphasis in original). This knowledge, according to the Court of Appeals, is a knowledge of both the component's particular use and "knowledge of the patent which proscribed that use." Id. at 1469 n.4. Consistent with the court's interpretation of controlling authority, the jury was instructed that a finding of contributory infringement required proof that CRI acted "with knowledge that the component was especially made for use in a manner that infringes claim 4 of the '243 patent." (D.I. 601 at 21) Consequently, to the extent Shell's motion depends upon an interpretation of § 271(c) inconsistent with this court's jury instructions, its motion for a judgment as a matter of law will be denied. (D.I. 609, D.I. 645-1)

In the alternative, Shell moves for a new trial contending that the jury verdict form was erroneous, the jury instructions were erroneous and that the exclusion of the '481 patent was

¹²Union Carbide admitted that if "the law requires that Shell had knowledge that their catalysts met the efficiency equation there is no evidence that they had that knowledge." (D.I. 629 at 1466-67)

substantially prejudicial. The '481 patent was an issue determined by the court during pretrial evidentiary rulings. ((D.I. 561) The verdict form was the subject of oral argument during the charge conference. (D.I. 628 at 1451-56; D.I. 629 at 1471-72) As Shell's motion depends upon arguments already rejected by the court, its motion for a new trial is denied. (D.I. 647-2)

D. Willfulness

Prior to submission of the case to the jury, Union Carbide orally moved for judgment as a matter of law on the issue of willful infringement. (D.I. 628 at 1396) The court declined to consider the motion and submitted it to the jury. The jury returned a verdict finding that Union Carbide had not shown by clear and convincing evidence that Shell had willfully infringed the '243 patent. On December 22, 2003, Union Carbide renewed its motion for judgment as a matter of law on willful infringement. (D.I. 662)

As grounds for its motion, Union Carbide asserts that it was undisputed that Shell had knowledge of the '243 patent prior to beginning to use or sell the Shell catalysts and that Shell lacked a good faith basis to believe that its uses or sales were not infringements thereof. (Id.) The jury heard evidence that Dr. Clendenen, a Ph.D. chemical engineer and patent attorney, was responsible for monitoring the technical aspects of Shell's

catalyst business. (D.I. 625 at 360, 366, 790, 1092) Dr. Clendenen testified that he reviewed PTO publications for patents issued in the area for which he was responsible. He also reported patents which might require a legal opinion with respect to noninfringement. Dr. Clendenen testified that he reviewed the '243 patent and, in his opinion, determined that it did not require further action by Shell. (Id. at 371-72) Dr. Clendenen never sought further action on the '243 patent and never told any other business person or decision maker at Shell about his belief. (Id. at 369-70; D.I. 627 at 1108, 1111) Shell, therefore, did not seek a legal opinion on the '243 patent. In light of Dr. Clendenen's testimony, the court finds there to be sufficient evidence by which a reasonable jury could conclude that Union Carbide did not meet its burden of proof. Union Carbide's motion for judgment as a matter of law on willfulness will be denied. (D.I. 662)

E. Non-Enablement

At the close of evidence and before submission of the case to the jury, Shell moved for judgment as a matter of law on its invalidity defense that claim 4 of the '243 patent is not enabled. (D.I. 613) The court declined to rule on Shell's motion and the jury returned a verdict finding the '243 patent to be valid. Post-trial, Shell renewed its motion for judgment as a matter of law that the '243 patent is invalid for lack of

enablement. (D.I. 657) Shell contends that claim 4 of the '243 patent is not enabled for two reasons: (1) it requires undue experimentation to practice; and (2) it is inoperable. (D.I. 658)

Section 112 of the Patent Act states:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same.

35 U.S.C.A. § 112. A patent is not enabled if it does not teach a person skilled in the art "to make and use the invention without undue experimentation." In re Wands, 858 F.2d 731, 737 (Fed. Cir. 1988). "The determination of what constitutes undue experimentation in a given case requires the application of a standard of reasonableness, having due regard for the nature of the invention and the state of the art." Id. Several factors may be considered in determining whether experimentation is undue, including: (1) the quantity of experimentation necessary; (2) the amount of direction or guidance presented; (3) the presence or absence of working examples; (4) the nature of the invention; (5) the state of the prior art; (6) the relative skill of those in the art; (7) the predictability or unpredictability of the art; and (8) the breadth of the claims. See id. (quotations omitted).

Shell contends that the '243 patent requires undue experimentation because, "[t]o fully enable the invention of claim 4, one would have to conduct the requisite tests to determine whether [the comparison test and characterizable test] were met and would have to conduct those requisite tests at every possible combination of reaction condition variables within the broad ranges of the preamble of claim 1." (D.I. 658 at 9) The jury, however, was presented with evidence that undue experimentation was not required. (D.I. 625 at 306-09, 460-62; D.I. 626 at 825-32)

Shell also contends claim 4 is inoperable, alleging that the "efficiency of an EO process using a catalyst containing silver, cesium, and lithium can never be greater than the efficiency of a process using a silver and cesium-only catalyst, or a silver and lithium-only catalyst, as required by claim 4." (D.I. 658 at 12) Shell's argument is one of fact that was resolved by the jury. The jury heard substantial evidence that Shell's catalysts showed that lithium increases efficiency. (D.I. 625 a 460-62) While Shell's experts dispute the conclusions of Union Carbide's expert, the jury resolved the dispute in Union Carbide's favor.

Consequently, the court finds that there was legally sufficient evidence for a reasonable jury to conclude that Shell did not prove its defense of nonenablement by clear and convincing evidence. Further, for the reasons stated above, the

jury's verdict is not against the clear weight of the evidence such that it shocks the conscience of the court. Therefore, Shell's motion for judgment as a matter of law and, in the alternative, for a new trial will be denied. (D.I. 613; D.I. 657-1; D.I. 657-2)

F. Indefiniteness

At the close of evidence, Union Carbide, by oral motion, moved for judgment as a matter of law on Shell's defense of indefiniteness. (D.I. 628 at 1397) Shell also moved for judgment as a matter of law that claim 4 of the '243 patent was indefinite as a matter of law. (D.I. 611) That motion was renewed post-trial by Shell or, in the alternative, for a new trial. (D.I. 653)

After the presentation of evidence was completed, the court found that Shell had failed to adduce direct evidence creating a disputed issue of fact as to whether claim 4 is indefinite.¹³ (D.I. 628 at 1447) Consequently, the court declined to send Shell's defense of claim indefiniteness to the jury. (Id. at 1450) In so concluding, the court granted Union Carbide's oral motion for judgment as a matter of law that the '243 patent is not invalid for reason of claim indefiniteness and implicitly

¹³Shell's enablement and indefiniteness defense, however, largely relied upon DTX 14, which the court precluded from evidence when it granted one of Union Carbide's motions in limine. (D.I. 561 at ¶ 18; D.I. 488)

denied Shell's motion.¹⁴ Consequently, the court shall construe Shell's renewed motion for judgment as a matter of law as a motion for reconsideration. (D.I. 612 at 2)

A motion for reconsideration may be entertained to "correct manifest errors of law or fact or to present newly discovered evidence." Max's Seafood Café ex-rel. Lou-Ann, Inc. v. Quinteros, 176 F.3d 669, 677 (3d Cir. 1999). Accordingly, a court may alter or amend its judgment if the movant demonstrates at least one of the following: (1) a change in the controlling law; (2) availability of new evidence not available when summary judgment was granted; or (3) a need to correct a clear error of law or fact or to prevent manifest injustice. See id.

The Patent Act requires patent claims to "particularly point out and distinctly claim the subject matter which the applicant regards as his invention." 35 U.S.C. § 112. Indefiniteness is a question of law. See Personalized Media Communications v. Int'l Trade Comm'n, 161 F.3d 696, 705 (Fed. Cir. 1998). In a jury trial, if there are disputed factual issues related to indefiniteness, they may be submitted to the jury for resolution. See e.g., BJ Services Co. v. Halliburton Energy Serv., Inc., 338 F.3d 1368, 1372 (Fed. Cir. 2003). As a patent is presumed valid,

¹⁴The court notes that the record is unclear as initially the court stated that it would reserve judgment and did not make it explicit on the record that the oral motion was granted. (D.I. 628 at 1400, 1450)

a party asserting a defense of invalidity on the basis of claim indefiniteness has the burden of proof by clear and convincing evidence. See Orthokinetics, Inc. v. Safety Travel Chairs, Inc., 806 F.2d 1565, 1575-76 (Fed. Cir. 1986).

Shell presents three arguments for indefiniteness: (1) the use of a catalyst can simultaneously infringe or not infringe depending on the reaction conditions to test for infringement; (2) the test results of any catalyst would vary depending on the interpretation of conversion; (3) the absence of a criterion to determine whether a combination of silver, cesium and lithium is characterizable by the efficiency equation. (D.I. 654)

1. Effect of Reaction Conditions

In its first argument for indefiniteness, Shell asserts that the comparison test can be met using any set of reaction conditions within the broad range set forth in the preamble of claim 1 and, therefore, infringement will exist or not exist depending upon the particular reaction conditions selected by the party seeking to examine infringement. (D.I. 654 at 6-7) Union Carbide's evidence showed that, while the absolute value of efficiency measurements would change based upon the reaction conditions, the relative efficiencies would not. (D.I. 625 at 330-31, 478-80) Consequently, although a catalyst's absolute efficiency value may change at different test conditions, its comparative efficiency would not. (Id.) Shell, which bore the

burden of proof on this issue, presented no evidence to contradict Union Carbide and, as a consequence, its defense of indefiniteness on these grounds fails as a matter of law.

2. Interpretation of Conversion

Shell next argues that claim 1, upon which claim 4 depends, is indefinite because test results of a catalyst would vary depending upon the measurement of conversion. (D.I. 654 at 12-14) Shell's argument, in this regard, regurgitates an argument it makes relating to direct infringement. For those reasons already discussed, the court finds Shell's defense of indefiniteness on these grounds fails. See infra Part III.B.1 (discussing measurement of conversion for purposes of determining infringement).

3. Criterion to Determine Whether Characterization Test Is Met

Shell's final argument for claim indefiniteness asserts that claim 1, upon which claim 4 depends, is indefinite because one of ordinary skill in the art would not know how to determine whether a combination of cesium, lithium and silver would meet the characterizable test. (D.I. 654 at 14-15) Union Carbide's expert explained that using widely known statistical regression analysis, in particular R-squared, a person may determine how well test data is represented by a mathematical equation. (D.I. 625 at 423-24) Union Carbide's expert used this form of

statistical analysis to determine whether Shell's catalysts were characterizable by the efficiency equation in claim 1. (D.I. 625 at 465-68) Moreover, the '243 patent itself discloses the use of such methods in the written description and describes them as routine. ('243 patent, col. 11, ll. 28-41) Failure to specify a particular means of measurement does not render a claim indefinite where a person of ordinary skill in the art would, nevertheless, be able to practice the invention. See PPG Industries, Inc. v. Guardian Industries Corp., 75 F.3d 1558, 1563 (Fed Cir. 1996). Shell presented no evidence to contradict the Union Carbide expert's assertion that R-squared provides an appropriate means of determining infringement or even to suggest that another method would be more appropriate. Consequently, the '243 patent's failure to specify a particular measurement method does not render it invalid.

Shell bore the burden of proof on its invalidity defense of claim indefiniteness, a burden which was not met. Therefore, the court's granting of judgment as a matter of law in favor of Union Carbide on this issue during the charging conference was proper as a matter of law. As Shell's arguments fail to show a clear error of law in the court's decision, Shell's motion for reconsideration shall be denied. (D.I. 653)

G. Anticipation and Obviousness

At the close of evidence, Shell moved for judgment as a

matter of law on its invalidity defenses of anticipation and obviousness. (D.I. 618) The court declined to rule on Shell's motion and the case was submitted to the jury. The jury found that Shell did not prove by clear and convincing evidence that the '243 patent is invalid due to anticipation or obviousness. Shell has renewed its motion for judgment as a matter of law or, in the alternative, for a new trial. (D.I. 651)

1. Anticipation

Shell argues that the '243 patent is anticipated by United States Patent No. 4,212,772, and Belgium Patent No. 867,045 (collectively "the Mross patents"). The defense of invalidity due to anticipatory prior art requires proof by clear and convincing evidence that a single prior art reference discloses all of the limitations of the claim at issue. See 35 U.S.C. § 102; Minnesota Mining & Mfg. Co. v. Johnson & Johnsons Orthopaedics, Inc., 976 F.2d 1559, 1565 (Fed. Cir. 1992). Even where the prior art reference does not expressly disclose a limitation of a claim at issue, a jury may find that the prior art inherently discloses the limitation. See Atlas Powder v. IREOCO Inc., 190 F.3d 1342, 1347 (Fed. Cir. 1999).

In the present case, in order to find that the Mross patents anticipated the '243 patent, a jury would have to find that the catalyst disclosed in the Mross patent (the "L1 catalyst") was an inherent disclosure of claim 1's characterizable test limitation.

The jury heard evidence that, from Shell's expert's own results, the L1 catalyst is not characterizable by the efficiency equation. (D.I. 627 at 1051, 1090-91; D.I. 628 at 1389-90) As there was legally sufficient evidence for a reasonable jury to conclude that there was not clear and convincing evidence that the Mross patents anticipate the '243 patent, Shell's motion for judgment as a matter of law on anticipation will be denied. (D.I. 617; D.I. 651-1)

2. Obviousness

The defense of invalidity due to obviousness under the prior art requires proof by clear and convincing evidence that the differences between the claimed invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the relevant field. 35 U.S.C. § 103(a). In determining whether a claimed invention is obvious, the finder of fact considers the following four factors: (1) scope and content of the prior art; (2) differences between the prior art and the claimed invention; (3) level of ordinary skill in the pertinent field; and (4) secondary considerations such as commercial success, long felt but unsolved needs, failure of others that may shed light on the circumstances surrounding the origin of the subject matter sought to be patented. See Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 17-18 (1966). See also Ryko Mfg.

Co. v. Nu-Star, Inc., 950 F.2d 714, 716 (Fed. Cir. 1991). Where obviousness is based on a single prior art reference, a party seeking to invalidate a patent must show a "suggestion or motivation to modify the teachings of that reference." In re Kotzab, 217 F.3d 1365, 1370 (Fed. Cir. 2000).

Shell argues that even if the Mross patents do not anticipate the '243 patent, they are proof that the '243 patent is obvious. According to Shell, the prior art teaches that lithium is an effective promoter; therefore, it would have been obvious to a person skilled in the art that using lithium in combination with cesium on the L1 catalyst would result in an EO process of a higher efficiency than that of an EO process using a silver/cesium or a silver/lithium catalyst. (D.I. 652 at 19)

As there was no evidence of an express suggestion in the prior art, whether the prior art contained an inherent suggestion was an issue of fact for the jury. While Shell offered evidence that efficiency was the central objective of EO catalysts and that a person skilled in the art with knowledge of the Mross patents could have created a catalyst that satisfied the limitations of claim 4, the jury also heard evidence regarding the unexpected results, long-felt need and commercial success of the claimed invention. (D.I. 624 at 204-06, 246-67; D.I. 625 at 266, 270, 275-78; D.I. 626 at 674-76, 750-51) Consequently, the court finds that there was legally sufficient evidence by which a

reasonable jury could conclude that Shell failed to prove by clear and convincing evidence that the '243 patent was invalid due to obviousness. (D.I. 611; D.I. 653-1) Further, to the extent that Shell's motion depends upon arguments already discussed and rejected by the court, its motion for a new trial is denied. (D.I. 653-2)

H. Damages

Prior to submission of the case to the jury, Shell moved for judgment as a matter of law on Union Carbide's claims for damages. (D.I. 607) The court declined to rule on Shell's motion and the jury returned a verdict finding infringement and awarding \$112,198,893 in damages as a reasonable royalty. Shell has renewed its motion for judgment as a matter of law or, in the alternative, for a new trial or, in the alternative, for remittitur. (D.I. 655)

The parties agree that the appropriate measurement of damages in the present case is a reasonable royalty. A reasonable royalty is the amount a willing licensor and willing licensee would agree to in a hypothetical negotiation at the time infringement begins. See Georgia-Pacific Corp. v. United States Plywood Corp., 318 F. Supp. 1116 (S.D.N.Y. 1970). The Georgia-Pacific factors include a wide variety of relevant factors which reasonable parties would take into consideration in a hypothetical negotiation. Id. at 1120.

The jury was given evidence that Shell's catalysts resulted in substantial savings on raw materials due to increased selectivity. (D.I. 625 at 682-83) The jury also heard evidence that Shell had used 5,102,436 pounds of the infringing catalysts internally. (D.I. 625 at 674-75; PTX 1094) At its own plants, this savings translated into approximately \$31 per pound of catalyst. (D.I. 625 at 674-75) The jury heard testimony showing that Shell realized a ten to thirty percent increase in production capacity, due to Shell's use at its own plants of the infringing catalysts. (Id. at 683-84) This increased production capacity resulted in a profit of approximately \$133 million or \$26 per pound of catalyst. Union Carbide's damages expert testified that at a hypothetical negotiation in 1993, the parties would have used the most conservative estimates of these savings and anticipated profits to reach a total value to Shell of \$41.27 per pound of catalyst used internally. (Id. at 686, 688-89, 692. Consequently, Union Carbide's damages expert testified that a reasonable royalty base would be \$20.63 per pound for Shell's internal infringing catalyst use, based upon an even sharing of the benefit to Shell.¹⁵ (Id. at 697)

¹⁵Union Carbide's damages theory that a reasonable royalty base would be fifty percent of benefit Shell received from use of the infringing catalysts was supported by evidence of certain of Union Carbide's joint ventures. (D.I. 626 at 738) The fifty percent figure was also supported by UCCPTC's practice of not licensing its catalyst technology due to the effect such licensing would have on Union Carbide's competitors' cost

With respect to external sales, the jury heard evidence that Shell generated an average profit of \$12.82 per pound of its S-863, S-880 and S-882 catalysts. (Id. at 701) The jury also heard evidence that Shell had sold nearly 9,862,290 pounds of the infringing catalysts. (Id. at 674-75; PTX 1096) Consequently, based upon a fifty percent share of Shell's profits from its external sales, Union Carbide's expert testified that a reasonable royalty would be \$6.41 per pound of catalyst sold. (D.I. 625 at 702-03)

Although Union Carbide sought a reasonable royalty in the amount of fifty percent of Shell's profits from external sales and fifty percent of the estimated benefit from internal use, the jury awarded \$13.62 per pound used internally and \$4.23 per pound sold to third parties. (D.I. 629 at 1603)

The crux of Shell's argument is that some of the factors considered by Union Carbide's damages expert, and presented to the jury, were either irrelevant, improper and/or prejudicial. In particular, Shell contends the following should not have been considered as factors in a hypothetical negotiation: (1) harm to Union Carbide Corporation ("UCC") as opposed to Union Carbide Chemicals & Plastics Technology Corporation ("UCCPTC"); (2) evidence pertaining to Shell's profits for MEG production; (3) evidence related to third parties' use of Shell catalysts; and

structures. (Id. at 610-12)

(4) evidence of Shell's external leases of catalysts.

The present case presented a problem of first impression for this court, namely, the extent to which the impact on a nonexclusive licensee may be a factor considered in a reasonable royalty analysis where the nonexclusive licensee is the parent corporation of the patent holder and the patent holder is solely a technology holding corporation.¹⁶ Shell argues that such a factor, even if a pertinent consideration, is unduly prejudicial. The court recognizes the risk that such evidence may permit a patent holder, not entitled to lost profits as a remedy, to nevertheless seek damages based in part upon lost profits. At trial, Shell objected to testimony from Union Carbide's damages expert that inaccurately portrayed the hypothetical negotiation to be between Union Carbide and Shell rather than UCCPTC and Shell. (D.I.626 at 654) The court sustained the objection and required Union Carbide to correct the record before the jury and to inform them that the expert's analysis included no numbers associated with Union Carbide's potential lost profits. (Id. at 655-57) In reviewing the record, the court finds that the damages expert's analysis was properly based on a substantial number of factors and the impact on UCC, as a factor a hypothetical patent holder would consider, was only one component

¹⁶This issue has appeared more than once and in more than one form over the course of the two trials in this case. (D.I. 561 at ¶ 35)

thereof. See Rite-Hite Corp. v. Kelley Co., Inc. 56 F.3d 1538, 1555 (Fed. Cir. 1995) ("The language of the statute requires 'damages adequate to compensate,' which does not include a royalty that a patentee who does not wish to license its patent would find unreasonable.").

The remainder of Shell's objections also relate to what factors were relevant to the determination of a reasonable royalty rate.¹⁷ In the present case, the court finds that the factors relied upon by Union Carbide's damages expert were consistent with the Georgia-Pacific standards and, as such, may be properly considered by the jury in determining a reasonable royalty base. The court also concludes that the damages award was supported by legally sufficient evidence on which a reasonable jury could rely. Consequently, Shell's motion for judgment as a matter of law will be denied. (D.I. 607; D.I. 655-1)

Where a jury's award of damages is clearly unsupported and/or excessive, it is within the court's discretion to reduce the award to the maximum amount a jury could reasonably find. See Spence v. Board of Educ., 806 F.2d 1198, 1201 (3d Cir. 1986). See also Gumbs v. Pueblo Int'l Inc., 823 F.2d 768, 772 (3d Cir. 1987). In the present case, the court does not find that the

¹⁷One of these factors, Shell's actual profits from MEG, has repeatedly been the subject of motion practice. (D.I. 269; D.I. 270; D.I. 561 at ¶ 36)

jury award is so excessive that it shocks the conscience. In the present case, while Union Carbide presented evidence that in a hypothetical negotiation it would have been entitled to fifty percent of Shell's profits from its use and sale of the infringing catalysts, the jury concluded that thirty-three percent was an appropriate royalty. See Rite-Hite Corp., 56 F.3d at 1555 (holding that it was "not unreasonable for the district court to find that an unwilling patentee would only license for one-half its expected lost profits and that such an amount was a reasonable royalty."). Viewing the evidence in the light most favorable to Union Carbide and giving Union Carbide the benefit of all reasonable inferences thereof, there is legally sufficient evidence to support the jury's award.

Consequently, Shell's motion for remittitur is denied. The court also finds that Shell has failed to establish that the verdict is against the great weight of the evidence such that it shocks the conscience and, therefore, its motion for a new trial will also be denied. (D.I. 655-2)

In reviewing the jury's verdict on damages, however, the court found that the total damages awarded by the jury were inconsistent with their determination as to the reasonable royalty rate.¹⁸ Based upon the undisputed evidence regarding the

¹⁸Question seven of the jury verdict asked what "amount of damages do you find Union Carbide has proved by a preponderance of the evidence?" (D.I. 602) The jury responded with the figure

number of pounds of catalyst actually sold or used by Shell, the jury's royalty rate and total damages do not bear a mathematical relationship.¹⁹ (D.I. 2197) While neither party raised this issue in its brief, it is well established the court has the inherent power to correct clerical errors in the record. Fed. R. Civ. P. 60(a). This extends to include errors in jury arithmetic. See U. S. for and on Behalf of Mississippi Road Supply Co. v. H. R. Morgan, Inc., 542 F.2d 262, 269 (5th Cir. 1976). Consequently, on its own motion the court will correct the verdict and judgment will be entered in the amount of \$111,212,665.02.

IV. EQUITABLE ISSUES

On March 25, 2004, consistent with this court's practice, a bench trial was held on Shell's equitable defenses of laches and estoppel. (D.I. 700) Those equitable issues have been fully

of \$112,198,893. The jury then responded to questions eight and nine which asked for the reasonable royalty rate in dollars for Shell's internal use and external sales respectively. In response to question eight, the jury responded \$13.62 per pound. In response to question nine, the jury responded \$4.23. (Id.)

¹⁹The evidence showed that Shell used 5,102,436 pounds of catalyst internally and 9,862,290 pounds of catalyst externally. (D.I. 2197) Based upon the royalty rates determined by the jury, the amount of royalties owed by Shell would be \$69,495,178.32 for internal use and \$41,717,486.70 for external sales. Consequently, total damages based upon the royalty rate determined by the jury would be \$111,212,665.02 which is \$986,237.98 less than the amount reported on the jury sheet. As there is no rational explanation for this discrepancy, the court can only conclude that this resulted from mathematical error.

briefed and are ripe for decision. These are the court's findings of fact and conclusions of law pursuant to Rule 52 of the Federal Rules of Civil Procedure.

A. Laches

1. Shell contends that Union Carbide had actual and constructive knowledge of Shell's potentially infringing activities as early as April 1990 and that Union Carbide's delay in bringing suit was inexcusable and prejudicial as to Shell. (D.I. 786)

2. **Facts of Record.** In February 1988, representatives from Shell and Union Carbide met and discussed a new Shell catalyst which was reported to have "broken through the theoretical selectivity barrier" of 85.7%. (D.I. 628 at 1338-40) This high selectivity catalyst, S-879, contained cesium, lithium, rhenium and sulfur. (D.I. 626 at 808; DTX 274 at S334247) Shell disclosed that it did have a new high selectivity catalyst but that its life span was relatively short. (D.I. 628 at 1340-41) Shell did not disclose to Union Carbide at that time, or any other time prior to suit, the composition of the S-879 catalyst. (D.I. 1717-19, 1762-63)

3. In May 1998, Shell's European patent application for its rhenium based catalysts was first published, European Patent application 266,015 ("EPA '015"). In one of its sixty examples, the EPA '015 discloses a catalyst which exceeds the theoretical

selectivity boundary of 85.7%. The preferred embodiment described in EPA '015 was a catalyst containing silver, rhenium and cesium only. (D.I. 700 at 1720-21)

4. Between August 1998 and February 1989, four more U.S. patents owned by Shell issued, including U.S. Patent Nos. 4,761,394, 4,766,105, 4,808,738, and 4,820,675 (the "U.S. Lauritzen patents"). The Lauritzen patents were all based on applications filed on October 31, 1986. The U.S. Lauritzen patents all disclose catalysts that include rhenium in addition to at least one alkali metal. By at least July 1988, Union Carbide scientists had reviewed EPA '015. (D.I. 700 at 1615-16, 1781-83; DTX 69 at U0093338)

5. Between 1988 and 1995, Union Carbide monitored publicly available information regarding Shell's catalysts and their commercial performance. Union Carbide had information indicating that Shell's rhenium catalysts had longevity problems. (D.I. 700 at 1789-94)

6. The first commercial use of an infringing Shell catalyst, S-880, occurred in July 1993.

7. Representatives of Shell and Union Carbide met in October 1995 and discussed prospects for collaboration. (D.I. 700 at 1799-1801) At that meeting, Union Carbide raised the issue that Shell may be infringing one of three Union Carbide patents. (D.I. 628 at 1345-46) Shell indicated it was aware of

the Union Carbide patents and denied infringement. (Id.; D.I. 700 at 1662-63, 1809) Following the meeting, Union Carbide continued to monitor available information about Shell's activities. (D.I. 700 at 1663)

8. In 1996, Union Carbide attended a presentation by a Shell scientist. (Id. at 1811-13) It was the impression of the Union Carbide representative that Shell's high selectivity catalysts were achieving efficiencies between 85-88%. (Id. at 1811-14)

9. In 1997, Union Carbide attended Shell's presentation at the Gordon Conference. (PTX 103 at U183745; D.I. 700 at 1814-17) Following the Gordon Conference, Union Carbide believed that the composition of Shell's high selectivity catalysts may infringe one or more Union Carbide patents, including the '243 patent. (D.I. 700 at 1815-18) Union Carbide began internally reviewing the information it had obtained. (Id. at 1664-69, 1818-19)

10. In October 1998, Union Carbide initiated discussions with Shell toward reaching an amicable resolution of the potential infringement issues. Discussions toward an amicable resolution failed when Shell filed a declaratory judgment suit.

11. Throughout the relevant period, Shell has actively guarded the composition of its catalysts. (Id. at 1765; PTX72 at S076322) CRI's catalyst customers were contractually prohibited from conducting tests on the catalysts. Prior to discovery in

this litigation, Union Carbide did not have any access to Shell's catalysts.

12. **Conclusions of Law.** It is well established that laches is a defense to a patent infringement suit brought in equity. See Lane & Bodley Co. v. Locke, 150 U.S. 193 (1893); Wollensak v. Reiher, 115 U.S. 96 (1885); Mahn v. Harwood, 112 U.S. 354 (1884). A.C. Aukerman Co. v. R.L. Chaides Const. Co. 960 F.2d 1020, 1028 (Fed. Cir. 1992). "In a legal context, laches may be defined as the neglect or delay in bringing suit to remedy an alleged wrong, which taken together with lapse of time and other circumstances, causes prejudice to the adverse party and operates as an equitable bar." A.C. Aukerman Co., 960 F.2d at 1028-29.

13. To prevail on its equitable defense of laches, Shell must prove by a preponderance of the evidence that: (1) Union Carbide delayed filing suit for an unreasonable and inexcusable period from the time that Union Carbide knew or should have known of its infringement claim against Shell; and (2) Union Carbide's delay operated to Shell's prejudice or injury. Id. at 1032.

14. The first prong of a laches defense requires proof that the patent holder had either actual or constructive knowledge of infringing activity. See Johnston v. Standard Min. Co., 148 U.S. 360, 370 (1893); Eastman Kodak Co. v. Goodyear Tire & Rubber Co., 114 F.3d 1547, 1559 (Fed. Cir. 1997). Constructive knowledge imposes upon patent holders the duty to police their rights. See

Wanlass v. General Electric Co., 148 F.3d 1334, 1338 (Fed. Cir. 1998). Under a constructive knowledge theory of laches, a patentee is charged with "such knowledge as he might have obtained upon inquiry, provided the facts already known by him were such as to put upon a man of ordinary intelligence the duty of inquiry." Johnston, 148 U.S. 360 at 370.

15. The defense of laches focuses on the conduct of the patentee, not the infringer. Nevertheless, the infringer's activities are relevant to whether the patentee's conduct was reasonable, including the infringer's efforts to maintain the secrecy of its processes and its denials of infringement. See Eastman Kodak Co., 114 F.3d at 1559. An infringer can not cloak its activities in secrecy and simultaneously accuse the patent holder of failing to adequately protect its rights. See, e.g., Fromson v. Western Litho Plate and Supply Co., 670 F. Supp. 861, 868-69 (E.D. Mo. 1987), rev'd on other grounds by 853 F.2d 1568 (Fed. Cir. 1988).²⁰

16. The court finds that there is no evidence that Union Carbide had actual knowledge that Shell's catalysts infringed the

²⁰Laches, and a property owner's duty to police its rights, are universal concepts in property law. In fact, a patentee's duty to inquire is directly attributed to trademark law. Compare Potash Co. v. Int'l Minerals & Chem. Corp., 213 F.2d 153, 155 (10th Cir. 1954) with Johnston, 148 U.S. at 370. The requirement that only activities which are open and notorious can give rise to a subsequent defense of laches insures that a patentee's rights will not be diminished in secret.

'243 patent. Therefore, Shell can only prevail on its laches defense if it can establish that there were sufficient facts to warrant imputing constructive knowledge of Shell's infringing activities to Union Carbide and that Union Carbide's delay was unreasonable and inexcusable.

17. Where an infringer invokes the defense of laches based upon the patentee's constructive knowledge, the infringer must demonstrate that there were sufficient facts available to the patentee such that a duty to inquire arose. Wanlass, 148 F.3d at 1338. This duty to inquire commands that a patentee may not fail to police its property rights under circumstances where it has reason to suspect infringement. Circumstances which give rise to a duty to inquire must be "pervasive, open, and notorious" and include "sales, marketing, publication or public use of a product similar to or embodying technology similar to the patented invention, or published descriptions of the defendant's potentially infringing activities." Id. at 1339.

18. A patentee's duty to inquire is subject to a standard of reasonableness. As such, the extent to which a reasonable method of detection of infringement is available to the patentee is relevant. See Wanlass, 148 F.3d at 1334; Wanlass v. Fedders Corp., 145 F.3d 1461, 1467 (Fed. Cir. 1998); Hall v. Aqua Queen Mfg., Inc., 93 F.3d 1548, 39 (Fed. Cir. 1996); Imperial Chem. Mfg. Co. v. Stein, 77 F. 612 (2d Cir. 1896).

19. As an initial matter, the court finds that Shell's activities occurring before July 1993, when S-880 was first commercially used, do not give rise to a duty to inquire. Any activities of Shell before that date can not be said to have put Union Carbide on notice as they were not, in fact, infringing activities. Moreover, it is also relevant that Shell's actual infringing activities were concealed.

20. As result of its continuing efforts to remain abreast of its competitors' activities and of advances in technology, Union Carbide was aware that in the early 1990s, Shell was attempting to commercialize a high selectivity catalyst. Based upon Shell's patents, Union Carbide's belief that these were rhenium based and not mixed alkali based was reasonable. The fact that some examples contained in certain Shell patents disclosed mixed alkali catalysts raises only a suggestion and is not sufficient evidence that Shell was infringing the '243 patent. Even when combined with the fact that it was known to Union Carbide that Shell was attempting to commercialize a high selectivity catalyst, these facts are not sufficient evidence by which a reasonable person would conclude that Shell was infringing or was likely infringing the '243 patent. Instead, these facts at most give rise to a suspicion.

21. Union Carbide's decision to pursue its suspicion by directly inquiring of Shell in 1995 was consistent with a

patentee exercising reasonable diligence. It is contrary to principles of equity for Shell to affirmatively represent in 1995 that its activities were noninfringing and then permit it to subsequently assert laches as a defense when Union Carbide, at least in part, relied on Shell's representations. Otherwise, the duty to inquire essentially becomes a duty to sue upon suspicion. While it is true that Union Carbide did not need to know the actual composition of Shell's catalysts to bring suit, that does not mean that its prudence in bringing suit was unreasonable.

22. Under the circumstances of the present case, including the secret nature of Shell's infringing activities, Union Carbide's reasonable diligence in monitoring the market, and Shell's resistance to Union Carbide's efforts to ascertain whether Shell infringed the '243 patent, the court finds that Union Carbide's conduct was not unreasonable.

B. Equitable Estoppel

23. Shell contends that Union Carbide's failure to bring suit misled Shell to believe that Union Carbide would not bring suit and Shell detrimentally relied upon that belief.

24. **Conclusions of Law.** Equitable estoppel is similar to laches but focuses on the reasonableness of the infringer's reliance rather than the unreasonableness of the patentee's delay. To obtain relief from enforcement of a patent under the

doctrine of equitable estoppel, the defendant must prove by clear and convincing evidence three elements: (1) the patentee, through misleading conduct, led the infringer to reasonably infer that the patentee did not intend to enforce its patent; (2) reliance by the infringer on the patentee's misleading conduct; (3) material prejudice to the infringer. See A.C. Auckerman Co., 960 F.2d at 1028.

25. Having already concluded that Shell failed to prove that Union Carbide had actual knowledge of Shell's infringing activities, Shell's defense of equitable estoppel fails. Union Carbide could not have affirmatively misled Shell that it would not enforce its patents, if Union Carbide did not have knowledge of Shell's infringement. Consequently, the court finds that Shell's defense of equitable estoppel fails.

V. PREJUDGMENT INTEREST

Pursuant to 35 U.S.C. § 284, Union Carbide filed a motion for the award of prejudgment interest. (D.I. 661) Union Carbide seeks prejudgment interest at the prime rate compounded annually from July 1993 until the entry of judgment.²¹ The prime rate for the relevant period ranges from as low as 4% to as high as 9.5%. (D.I 689, ex. A) Both parties seek a further expansion of the

²¹Union Carbide's brief is internally inconsistent on this point, initially asserting that interest should be compounded quarterly but later stating that it should be compounded annually. (D.I. 661 at 1-2, 4)

evidentiary record on this issue. (Id. at 4; D.I.679 at 1) The court concludes, however, that further evidence is not necessary to resolve the issue.

The rate, if any, of prejudgment interest to be awarded is within the discretion of the court. See Studiengesellschaft Kohle, m.b.H. v. Dart Industries, Inc., 862 F.2d 1564, 1580 (Fed. Cir. 1988). A patent holder need not prove that it borrowed at the prime rate in order to be entitled to prejudgment interest on that basis. See Uniroyal, Inc. V. Rudkin-Wiley Corp., 939 F.2d 1540, 1545 (Fed. Cir. 1991). The determination of whether to award simple or compounded interest is within the discretion of the court. See Rite-Hite Corp., 56 F.3d at 1555.

The court finds that the appropriate rate of interest to be awarded in the present case is the prime rate. Mindful of its discretion, the court finds that simple interest will adequately compensate Union Carbide in this case. Interest will be awarded for a period beginning on July 1, 1993 and ending on May 31, 2004. Based upon the damages award of \$111,212,665.02, the court finds that Union Carbide is entitled to prejudgment interest in the total amount of \$42,403,108.67.²²

²²In calculating the interest, the court relied upon catalysts actually used internally and sold externally during each year beginning in July 1993. (D.I. 2204) The court then calculated simple interest for each year based upon the total accrued amount of catalyst used or sold through that year. (D.I. 689 ex. A) For the years 2003 and 2004 the court prorated the

VI. PERMANENT INJUNCTION

Union Carbide seeks a permanent injunction enjoining Shell from making, using, selling or offering for sale: (1) the Shell catalysts, S-880, S-882 and S-863, for use in a process for the production of ethylene oxide or (2) any other Shell catalyst falling within the scope of claim 4 of the '243 patent. In a patent infringement suit, a district court may grant a preliminary injunction pending trial or a permanent injunction "after a full determination on the merits." High Tech. Med. Instr., Inc. v. New Image Indus., Inc., 49 F.3d 1551, 1554 (Fed. Cir. 1995). Indeed, the Federal Circuit has indicated that once a finding of infringement has been made, an injunction should issue absent a sufficient reason for denying it. Richardson v. Suzuki Motor Co., Ltd., 868 F.2d 1226, 1247 (Fed. Cir. 1989). Courts, therefore, are given wide latitude in framing injunctive relief. See KSM Fastening Sys., Inc. v. H.A. Jones Co., 776 F.2d 1522, 1527 (Fed. Cir. 1985). Nonetheless, consistent with the equitable nature of a permanent injunction, the court "must consider all circumstances, including the adequacy of the legal remedy, irreparable injury, whether the public interest would be served, and the hardship on the parties and third parties". E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co., 659 F. Supp.

interest consistent with number of months for which interest was to be applied.

92, 94 (D. Del. 1987). Additionally, Fed. R. Civ. P. 65(d) requires an injunction to "set forth the reasons for its issuance, be specific in its terms, and shall describe in reasonable detail, and not by reference to the complaint or other document, the act or acts sought to be restrained; and is binding only upon the parties to the action." Fed. R. Civ. P. 65(d).

In the present case, the court finds that Union Carbide will suffer irreparable harm without a permanent injunction to prevent Shell from practicing its patented catalytic process for the manufacture of EO. See H.H. Robertson Co. v. United Steel Deck, Inc., 820 F.2d 384 (Fed. Cir. 1987). Further, the court finds that there are not countervailing equities in the present case to the patentee's right to exclude others from practicing the invention. Accordingly, the court finds that a permanent injunction is warranted.

The parties agree that the scope of the injunction should not include catalysts upon which damages were awarded by the jury. Therefore, the court will order a permanent injunction barring Shell from making, using or selling S-880, S-882 and S-863 catalysts which were not covered by the jury's damages award.

Shell seeks a stay of this injunction pending resolution of Shell's anticipated appeal to the Federal Circuit. (D.I. 681) Pursuant to Fed. R. Civ. P. 62(c), it is within the discretion of the court to stay an injunction pending the outcome of an appeal

of the judgment. A determination to stay a permanent injunction is guided by four factors: (1) likelihood of success on the merits of the appeal; (2) irreparable injury absent a stay; (3) substantial injury to the other party if the stay is granted; and (4) the public interest. Hilton v. Braunskill, 481 U.S. 770, (1987); Standard Havens Products, Inc. v. Gencor Industries, Inc., 897 F.2d 511, 512 (Fed. Cir. 1990). The four factors often effectively merge as the likelihood of success is weighed with the equities affecting the parties and the public. Standard Havens Products, Inc., 897 F.2d at 513.

With respect to the first factor, the parties have raised complex issues of law, issues which this court and the parties recognize would ultimately be resolved on appeal. Union Carbide can not fairly assert that a permanent injunction would not affect Shell's commercial practices as the record clearly demonstrates that the infringing catalysts are a substantial source of revenue. Further, the court is mindful of the fact that the legal holder of the patent is a technology holding company; there is nothing in the record to suggest that UCCPTC's interests would not be adequately protected through an appeal bond or similar assurance. Finally, the court finds that there are not unique public interests weighing in either party's favor in the present patent dispute. Consequently, the court finds that the equities in the present case substantially weigh in

favor of maintaining the status quo. Therefore, the permanent injunction will be stayed pending the outcome of any appeals.

VII. CONCLUSION

For the reasons discussed above, the court will deny Shell's post-trial motions for judgment as a matter of law or in the alternative for a new trial. (D.I. 605, 607, 609, 611, 613, 615, 617, 645, 647, 649, 651, 653, 655, 657) The court will also deny Union Carbide's motion for judgment as a matter of law on its claim of willful infringement. (D.I. 662) The court has also found that Shell has failed to prove by clear and convincing evidence its equitable defenses of laches and estoppel. Therefore, the court will enter judgment in favor of Union Carbide for damages in the amount of \$111,212,665.02 and prejudgment interest in the amount of \$42,403,108.67. Finally, the court will grant Union Carbide's motion for permanent injunction (D.I. 665), but will also grant Shell's motion for a stay of the permanent injunction pending the outcome of any appeals. (D.I. 681) An order consistent with this opinion shall issue.

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

UNION CARBIDE CHEMS. &)	
PLASTICS TECH. CORP. and)	
UNION CARBIDE CORP.,)	
)	
Plaintiffs,)	
Counter-Defendants,)	
v.)	Civ. No. 99-CV-274-SLR
)	(Consolidated)
SHELL OIL CO.,)	
SHELL CHEMICAL CO., and)	
CRI CATALYST CO.,)	
)	
Defendants,)	
Counter-Plaintiffs.)	
)	
)	
SHELL OIL CO.,)	
)	
Plaintiff,)	
v.)	Civ. No. 99-846-SLR
)	
UNION CARBIDE CHEMS. &)	
PLASTICS TECH. CORP. and)	
UNION CARBIDE CORP.,)	
)	
Defendants.)	

O R D E R

At Wilmington, this 9th day of June, 2004, consistent with the memorandum opinion in the above captioned case issued this same day;

IT IS ORDERED that:

1. Defendants' motion to exclude certain testimony of Dr.

Parvez H. Wadia is **denied**. (D.I. 704)

2. Defendants' motion for judgment as a matter of law on plaintiff's claim of willfulness is **denied as moot** per the jury's verdict. (D.I 615)

3. Defendants' motions for judgment as a matter of law or, in the alternative, for a new trial are **denied**. (D.I. 605; D.I. 607; D.I. 609; D.I. 611; D.I. 613; D.I. 617; D.I. 645-1; D.I. 645-2; D.I. 647-1; D.I. 647-2; D.I. 649; D.I. 651-1; D.I. 651-2; D.I. 653-1; D.I. 653-2; D.I. 655-1; D.I. 655-2; D.I. 657-1; D.I. 657-2)

4. Plaintiffs' motion for judgment as a matter of law is **denied**. (D.I. 662)

5. Plaintiff's motion for prejudgment interest is **granted**. (D.I. 661)

6. Plaintiffs' motion for a permanent injunction is **granted**. (D.I. 665)

7. Defendants' motion for a stay of the permanent injunction is **granted**. (D.I. 681)

8. IT IS THEREFORE ADJUDGED AND DECREED that, within fifteen (15) days after the entry of this order until April 10, 2007, the expiration date of United States Patent No. 4,916,243 ("the '243 patent"), defendants Shell Oil Company, Shell Chemical Company and CRI Catalyst, their officers, agents, servants, employees, and attorneys as well as all persons in active concern

or participation therewith are hereby enjoined from: (1) making, using, selling, or offering to sell in the United States the S-880, S-882 and S-863 catalysts used in a process for making ethylene oxide found by the jury in this case to have infringed claim 4 of the '243 patent, except that the injunction against said catalysts shall not apply to the use of any charges of those catalysts that were included in the plaintiffs' evidence at trial to support an award of damages; and (2) making, using, selling or offering to sell in the United States any other Shell catalyst falling within the scope of the catalyst limitations of claim 4 of the '243 patent for use in an ethylene oxide production system in the United States.

9. IT IS FURTHER ADJUDGED AND DECREED that, pursuant to Fed. R. Civ. P. 62, this permanent injunction is hereby stayed during the pendency of any appeals of the judgment in this case. The stay shall be effective until the issuance of the Federal Circuit's mandate of a decision on the merits of any appeal of the judgment of the case.

10. The clerk of the court is directed to enter judgment in favor of plaintiffs and against defendants in the amount of \$153,615,773.69.

Sue L. Robinson
United States District Court