

United States Court of Appeals for the Federal Circuit

00-5077

EXXON RESEARCH AND ENGINEERING COMPANY,

Plaintiff-Appellant,

v.

UNITED STATES,

Defendant?Appellee.

E. Edward Bruce, Covington & Burling, of Washington, DC, argued for plaintiff-appellant. With him on the brief were Christopher N. Sipes, and Kevin C. Newsom. Of counsel on the brief were Steven D. Glazer, James W. Quinn, Kevin McMahon, and Elizabeth S. Weiswasser, Weil, Gotshal & Manges LLP, of New York, New York. Of counsel were Matthew D. Powers, David J. Lender, and Peter Tu, Weil Gotshal & Manges, LLP.

Grace S. Karaffa, Attorney, Commercial Litigation Branch, Civil Division, Department of Justice, of Washington, DC, argued for defendant-appellee. With her on the brief was Vito J. DiPietro, Director. Of counsel on the brief were Thomas J. Byrnes, Richard T. Ruzich, and Ken B. Barrett, Attorneys.

Appealed from: United States Court of Federal Claims

Judge Edward J. Damich

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DECIDED: September 19, 2001

Before MAYER, Chief Judge, LOURIE and BRYSON, Circuit Judges.

BRYSON, Circuit Judge.

Exxon Research and Engineering Co. is the assignee of U.S. Patent Nos. 5,292,705 (“the ’705 patent”) and 5,348,982 (“the ’982 patent”), which are directed to improvements in a method for converting natural gas into liquid hydrocarbon products. Exxon brought suit against the United States in the Court of Federal Claims, asserting that the government infringed the ’705 and ’982 patents by authorizing Department of Energy subcontractors to use conversion methods covered by the patents. The government filed a motion for summary judgment seeking to have both patents held invalid for indefiniteness. In a detailed and careful opinion, the Court of Federal Claims granted the government’s motion, and Exxon appealed. We conclude that, although this case presents several close questions, the claims at issue are not invalid for indefiniteness. Accordingly, we reverse the court’s judgment of invalidity with respect to the two Exxon patents and remand the case for further proceedings.

I

The ’705 and ’982 patents relate to improvements in what is known as the Fischer-Tropsch process for converting natural gas to liquid hydrocarbon products. As the process is described in the patents, natural gas is first broken down to produce synthesis gas (carbon monoxide and hydrogen). The synthesis gas is then introduced into a slurry bubble column where it undergoes the Fischer-Tropsch reaction. In the slurry bubble column, catalytic particles are suspended in liquid hydrocarbons. Gas phase reactants, including the synthesis gas, are then bubbled through the reactor. As the gas bubbles rise, the reactants are absorbed into the liquid and diffuse to the catalyst where they are converted to liquid hydrocarbon products.

A

The ’705 patent is directed to a method of activating an essentially fresh, reduced cobalt-containing Fischer-Tropsch catalyst. According to the specification, the cobalt catalyst is incorporated into an inert support material such as an inorganic refractory oxide. Because cobalt

can be dangerous to handle, the supported cobalt catalyst is then typically heated in air to form an inactive cobalt oxide. The cobalt oxide must then be “reduced” to active cobalt metal before it is introduced into the slurry bubble column reactor. That is conventionally done by treating the cobalt oxide with hydrogen or hydrogen-containing gas at elevated temperatures or pressures. The specification teaches that the essentially fresh, reduced cobalt catalyst can then be “super activated” in a way that accelerates the conversion of the natural gas components into liquid hydrocarbons if the cobalt is further treated with hydrogen or a hydrogen-containing gas after the catalyst is introduced into the slurry bubble column reactor. The super-activation procedure is conducted either before synthesis gas is introduced into the reactor or shortly after the synthesis reaction has begun. The '705 patent states that the claimed treatment method increases the relative catalyst productivity in the Fischer-Tropsch reaction by at least 30%. '705 patent, col. 1, ll. 59-64. The '705 patent claims:

1. A method for activating an essentially fresh, reduced cobalt containing Fischer-Tropsch catalyst which comprises treating the catalyst with hydrogen or a hydrogen containing gas in the presence of hydrocarbon liquids for a period sufficient to increase substantially the initial catalyst productivity.

All other claims of the '705 patent depend from claim 1.

In its motion for summary judgment, the government asserted that the terms “for a period sufficient” and “to increase substantially” in claim 1 of the '705 patent were both indefinite. The Court of Federal Claims agreed with the government's submission and therefore held the '705 patent invalid.

B

The '982 patent teaches a method for optimally operating a slurry bubble column using a supported cobalt catalyst to produce hydrocarbon products at an increased rate. This result is achieved by controlling certain reactor variables. Claim 1 of the '982 patent recites:

1. A method for optimally operating a large diameter three phase (gas, liquid, solid) slurry bubble column having a diameter greater than 15 cm for Fischer-Tropsch synthesis over a supported cobalt catalyst in which solid particles are fluidized in the liquid phase by bubbles of the gas phase, comprising:

(a) injecting the gas phase into said column at an average gas velocity along said column, $U_g > 2$ cm/sec, such that the flow regime is in the substantial absence of slug flow;

(b) fluidizing the solid supported cobalt catalyst particles of average diameter, $d_p > 5$ μ m, to the height, $H > 3$ m, of the expanded liquid in the column by operating with a catalyst settling velocity, U_s , and dispersion coefficient, D , such that

$$0.5 (U_s - U_L) \cong \frac{D}{H}, \text{ where } H > 3 \text{ m}$$

where

$$U_s = \frac{1}{18} d_p^2 \frac{\rho_s - \rho_l}{\mu} g f(C_p), \text{ where } d_p > 5 \mu\text{m}$$

(c) maintaining plug flow in said column by operating with a gas phase velocity, U_g , expanded liquid height, H , and dispersion coefficient, D , such that

$$U_g = 0.2D/H, \text{ where } H > 3\text{m}, U_g > 2 \text{ cm/sec}$$

wherein

ρ_s = effective density of the particles

ρ_l = density of the liquid

μ = viscosity of the liquid

$f(C_p)$ = hindered settling function

C_p = volume fraction of solids in the slurry (liquid plus solids)

U_L = liquid velocity along the column

H = height of the expanded liquid in said reactor

g = gravitational constant

d_p = diameter of particles

m = meters.

All other claims of the '982 patent depend from claim 1.

On the government's motion for summary judgment, the Court of Federal Claims found that four of the terms in claim 1 of the '982 patent were indefinite and that claim 1 and all the dependent claims were therefore invalid. The four terms that the court found to be indefinite are: "substantial absence of slug flow," "fluidizing the . . . catalyst particles . . . to the height, $H > 3m$," "particles of average diameter," and the term " U_L " as used in the first formula set out in claim 1.

II

A

Section 112 paragraph 2 of the Patent Act requires that a patent specification conclude with one

or more claims “particularly pointing out and distinctly claiming subject matter which the applicant regards as his invention.” 35 U.S.C. § 112, ¶ 2. We have stated the standard for assessing whether a patent claim is sufficiently definite to satisfy the statutory requirement as follows: If one skilled in the art would understand the bounds of the claim when read in light of the specification, then the claim satisfies section 112 paragraph 2. Miles Labs., Inc. v. Shandon, Inc., 997 F.2d 870, 875, 27 USPQ2d 1123, 1126 (Fed. Cir. 1993).

While that standard is easy to state, it has not always proved easy to apply. The Supreme Court explained the reason underlying the indefiniteness doctrine 60 years ago in United Carbon Co. v. Binney & Smith Co., 317 U.S. 228, 236, 55 USPQ 381, 385 (1942):

A zone of uncertainty which enterprise and experimentation may enter only at the risk of infringement claims would discourage invention only a little less than unequivocal foreclosure of the field. Moreover, the claims must be reasonably clear-cut to enable courts to determine whether novelty and invention are genuine.

In determining whether that standard is met, i.e., whether “the claims at issue [are] sufficiently precise to permit a potential competitor to determine whether or not he is infringing,” Morton Int’l, Inc. v. Cardinal Chem. Co., 5 F.3d 1464, 1470, 28 USPQ2d 1190, 1195 (Fed. Cir. 1993), we have not held that a claim is indefinite merely because it poses a difficult issue of claim construction. We engage in claim construction every day, and cases frequently present close questions of claim construction on which expert witnesses, trial courts, and even the judges of this court may disagree. Under a broad concept of indefiniteness, all but the clearest claim construction issues could be regarded as giving rise to invalidating indefiniteness in the claims at issue. But we have not adopted that approach to the law of indefiniteness. We have not insisted that claims be plain on their face in order to avoid condemnation for indefiniteness; rather, what we have asked is that

the claims be amenable to construction, however difficult that task may be. If a claim is insolubly ambiguous, and no narrowing construction can properly be adopted, we have held the claim indefinite. If the meaning of the claim is discernible, even though the task may be formidable and the conclusion may be one over which reasonable persons will disagree, we have held the claim sufficiently clear to avoid invalidity on indefiniteness grounds. See, e.g., Modine Mfg. Co. v. U.S. Int'l Trade Comm'n, 75 F.3d 1545, 1557, 37 USPQ2d 1609, 1617 (Fed. Cir. 1996) (rejecting indefiniteness argument after construing claims; stating that “when claims are amenable to more than one construction, they should when reasonably possible be interpreted to preserve their validity”); Athletic Alternatives, Inc. v. Prince Mfg., Inc., 73 F.3d 1573, 1581, 37 USPQ2d 1365, 1372 (Fed. Cir. 1996) (court chose the narrower of two equally plausible claim constructions in order to avoid invalidating the claim). By finding claims indefinite only if reasonable efforts at claim construction prove futile, we accord respect to the statutory presumption of patent validity, see N. Am. Vaccine, Inc. v. Am. Cyanamid Co., 7 F.3d 1571, 1579, 28 USPQ2d 1333, 1339 (Fed. Cir. 1993), and we protect the inventive contribution of patentees, even when the drafting of their patents has been less than ideal.

B

A decision holding a patent invalid for indefiniteness presents a question of law, which we review de novo. See Atmel Corp. v. Info. Storage Devices, Inc., 198 F.3d 1374, 1378, 53 USPQ2d 1225, 1227 (Fed. Cir. 2000). Despite a multitude of recent authorities stating that indefiniteness is a question of law, see, e.g., S3 Inc. v. nVIDIA Corp., No. 00-1257, slip. op. at 4 (Fed. Cir. Aug. 3, 2001); Union Pac. Res. Co. v. Chesapeake Energy Corp., 236 F.3d 684, 692, 57 USPQ2d 1293, 1297 (Fed. Cir. 2001); Process Control Corp. v. Hydrexclaim Corp., 190 F.3d 1350, 1358 n.2, 52 USPQ2d 1029, 1034 n.2 (Fed. Cir. 1999); Solomon v. Kimberly-Clark Corp., 216 F.3d 1372, 1377, 55 USPQ2d 1279, 1281 (Fed. Cir. 2000); and Personalized Media Communications, L.L.C. v. Int'l Trade Comm'n, 161 F.3d 696, 702, 48 USPQ2d 1880, 1886 (Fed. Cir. 1998), Exxon contends that

indefiniteness depends on underlying questions of fact. It argues that in this case there is a genuine issue of material fact as to whether the claims of the two patents at issue, read in light of their specifications, reasonably apprise those skilled in the art of the scope of the invention. For that reason, Exxon asks us to reverse the summary judgment so that the Court of Federal Claims, sitting as a fact-finder at trial, can decide the purported factual issues and reconsider its prior invalidity determination.

We adhere to the principle that “determination of claim indefiniteness is a legal conclusion that is drawn from the court’s performance of its duty as the construer of patent claims.” Personalized Media Communications, 161 F.3d at 705, 48 USPQ2d at 1888; see also Cybor Corp. v. FAS Techs., Inc., 138 F.3d 1448, 1454-55, 46 USPQ2d 1169, 1172-73 (Fed. Cir. 1998) (en banc). In Cybor, we reaffirmed that although a court may consider or reject certain extrinsic evidence in resolving disputes en route to pronouncing the meaning of claim language, “the court is not crediting certain evidence over other evidence or making factual evidentiary findings. Rather, the court is looking to the extrinsic evidence to assist in its construction of the written document” Cybor, 138 F.3d at 1454, 46 USPQ2d at 1173 (quoting Markman v. Westview Instruments, Inc., 52 F.3d 967, 981, 34 USPQ2d 1321, 1331 (Fed. Cir. 1995) (en banc)). We therefore reject Exxon’s argument that the issue of indefiniteness turns on an underlying factual dispute that should not have been resolved as a matter of law on summary judgment.

C

The trial court was correct to fault the Exxon patents as lacking in specificity in several respects—specificity that in some instances would have been easy to provide and would have largely obviated the need to address the issue of indefiniteness. As is often the case when problems in document drafting lead to litigation, the ideal of precision was not achieved here, and we are left to deal with an imperfect product. While we agree with the trial court that the product was less than perfect, we disagree that the flaws were fatal.

III

The trial court held claim 1 of the '705 patent to be indefinite based on the absence of a specified period of time in the claim for treating the Fischer-Tropsch catalyst with hydrogen or a hydrogen-containing gas. The claim recites that the treatment should be “for a period sufficient to increase substantially the initial catalyst activity.” The trial court broke that clause down into two parts for purposes of its indefiniteness analysis, and it ruled that both the phrase “for a period sufficient” and the phrase “to increase substantially” were indefinite.

A

The term “to increase substantially” in claim 1 of the '705 patent refers to the claimed increase achieved by the invention in the relative productivity of the catalyst used in the Fischer-Tropsch process. The specification defines “substantially increased” catalyst activity or productivity as an increase of at least about 30%, more preferably an increase of about 50%, and still more preferably an increase of about 75%. '705 patent, col. 1, ll. 59-63. Based on that language from the specification, the trial court found, and the parties agree, that the term “to increase substantially” requires an increase of at least about 30% in the relative productivity of the catalyst. Notwithstanding that numerical boundary, the trial court found the phrase “to increase substantially” to be indefinite because the court concluded that there were two possible ways to calculate the increase in productivity, the subtraction method and the division method, and the patent did not make clear which of those ways was used in the claim.

An example from the specification will illustrate the difference between the two methods of calculating the increase in catalyst productivity. The specification gives two examples showing the relative productivity “before” and “after” super-activation according to the method of the invention. In the experiment reported in Example 1, the “before” productivity was 60 and the “after” productivity was 100. In the experiment reported in Example 2, the “before” productivity

was 25 and the “after” productivity was 100. The court found that the increase in relative productivity could be calculated either by the subtraction method or the division method. That is, in Example 2 there would be either a 75% increase (100 minus 25) or a 300% increase ([100 minus 25] divided by 25). The difference in the numerical outcome produced by the two results is relevant because in certain circumstances calculating relative productivity by the first method could produce an increase of less than 30% in relative productivity, but using the second method could produce an increase of more than 30%. In such a case, the trial court explained, a person of skill in the art would not be able to determine whether the claims of the ’705 patent were infringed. That ambiguity, according to the court, rendered the claims indefinite.

We disagree with the court’s conclusion as to the indefiniteness of the phrase “to increase substantially.” The specification makes it reasonably clear that the patentee intended to use the subtraction method in calculating relative productivity. As noted above, the specification recites that catalyst productivity can “more preferably” be increased by as much as 75%. Corresponding to that preferable level of increased productivity, the best result reported in the patent is found in Example 2, which shows an increase in relative productivity from 25% to 100%, which is an increase of 75% by the subtraction method. The same result is shown graphically in Figure 1 of the patent, which depicts a 75% difference between the “before” and “after” relative productivity levels, as calculated by the subtraction method. In contrast, there is no suggestion in the specification that the claimed invention was able to achieve increases on the order of 300%, which would be the way the Figure 1 increase would be characterized if the division method were used. In light of the intrinsic evidence, one of skill in the art would likely understand that the patentee employed the subtraction method of measuring the increase in relative productivity. Thus, the term “to increase substantially” does not introduce any insoluble ambiguity into the claims of the ’705 patent and does not render the claims invalid for indefiniteness.

B

The trial court also found that the “for a period sufficient” limitation in claim 1 of the ’705 patent was indefinite and that it rendered claim 1 and the dependent claims of the ’705 patent invalid. The court based that conclusion on the fact that neither the claims nor the specification identified any upper or lower boundary for the prescribed period. Without such boundaries, the court concluded, a person of ordinary skill in the art could not determine the scope of the claims.

Although the specification teaches away from treating the cobalt catalyst for a period longer than necessary to obtain maximum activity enhancement, see ’705 patent, col. 3, ll. 21-23, the claims are not indefinite on the ground that they fail to recite an upper boundary for the “for a period sufficient” limitation. The claims provide that the catalyst must be treated “for a period sufficient” to attain a 30% increase in catalyst productivity. That limitation sets the minimum period of treatment, but any longer period would also fall within the reach of the claim language. Thus, the “period sufficient” limitation by its terms delineates only a lower boundary. While treatment of the catalyst for a much longer period might not be as effective as treatment for a period barely sufficient to achieve the prescribed increase in catalyst productivity, the fact that the invention may be inoperable with very long treatment periods does not make the claim language indefinite. See N. Am. Vaccine, 7 F.3d at 1579, 28 USPQ2d at 1339 (the fact that claims “include species which might not meet the objects of the invention does not by itself prove that one skilled in the art cannot ascertain the scope of the asserted claims”). The indefiniteness issue thus turns on whether the lower boundary of the “for a period sufficient” limitation is impermissibly vague.

The trial court rejected Exxon’s contention that the lower boundary could be ascertained by conducting activity checks during the super-activation procedure. The court noted that the patent taught the use of such checks only to determine the initial activity of the fresh catalyst, and that conducting activity checks to determine whether the catalyst has been sufficiently exposed would risk corrupting the catalyst and would significantly disrupt the super-activation procedure. In addition, the court rejected Exxon’s alternative argument that the claim term “a period sufficient” is

as definite as possible given the varying conditions, including temperature and treat ratio.

Although the patent does not quantify the “period sufficient” limitation by reference to any specific period or range of periods, it does not leave those skilled in the art entirely without guidance as to the scope of that requirement. The specification states:

The period necessary for activation is that period that results in substantial increases in initial, e.g., start of run, catalyst productivity, preferably at least about a thirty percent (30%) increase in relative catalyst productivity and may vary with temperature and treat ratio, etc., but is usually accomplished in about 0.25-24 hours, preferably about 0.5-2 hours.

'705 patent, col. 2, ll. 58-64. As the trial court noted, the specification does not give a specific example of a period of time sufficient to achieve a particular increase in catalyst productivity for a certain supported catalyst. However, a preferred treatment period is provided that presumptively correlates to the preferred catalyst, hydrogen treat rate range, and temperature range disclosed in the specification. By looking to the specification, one of skill in the art could determine that “a period sufficient” is about 0.25 hours, and preferably 0.5 hours. Because the patent makes clear that the period in question will vary with changes in the catalyst and the conditions in which the process is run, we conclude that the claim limitation is expressed in terms that are reasonably precise in light of the subject matter. See Orthokinetics, Inc. v. Safety Travel Chairs, Inc., 806 F.2d 1565, 1576, 1 USPQ2d 1081, 1088 (Fed. Cir. 1986) (construing “so dimensioned” as definite and stating that the term “is as accurate as the subject matter permits, automobiles being of various sizes”).

In addition, it appears that one of skill in the art could measure the period “sufficient to increase substantially the initial catalyst activity” for a particular catalyst more precisely by conducting

activity checks. As the trial court noted, conducting such checks could contaminate the catalyst or disrupt the super-activation procedure. However, that does not mean that the data collected would be any less relevant in determining the scope of the claim. Once the “period sufficient” for a particular catalyst is determined, there would be no need to duplicate the activity checks during normal slurry bubble column reactor operations, and there would be no continuing risk of contamination or disruption. Even the government’s expert agreed that the “period sufficient” could be determined from conducting such checks, and that he “wouldn’t say they are difficult to do.” Provided that the claims are enabled, and no undue experimentation is required, the fact that some experimentation may be necessary to determine the scope of the claims does not render the claims indefinite. See W.L. Gore & Assocs., Inc. v. Garlock, Inc., 721 F.2d 1540, 1557, 220 USPQ 303, 316 (Fed. Cir. 1983).

Our predecessor court’s decision in In re Jolly, 172 F.2d 566, 80 USPQ 504 (CCPA 1949), although offering support to the government’s position, does not compel a contrary result. In re Jolly concerned an indefiniteness rejection based on similar claim language, “a time sufficient to produce a substantially homogeneous product but insufficient to cause the formation of a substantial proportion of oil-insoluble reaction products.” The court there found that since the time of reaction was taught to be critical, the claims must recite a time range for the sulfurization step at issue. While an upper time limit was recited, at least in some claims and in the written description, there was no lower limit recited. For that reason, the court affirmed the examiner’s rejection, stating that “[s]o far as the time of reaction is concerned, it seems to us that all that appellant’s specification teaches those skilled in the art is to experiment and find out for themselves how much time will be required where different amounts, or proportions, of nitriles and sulfur are used.” In re Jolly, 172 F.2d at 569, 80 USPQ at 506.

In re Jolly is admittedly quite similar in some respects to this case. In Jolly, however, it appears that there was no lower boundary recited in the applicant’s specification, while in this case the

patentee has stated that the catalyst should be treated for about 0.25 hours, and preferably 0.5 hours. Moreover, the specification in Jolly taught that reaction time was critical to the patentability of the invention, and the court emphasized that point in holding the claim language indefinite. There is no equivalent representation as to the criticality of the treatment period in this case, and in a post-Jolly decision, the Court of Customs and Patent Appeals explained that it is not fatal for an applicant to express noncritical limitations with regard to factors such as time or quantity in functional rather than numerical terms. In re Caldwell, 319 F.2d 254, 258, 138 USPQ 243, 246-47 (CCPA 1963) (upholding claim language that referred to the amount of aspirin to be used in a method for stimulating growth in certain animals as “an effective amount . . . for growth stimulation”). Finally, Jolly was a case in which the court was reviewing the rejection of a patent application, not an infringement action based on an issued patent. Patent applicants have the opportunity to amend their claims during prosecution in order to overcome an indefiniteness rejection. See In re Zletz, 893 F.2d 319, 322, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989) (“[D]uring patent prosecution when claims can be amended, ambiguities should be recognized, scope and breadth of language explored, and clarification imposed. . . . An essential purpose of patent examination is to fashion claims that are precise, clear, correct, and unambiguous. Only in that way can uncertainties of claim construction be removed, as much as possible, during the administrative process.”). That factor explains, for example, the practice of construing claims according to their broadest reasonable interpretation consistent with the specification where the patent has not yet issued and the applicant has an opportunity to amend the claim to avoid invalidity. See, e.g., In re Wiggins, 488 F.2d 538, 541-42, 179 USPQ 421, 423-24 (CCPA 1973).

Unlike the applicant in Jolly, Exxon has the benefit of a statutory presumption of validity, 35 U.S.C. § 282. In light of that presumption and the difference in posture between an applicant whose application has been rejected and a patentee with an issued patent, close questions of indefiniteness in litigation involving issued patents are properly resolved in favor of the patentee. Thus, in cases subsequent to In re Jolly that have involved issued patents, this court has held

claims definite even when some degree of experimentation was necessary, as long as the claims otherwise met the enablement requirement. See, e.g., Chiuminatta Concrete Concepts, Inc. v. Cardinal Indus., 145 F.3d 1303, 1312, 46 USPQ2d 1752, 1759 (Fed. Cir. 1998) (holding that the recitation of a quantitative drop rod test rendered definite a claim limitation); W.L. Gore & Assocs., 721 F.2d at 1557, 220 USPQ at 316. The government's expert admitted that the "period sufficient" can be ascertained by conducting activity checks. Therefore, a person of ordinary skill in the art would understand the scope of that claim limitation, which is all that paragraph 2 of section 112 requires.

Because we hold that the terms "for a period sufficient" and "to increase substantially" are not indefinite, we reverse the Court of Federal Claims' summary judgment of invalidity as to the '705 patent.

IV

The trial court invalidated claim 1 of the '982 patent (and therefore also the remaining dependent claims of that patent) based on its conclusion that four of the terms used in that claim were indefinite. Upon close analysis of the claim language in the context of the written description of the '982 patent, we are persuaded that none of the four terms introduces sufficient uncertainty into the claim to compel its invalidation.

A

The trial court found the term "substantial absence of slug flow" to be indefinite because the specification did not provide any empirical standard for determining when the process could be said to be substantially lacking in slug flow. A slug is a large gas bubble that forms in a slurry bubble column reactor and extends across the full width of the column. It is understood in the art that slugs may adversely affect reactor performance and efficiency. '982 patent, col. 8, ll. 29-33 (noting that small gas bubbles give better mass transfer performance). Exxon therefore argued to

the trial court, and argues to us, that a “substantial absence of slug flow” in the ’982 patent means that there is no “appreciable degree of gas slugs that would adversely impact performance of the claimed reactor.” The trial court, however, found that definition to be insufficiently precise to save the patent from invalidation on the ground of indefiniteness.

This court has stated that the fact that “some claim language may not be precise . . . does not automatically render a claim invalid. When a word of degree is used the district court must determine whether the patent’s specification provides some standard for measuring that degree.” Seattle Box Co. v. Indus. Crating & Packaging, Inc., 731 F.2d 818, 826, 221 USPQ 568, 574 (Fed. Cir. 1984).

The ’982 patent specification teaches that slug flow should be avoided because it may interfere with reactor operations. It is for that reason that the claims require a substantial absence of slug flow, or substantially zero slug flow. One of skill in the art would understand from the specification that the reason slug flow should be avoided is that it may interfere with reactor efficiency. Whether there is a “substantial absence of slug flow” therefore can be determined with reference to whether reactor efficiency is materially affected. If there is no slug flow or such minimal slug flow that the slug flow has no appreciable impact on reactor efficiency, then there is a “substantial absence of slug flow” within the meaning of the claims. In this setting, as in others, mathematical precision is not required—only a reasonable degree of particularity and definiteness. See Modine Mfg., 75 F.3d at 1557, 37 USPQ2d at 1617. We agree with Exxon that in light of the reasons for minimizing slug flow described in the specification, the “substantial absence” limitation does not render the ’982 patent invalid for indefiniteness.

B

The trial court next held claim 1 of the ’982 patent (and its dependent claims) to be indefinite because the court concluded that claim 1 contains inconsistent requirements regarding

the extent to which the catalyst particles had to be fluidized in the reactor column. Fluidization relates to the distribution of catalyst particles in the slurry bubble column. The term “H,” as used in the '982 patent, refers to the expanded height of the liquid in the column. '982 patent, col. 7, ll. 52-53 & col. 14, l. 24. The patent refers to the extent of fluidization with reference to the term “H,” and the parties disagree about whether the claim contains two fluidization height limitations or only one.

The specification explains that the maximum height to which the catalyst can be fluidized is given by $D/(U_S - U_L)$, where D is the dispersion coefficient for the catalyst particles, U_S is the particle settling velocity, and U_L is the liquid velocity along the column. According to the specification, excellent reactor performance can be achieved when the reactor is designed and the operating conditions are selected so that that $H = D/(U_S - U_L)$. '982 patent, col. 7, ll. 33-53. The specification further explains that if the dispersion is maintained at a level just sufficient to fluidize the particles, i.e., $D \cdot 0.5H(U_S - U_L)$, then a condition known as “plug flow” will prevail. '982 patent, col. 7, ll. 62-66. Plug flow is described in the specification as a desired property of the claimed invention. The claims of the patent explicitly reference that equation, requiring that the catalyst particles be fluidized according to the formula $0.5(U_S - U_L) \leq D/H$, where the height of the liquid in the column is greater than three meters.

The trial court interpreted that limitation as requiring fluidization of the catalyst particles to at least the height $0.5H$ (i.e., according to the formula $0.5H \leq D/(U_S - U_L)$). The court also found that the patent claims implicitly reference the first equation, requiring “fluidizing the . . . catalyst particles . . . to the height, $H > 3m$ ” (i.e., according to the formula $H = D/(U_S - U_L)$). According to the trial court’s construction, the claim “tells a person with ordinary skill in the art both that the solid particles must be fluidized to the top of the expanded liquid and that the particles may be fluidized to only one-half the height of the expanded liquid.” The court therefore concluded that those limitations were fatally inconsistent, and it therefore held the claims indefinite.

We disagree with the trial court's conclusion as to what the claim language requires. The specification discloses two conditions—a “sufficient” fluidization condition described by the equation $H \cdot 2D / (U_S - U_L)$, where the dispersion is just sufficient to fluidize the particles and to achieve plug flow, and an “excellent” fluidization condition described by the equation $H = D / (U_S - U_L)$, where the dispersion is greater. Although it is not entirely clear from the specification which condition is preferred, the “sufficient” fluidization condition is the only one claimed. The trial court improperly imported the “excellent” fluidization condition into the claims, thereby creating an apparent inconsistency. Because the reference to the fluidization requirement is sufficiently clear that a person of skill in the art would understand the scope of the claim, the claim satisfies paragraph 2 of section 112.

C

The trial court next held the claim term “particles of average diameter, $d_p > 5 \text{ }\mu\text{m}$ ” to be indefinite because the term does not set forth any upper limit on particle size. The specification states that “[p]articles with greater than 100 μm [100 microns] diameters cannot be effectively fluidized without a backmixing debit on the kinetic driving force.” '982 patent, col. 13, ll. 42-45. Although the court properly refused to read that language into the claims, it held that the failure to include such a limitation on particle size in the claims rendered the claims indefinite. That was error. The claims do not contain any limitation on maximum particle size, and no limitation is required as a matter of definiteness. Thus, the claims expressly reach any composition with catalyst particles having an average diameter greater than five microns, no matter how large the particles may be; as such, there is no indefiniteness as to the scope of that limitation. The government's real objection to the claims as written is that they may include some inoperable embodiments, such as one in which the particles have an average diameter greater than 100 microns. However, that is an issue of enablement, and not indefiniteness. See Miles Labs., 997 F.2d at 875, 27 USPQ2d at 1126 (“The invention's operability may say nothing about a skilled artisan's understanding of the bounds of

the claim.”); see also Personalized Media Communications, 161 F.3d at 705, 48 USPQ2d at 1888; N. Am. Vaccine, 7 F.3d at 1579, 28 USPQ2d at 1339. A patent claim to a fishing pole would not be invalid on indefiniteness grounds if it contained a limitation requiring that the pole be “at least three feet long,” even though a 50-foot-long fishing pole would not be very practical. By the same token, there is nothing indefinite about the claim language at issue in this case simply because it covers some embodiments that may be inoperable.

D

Finally, the trial court held the term “ U_L ” to be indefinite. U_L refers to the liquid velocity along the column. '982 patent, col. 7, ll. 36-37 & col. 14, l. 23. The court held that term to be indefinite on the ground that one of skill in the art could not understand whether the patentee meant to refer to interstitial velocity or superficial velocity. Interstitial velocity accounts for liquid holdup (i.e., internal structures, gas bubbles, and solid particles in the column that reduce the area through which a given volume of fluid flows), and therefore measures the actual or true velocity with which the liquid rises in the column. Superficial velocity refers to the velocity of the liquid without reference to impediments within the column. Interstitial and superficial velocity can vary by as much as 50%. Although the '982 patent does not explicitly define U_L in terms of interstitial velocity, Exxon argues that one of skill in the art would recognize that U_L must be expressed in terms of the interstitial liquid velocity. Exxon's expert, Dr. Bell, testified that the inequality, $0.5(U_S - U_L) \leq D/H$, would not make technical sense if U_L were expressed in terms of superficial velocity. That is because the other variables all measure conditions in the column: U_S is the particle settling velocity in the column, D is the dispersion coefficient for the particles in the column, and H is the height of the expanded liquid in the column. Moreover, U_L is subtracted from U_S , an operation that would make little sense unless U_L were an interstitial velocity. As it is, the expression $U_S - U_L$ represents the actual speed at which particles settle.

The government counters the testimony of Dr. Bell by pointing to another limitation in the

claims relating to the gas velocity along the column, U_g . Although in the trial court the government challenged the term U_g as indefinite on similar grounds, the court found that U_g referred to superficial gas velocity and was therefore not indefinite. The court based its determination on an example in the specification disclosing an equation in which U_g is divided by the gas holdup, E. '982 patent, col. 10, ll. 30-34. The court noted that one of skill in the art would divide superficial velocity by the holdup in order to calculate interstitial velocity. The trial court therefore concluded that because the specification discloses dividing U_g by E, U_g must be a superficial velocity. The government seizes on that conclusion to impeach Exxon's assertion that U_L is an interstitial velocity. The government argues that a person of ordinary skill in the art would read U_g and U_L consistently, and thus such a person would conclude that U_L may be a superficial velocity.

This is a close question. The patentee could easily have cured the ambiguity by adding a single word or phrase to the claims or specification of the '982 patent stating which method of measuring liquid velocity the patentee was using. In fact, much of the extrinsic evidence suggests that the practice in this field of art is to state specifically whether velocity is interstitial or superficial. That practice was not followed in the '982 patent, and the result is that there is some question as to the proper interpretation of the claims. The question we must answer is whether the claims are rendered so ambiguous that one of skill in the art could not reasonably understand their scope. We conclude that one of skill in the art could and would understand that U_L refers to the actual or interstitial liquid velocity along the column. That is the more reasonable interpretation of the term U_L in light of the other variables describing actual column conditions.

The government's argument that U_g and U_L should be read consistently is not without merit. However, that argument cuts both ways. According to the trial court, a person of ordinary skill in the art would interpret U_g as reflecting a superficial velocity, because the specification discloses dividing U_g by the gas holdup. A person of skill in the art faced with the value U_L might draw the

negative inference that because the specification nowhere discloses dividing U_L by the liquid holdup, it is an interstitial velocity.

If this case were before an examiner, the examiner might well be justified in demanding that the applicant more clearly define U_L , and thereby remove any degree of ambiguity. However, we are faced with an issued patent that enjoys a presumption of validity. In these circumstances, we conclude that a person of skill in the art would understand the scope of the term U_L , and that the degree of ambiguity injected into the claims by the patentee's lack of precision is therefore not fatal.

Because we hold that the terms "substantial absence of slug flow," "fluidizing the . . . catalyst particles . . . to the height, $H > 3m$," "particles of average diameter," and " U_L " are not indefinite, we reverse the Court of Federal Claims' summary judgment of invalidity as to the '982 patent.

Each party shall bear its own costs for this appeal.

REVERSED and REMANDED.