Some Solutions to Polymer Nomenclature Problems in the U.S. Patent Office*

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An applicant for patent may have recourse to nomenclature, formulas, diagrams, the preparatory process itself, and to certain properties in defining a chemical compound. To a limited extent he may be his own lexicographer. His choice of definition may have legally restrictive implications. The patent examiner prefers terms that have precise and standardized meanings and that properties be measurable. He may compel an applicant to employ terms in accordance with the usage of selected authorities. If an authority contains an unacceptable definition of any common term, it is difficult for an examiner to use that authority to solve a nomenclature problem. New terms do occur. An international authority, as exists in the pharmaceutical field, would be useful for validating them. The nature of the U. S. Patent places a unique burden upon generic terms. Any comprehensive nomenclature system that seeks precision must be elastic enough to accomodate the inevitable lack of complete information about a polymer.

One may reasonably ask how does a nomenclature problem arise in the U.S. Patent Office. Certainly nomenclature is a tool used in telling the applicant's story. (The word "nomenclature" is used herein in the broad sense of a set of chemical names that aims to tell the composition and often the structure of a given compound or of a related group of compounds. In this sense it is broader than the term "structure name.") But the patent statute states that after an applicant has described his invention he must also claim the subject matter that he regards as his invention. At the very least, the invention must be new to be patentable, so that any nomenclature employed must be capable of pointing out the novelty disclosed in the application. Sometimes a new word, like isotactic, has to be coined to accomplish that. Moreover, the invention may involve a special modification of a whole class of old compounds, so that the nomenclature employed must be capable of specifying relationships. Common examples of terms capable of doing that are "copolymer" and "chain ends." However, the condensation polymer art involving network structure is notably deficient in such expressions, a fact that reflects the complexity of the structures in that art. Further, the invention may involve a broad class of new compounds or involve a new association of broad classes of compounds, whether new or old, so that the nomenclature here must be capable of expansion or contraction. A simple example would be a definition of a linear polyamide as having monomer units containing n $-CH_2-$ groups between the amide functions, where n may vary from 5 to 7. As another example, the amide functions may be required to be carboxamide, thioamide, and so on. Finally the invention may involve a particular characteristic of a broad class of compounds, and the nomenclature must be capable of specifying it. An example might be the requirement that there be tertiary carbon in a linear polymer.

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The meaning of terms is an issue in patent cases and may be the subject of interrogatories.[1]

The significant legal requirement for our purpose is that the claims must "distinguish what is claimed from what went before in the art and clearly circumscribe what is foreclosed from future enterprise."[2] As Rossman has put it, a claim must "clearly point out what is forbidden territory so that no member of the public is innocently trapped into infringement liability."[3] He notes that this has been characterized by the term "peripheral definition," as opposed to "central definition." The governing statute itself requires "particularly pointing out and distinctly claiming the subject matter," 35 *U.S. Code* 112.

A particular task for nomenclature, which has taken on increasing significance of late and will become very important in the event that the Patent Corporation Treaty is finally brought into play, is that implied in the dependent claim practice. Each claim after the broadest one must further restrict it. According to this practice, the main claim may define a class of compounds, while each dependent claim may specialize it to a subclass of compounds or to a specific compound. Thus a radical may be identified generically as aryl and may then be limited to monocyclic aryl and be further limited to phenyl in dependent claims.

AVAILABLE MEANS FOR DEFINING COMPOUNDS

The most appealing way of defining a new chemical compound or a class of chemical compounds is by a structural formula. In the polymer field this is usually in terms of the repeating unit. One realizes at once, of course, that in this area structural formulas must be incomplete and in fact are to a considerable extent acts of faith. Polymers are after all mixtures. Usually little inquiry has been made of end groups.[4] Unsuspected branching, cyclizations, and rearrangements may have occurred during preparation of the compound. Residual groups may

be present. Head to tail linkage of units usually has to be implied if a formula in terms of repeating units is to make sense.

Nonetheless, the obvious advantages of such formulas are compelling. One can readily incorporate variable features, such as subscripts and generalized chemical group designations. One can readily show relationships difficult to describe in words.

A point that needs to be emphasized is that structural formulas in the polymer art are to be treated as associated with a body of specialized conventions, which one has to acquire in order to make sense of them. People unaware of those conventions either read more in them than is conventionally implied or are confused by them.

When one employs structural formulas to describe copolymers or cross-linked polymers, then of course one ignores a special type of uncertainty, the statistical distribution of the monomer units.

If the polymer molecules are identified by the names of hypothetical monomers prefixed by "poly" rather than by structural formulas, a somewhat different set of conventions is normally invoked, the most important aspect of which is that the polymer name is intended to refer to the composition of the polymer, rather than to its source. This is hard for the nonpolymer chemist to grasp. The effort to establish a system of "structure names" of the type approved by the Council of the International Union of Pure and Applied Chemistry[5] and by The American Chemical Society Council[6] does not appear to have caught on in the patent field.

An incidental problem with both structure names and structural formulas arises when there is the possibility of tautomerism. Here is a case where an applicant may name the compound by naming one of the tautomers. In effect, he is his own lexicographer.[7]

This leads us at once to the observation, that any of the features that the conventional repeating unit formula ignores can and have served as areas for investigation and as basis for patent applications.[8, 9] However, the fact that one can characterize a compound more accurately as being, for example, a block copolymer, does not necessarily result in a patent.[10]

The definition of copolymers raises another set of problems. The first of these is the term copolymer itself. A court in a recent case has stated that "a copolymer is thus in effect something in between a chemical composition and a mixture."[11] And in truth much of the case law relating to copolymers parallels the case law of mixtures, particularly in respect to proportions.[10, 11]

More significant for our purposes here is the ambiguity that arises because virtually all polymer names commonly used are inherently generic—i.e., of broad scope—since they encompass materials of different molecular weights. It has been held also that the terms "polymerized" and "polymers" are broad enough to include copolymers as well as homopolymers.[12, 13] Now then, what does one make of such terms as styrene polymers, polystyrenes, and a polystyrene? A recent book distinguishes between "regular polystyrenes" and "impact polystyrenes."[14] The obvious problem with such usage relates to the scope of such terms. More could be said, but I cannot refrain from wondering whether anyone has seen an expression like sulfonated regular polystyrene?

The patent examiner, at least during the time I was associated with Group 140, likes the word polystyrene to be synonymous with homopolystyrene and "a styrene polymer" to be generic to the homo- and copolymers of styrene. Nor does he think of the term "a polystyrene" as limited to those polymers in which styrene is the predominant component. So he would consider SBR (rubber) to be "a styrene polymer."

At this point it is useful to note that multicomponent copolymers having limited ranges of components often cannot be named by structure or structural names. In this case resort must be had to ternary diagrams like those so widely used to define alloys. This has found considerable use in specifying the proportions of reactants. Diagrams suggestive of spatial configurations have also been employed.[17]

If one is interested in noting how sophisticated the technique of defining polymers by structural names has become he might refer to the patents noted at (15) and (16) in the reference list as exemplary.

It may be remarked that in patent practice, one or more structural formulas, trivial names, and structure-based names may be used to describe different portions of the over-all molecule.

At this point it is useful to mention the words "consisting," "comprising," and "consisting essentially of." One can say that SBR is an example of an addition polymer comprising styrene units, that it is a rubbery polymer consisting essentially of a butadiene styrene copolymer, and if we knew the end groups we would know what it consists of.

I would suggest to those who may be interested in establishing a flexible structure-related nomenclature of the generic type that some thought be given to the usefulness of those words or at least to the concepts they embody. It would be useful if one could have such nomenclature that could express precisely—for example, "an addition polymer whose hypothetical repeating units consist of vinylidene monomer units 2 to 5% of which bear carboxy groups, said polymer comprising not more than 2% —CN containing units."

As an example of what is intended, the following is offered, the vinylidene monomer being styrene: poly-[phenylethylene-co- (215%) *o*-carboxy-phenylethylene]-subst (to 2%) [cyano].

Here the percentages are intended to relate to the units and by "subst" is meant "substituted by," the position of the substituent being unspecified.

Now suppose the available theory is not developed enough to enable one to specify the structure completely. Then one may supplement a designation in terms of nomenclature with a recitation of physical properties that are believed correlatable with structure. Thus one often sees viscosity values rather than molecular weight. The matter has been discussed quite fully by Hellfritz.[18] A point that I would like to emphasize is the equivocal character of many of these physical properties. Thus Tanford distinguishes form and intrinsic birefringence.[19] The X-ray powder pattern of a zeolite is probably a virtually invariant characteristic of the molecule as a whole because of its space filling structure. That of a crystallized linear high polymer may have a different explanation. One may question whether such a property is adequate as a dis-

tinguishing property of the molecule itself.

In any event, if properties are employed along with whatever is known of the formula, the collection of descriptors must be adequate to identify the compound. One differentiating property is not ordinarily considered to be enough.[20, 21]

However, no matter what the feature is that one relies upon to define the compound, it is important that it be measurable. By this I mean not only that the feature be a definite one, but also that means exist to measure it. In a recent decision relating to discovery proceedings in connection with controversy involving the Larchar and Pease polyethylene patent,[22] the court stated:[23]

> "... However, both parties appear to fully recognize that this case is an unusual one in that the adequacy of the procedures used by experts, or available to them, to determine the chemical properties of a product such as that claimed, comes very close to being an ultimate fact and a major issue in the case. ... Take, for example, one property specified in the claim—'containing side chains, at a frequency of less than 1 side chain per 200 carbon atoms in the main chain as determined by infra-red absorption analysis'. Fact testimony can describe the process of analysis which a witness used to identify such a property and the visible results of the process but further than that it cannot go. Unless the opinion of an expert supplements and interprets those results, there is simply no evidence before the Court. ...
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> .... The defendant has satisfied me that the identification of the product patented is a difficult matter, and there may be ground for its contention that not only is it difficult but that different results will be obtained depending upon which of a number of different procedures is used. The defendant is entitled to prove it if it can, and it is further entitled to know which procedures the plaintiff has tried which, of course, provided the basis of the plaintiff's charge that the defendant infringes the patent.
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> .... However, it appears to me that the contest will probably center upon the methods by which the results were obtained, and while the defendant can test its own product to identify its properties, it has no way, other than discovery, of finding out whether the plaintiff has been able to do so...."

Another interesting controversy in point here involved the Stookey patent,[24] relating to the production of ceramics by crystallization of glass. Here the Court of Appeals stated in holding the patent valid:[25]

> ".... The Corning patent teaches that its process results in a composition which contains 50% crystallinity by weight. In order to measure the weight percentage crystallinity the patent refers to the use of the X-ray diffraction method. The District Court indicated that Corning, in 1956 and in 1958, was unable to measure the percent crystallinity within the 7 to 10% range of error by X-ray diffraction. It was not until 1964, after a year of independent experimentation, that plaintiff refined its X-ray diffraction technique down to a 4 to 5% margin of error. Because of the uncertainty of the X-ray diffraction method defendant was forced to spend time and money in the development of its own testing methods and this in the opinion of the District Court invalidates the patent. Juxtaposed against the narrow interpretation of the patentee's claims the result reached by the District Judge was inevitable. Once, however, the District Court's cloak of strictness has been removed, and the broad construction due this pioneer patent is applied, it becomes evident that Anchor was not under any burden in determining whether or not is was infringing plaintiff's patent...."

Now to a limited extent an applicant for a patent may be his own lexicographer as was noted previously. Thus in a recent case,[26] the Court found a claim not to be indefinite or unduly broad where the claim called for "a high styrene resin," the term having been fully defined in the specification. But we cannot distort the accepted meaning of terms, and all claims must be construed in accordance with the laws of physics and chemistry. Thus one cannot define oxygen as being an inert gas under circumstances where one would expect it to react.

All else having failed, an applicant being ignorant of the structure of his product, or unable to present a collection of properties that can characterize it completely, he may define the product in terms of its method of manufacture.[21, 27]

An interesting court case dealt with the question of infringement of a claim to an acid derived by autolysis of mammalian liver tissue which was capable of exercising an antianemia vitamin effect in chicks. Certain optical and chemical properties were also detailed. The court stated:[28]

> ".... (3) It appears from the interrogatories and the answers thereto that appellees' product is a chemical compound identical with that described in the patent but that it is made from different starting materials and by an entirely different process from the product of appellant. The controlling question is whether the claims are so limited by the specification, the file wrapper proceedings and their own language that they do not cover appellees' product. The critical phrase, which is identical in each claim, is 'said acid being the acid derived by autolysis of mammalian liver tissue.' It is admitted that appellees' product is not derived from mammalian liver tissue nor from any animal product. It is obtained by synthesis from discrete chemical compounds of known chemical structure by a method unrelated to the method described and originally claimed in the patent.
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> We think the District Court correctly concluded that there is no genuine issue as to any material fact and that the claims of the patent do not cover appellees' products."

It is no wonder that in view of such decisions that applicants prefer polymer names or formulas to definitions in terms of the preparatory process. Nonetheless, such product-by-process recitations are very common in the polymer field.

A fairly common problem that arises here is whether a term is a product-by-process recitation or not. An example is "a condensation product of formaldehyde with a salt of a diphenylamino-4-diazonium base."[29]

SOME REMARKS ON THE TERMS THEMSELVES

Now the patent examiner, like the courts, prefers terms that have precise and standardized meanings. He then will know exactly what he is granting an applicant, and his search can be better defined. But as indicated above a term may have a meaning in a particular industry or trade quite unlike its ordinary chemical meaning. A good example is the term "polyester." In the adhesive art it apparently sometimes means the unsaturated alkyd and sometimes it means the alkyd combined with styrene. To distinguish the two the alkyd may be called the "base polyester" and the monomer mixture a "liquid polyester resin." It is sometimes distinguished from the so-called

allyl resins made from diallyl phthalate.[30] Yet there is no good chemical reason for refusing to view such allyl resins as polyesters. One may add to the list of compounds that are encompassed by the term polyester if one construes it broadly, such as polyphosphonates,[31] cellulose acetate, polyvinyl acetate, and polyvinyl chloride.

Consider another common term, such as "vinyl polymers." These are often distinguished from "acrylic polymers" such as poly(methylacrylate),[32] though the monomer contains the vinyl radical, and at other times not, as when vinyl is defined as monosubstituted ethylene.[31] A well-known text[33] which recognizes the problem distinguishes vinyl monomers, $CH_2=CHX$ and vinylidene monomers, $CH_2=CY_2$, in one section, and in another refers to compounds of the type $CH_2=CHX$ and $CH_2=CXY$ as vinyl monomers. The usage of the term vinylidene monomer to include the two types of compounds appears to be more appealing to many, as exemplified by U.S. Patents noted in the appended reference list.[34] *Chemical Abstracts*[35] employs vinylidene as the name of $CH_2{:}C=$ and does not demand that the free valences not be attached to hydrogen.

It is obvious that respected authors in the polymer field do not offer enough help to those who are trying to define an invention, particularly a broad one, with precision.

The power of systematic chemical nomenclature is so much greater than is that of any collection of terms prevailing in any single industrial field or restricted area of chemistry that one of necessity must make use of it. Accordingly, patent examiners whose task it is to examine applications for new polymers or for processes of making them tend to think in terms of it. They are very critical of terms whose meaning can be understood only in the context of some specialized industry. Fortunately for them there exists two excellent compendia of terms useful at least for the naming of monomers. One is that of *Chemical Abstracts*[35] and the other is the collection of definitions formulated with the consultation of Dr. Patterson found in the Merriam-Webster "New International Dictionary" (2nd and 3rd editions). Such order as there now exists in nomenclature in the patent field in the area of polymer chemistry I ascribe to a considerable degree to the influence of these two publications. Writers in the polymer field have offered insufficient help.

It is evident that the nature of the U.S. patent places a unique burden upon broad generic terms. Any comprehensive nomenclature system that seeks precision must be able to express generic concepts and also be elastic enough to accommodate the inevitable lack of complete information about a polymer.

Finally, new terms appear. It would be helpful to all if there were an organized procedure for dealing with these such as there is for nonproprietary names in the pharmaceutical field.[36]

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