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HYDROPHILIC POLYURETHANE POLYMERS

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No Drawing. Filed Aug. 2, 1972, Ser. No. 277,361
Int. Cl. C08g 22/08, 22/44

U.S. Cl. 260—75 NK

12 Claims

ABSTRACT OF THE DISCLOSURE

Water absorptive polyurethane polymers prepared from resins having a low ratio of carbon to oxygen to nitrogen or having ionic, quaternary ammonium or salt groups in the resin backbone and a low amount of isocyanate. The water absorptivity of the polyurethane polymers is about 10%, preferably above 20%, and these polymers may range to completely gel-like, high water absorptive polymers; these polymers are useful as coatings, membranes, etc.

This invention pertains to polyurethane polymers; more particularly, this invention pertains to polymers which absorb water; moreover, this invention pertains to articles of manufacture made therefrom and articles of manufacture from said polymers such as hydrophilic polymers in the form of films, sheets, various shapes, coatings and carriers.

CROSS REFERENCE TO RELATED APPLICATIONS

In a companion application entitled Water Absorptive Polyurethane Polymers, Ser. No. 265,541, filed June 23, 1972, polyurethane polymers which are rigid, machinable and polishable in the dry state have been disclosed. These polymers are highly hydrophilic and are useful for numerous applications. The present application represents a further development in said hydrophilic polyurethane polymer art, but the diversity of the polymers and the diverse properties of the present polymers make these polymers even more widely useful.

BACKGROUND OF INVENTION

Within the last few decades, the art pertaining to polyurethane chemistry has seen a tremendous growth. As a result, polyurethane polymers of various kinds and forms are fairly well known. In general terms the polyurethanes comprise polymers formed from a resin which has an active hydrogen atom and a polyisocyanate, such as a diisocyanate. Numerous resin systems now exist which have been combined in various ratios with the polyisocyanates, and the end polymers have ranged from rigid castable shapes to soft foams. Various polymer and prepolymer reactions for preparing the above types of polyurethanes have also been developed, and these reactions are fairly well explored.

Of the many resin systems which are known and the properties of which have been described, there are continuously being added new resin systems which in combination with the polyisocyanate overcome some vexing problems encountered with other resin systems or provide better properties for a particular end use. However, many of these resin system *a priori* do not predictably function in a given polymer system; and hence, the empirical observations still are at the foundation for the development of new resin systems as well as discovery of new polymers.

In addition, the various isocyanates which have been available (or proposed to be useful without being available) give different properties in any given resin system as well as give different properties from resin system to resin system. Hence, the predictability of an end polymer

properties cannot be inferred from a behavior of the resin system nor the behavior of this resin system in combination of isocyanate, except in very general terms. For this reason the proper combination of the particular resin system with the proper isocyanate and the proper interaction or intercombination with each other is still an empirical art with unpredictable end results.

PRIOR ART

Numerous publications exist in the polyurethane polymer art including surveys of the prior art such as J. H. Saunders et al., *Polyurethanes, Chemistry and Technology*, Part I Chemistry, Interscience Publishers (1962). This book summarizes in part the existing prior art. A great number of publications subsequent to the date of the publication of this book including patent literature have also appeared both in this country and abroad. These publications are too numerous to mention; but in some respect or another, these have some additional illustrations of the various polyurethane precursor resins, the isocyanates, the method of employing or making the same.

As it is well appreciated by those skilled in the art, the issued patents in this art are too numerous to list. Inasmuch as there is disclosed in these patents in some way or another a resin system, an isocyanate, and a polymer because of the common nature of the polyurethane polymer, these patents are all illustrative of polyurethane polymers as such. However, differences in the various polymers associated with resin systems or isocyanates, the proportions of each, linearity and branching of resin chains and functionality of isocyanates, which are often thought to be obvious to the uninitiated, are far more complex and subtle and often represent painstaking investigation of critical parameters and variables. If hydrophilicity or water absorption has been sought for polyurethane polymers, it has more generally been sought for polymers from which foams are formed which are useful as sponges. In general, the hydrophilic polymers have been rather soft and/or non-durable.

In respect to the present invention, the prior art which pertains to the same is most closely related to producing shapes, films, sheets and coatings which are strong and desirably non-variant in properties in either dry or wet state. However, whereas the prior art as a desideratum has striven to form strongly hydrophobic systems for the reason that the strongly hydrophobic polymers display low, if any, dimensional variation in the polymer, the present invention is directed to a combination of properties, i.e. high hydrophilicity, excellent polymer properties in the wet state, and variations from dry to wet state which are tolerably uniform.

Of the more prevalent resin systems for producing soft hydrophilic polyurethanes, the polyethylene glycol and polyalkylene amine resin systems are known; the last two resin systems—in distinction from the polypropylene glycol resin systems which are generally hydrophobic—are used for this purpose. Further, the combination of the polyethylene glycol and polypropylene glycol resins with an appropriate, i.e. far in excess of stoichiometric requirements of isocyanate, have been used to achieve sufficient softness and at the same time sufficient hydrophobicity so that the end product would have the desirable properties. Predominantly, aromatic polyisocyanates such as toluene diisocyanate have been used as the isocyanates.

In reference to the isocyanates which have been employed in combination with the above described resins, conventional aromatic isocyanates, when reacted with the various resins, display properties which are often unacceptable for a number of reasons.

Although the unacceptable properties can be tolerated in a number of products, in other products the use of