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CA 2203730 C 2003/10/28

(11)(21) 2 203 730

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) **Date de dépôt/Filing Date**: 1997/04/25
(41) **Mise à la disp. pub./Open to Public Insp.**: 1997/05/25
(45) **Date de délivrance/Issue Date**: 2003/10/28
(30) **Priorité/Priority**: 1996/04/26 (60/017,050) US

(51) **Cl.Int.^{6}/Int.Cl.^{6}** C08L 75/04, B01J 13/00, C08J 9/08, C08J 3/09, C08L 75/08

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(54) **Titre** : MOUSSE DE POLYURETHANE ET PROCEDE DE FABRICATION DE CETTE DERNIERE
(54) **Title**: POLYURETHANE FOAM AND PROCESS FOR PRODUCTION THEREOF

(57) **Abrégé/Abstract**:

A polyurethane foam comprising a polyurethane foam matrix having disposed therein polyvinyl chloride in particulate form having an average particle size of less than about 25 µm, the polyvinyl chloride being at least partially modified. A process for producing the polyurethane foam is also described. A polyol dispersion useful in the production of the polyurethane foam comprises a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 70 percent by weight of the polyol dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 µm. A process for producing the polyurethane foam is also described. It is suspected that a potential chemical inter-reaction between the partially modified polyvinyl chloride and the nascent polyurethane plays a large role in the enhanced load properties of the polyurethane foam.

ABSTRACT OF THE DISCLOSURE

A polyurethane foam comprising a polyurethane foam matrix having disposed therein polyvinyl chloride in particulate form having an average particle size of less than about 25 μm, the polyvinyl chloride being at least partially modified. A process for producing the polyurethane foam is also described. A polyol dispersion useful in the production of the polyurethane foam comprises a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 70 percent by weight of the polyol dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm. A process for producing the polyurethane foam is also described. It is suspected that a potential chemical inter-reaction between the partially modified polyvinyl chloride and the nascent polyurethane plays a large role in the enhanced load properties of the polyurethane foam.

POLYURETHANE FOAM AND PROCESS FOR PRODUCTION THEREOF

In one of its aspects, the present invention relates to a polyurethane foam and to a process for production thereof. In another of its aspects, the present invention relates to a polyol-solids dispersion useful in the production of the polyurethane foam and to a process for production of the polyol-solids dispersion.

Isocyanate-based polymers are known in the art. Generally, those of skill in the art understand isocyanate-based polymers to be polyurethanes, polyureas, polyisocyanurates and mixtures thereof.

It is also known in the art to produce foamed isocyanate-based polymers. Indeed, one of the advantages of isocyanate-based polymers compared to other polymer systems is that polymerization and foaming can occur in situ. This results in the ability to mould the polymer while it is forming and expanding.

One of the conventional ways to produce a polyurethane foam is known as the "one-shot" technique. In this technique, the isocyanate, a suitable polyol, a catalyst, water (which acts as a reactive “blowing” agent and can optionally be supplemented with one or more physical blowing agents) and other additives are mixed together at once using, for example, impingement mixing (e.g. high pressure). Generally, if one were to produce a polyurea, the polyol would be replaced with a suitable polyamine. A polyisocyanurate may result from cyclotrimerization of the isocyanate component. Urethane modified polyureas or polyisocyanurates are known in the art. In either scenario, the reactants would be intimately mixed very quickly using a suitable mixing technique.

Another technique for producing foamed isocyanate-based polymers is known as the "prepolymer" technique. In this technique, a prepolymer is produced by reacting polyol and isocyanate (in the case of a polyurethane) in an inert atmosphere to form a liquid polymer terminated with reactive groups (e.g. isocyanates). To produce the foamed polymer, the prepolymer is thoroughly mixed with a lower molecular weight polyol (in the case of producing a polyurethane) or a polyamine (in the case of producing a modified polyurea) in the presence of a curing agent and other additives, as needed.

Regardless of the technique used, it is known in the art to include a filler material in the reaction mixture. Conventionally, filler materials have been introduced into foamed polymers by loading the filler material into one or both of the liquid isocyanate and the liquid active hydrogen-containing compound (i.e. the polyol in the case of polyurethane, the polyamine in the case of polyurea, etc.).

The nature and relative amounts of filler materials used in the reaction mixture can vary, to a certain extent, depending on the desired physical properties of the foamed polymer product, and limitations imposed by mixing techniques, the stability of the system and equipment imposed limitations (e.g. due to the particle size of the filler material being incompatible with narrow passages, orifices and the like of the equipment).

In the art of isocyanate-based foam polymers, particularly polyurethane foam, it is known to use polyvinyl chloride as a filler material. See, for example, United States patent 5,432,204.

In the past, polyvinyl chloride has been incorporated into polyurethane foams to confer flammability resistance to the latter. Conventionally, particulate polyvinyl chloride would be incorporated into the resin stream and, upon reaction of the resin stream with the isocyanate stream, the particulate polyvinyl chloride would be physically dispersed throughout the polyurethane foam matrix.

Other than such a physical mixture of the two polymers, to the knowledge of the present inventors, there has been no report of the use of partially modified polyvinyl chloride to enhance the "hardness" or "load building" properties of a polyurethane foam.

In the art of polyurethane foam there is a consistent need for the development of novel load building techniques. In this regard, it is conventional to build load in polyurethane foam by the use of polymer polyols (discussed in more detail hereinbelow) or the addition of solid filler materials. Thus, it would be desirable to have a load building technique which could be conveniently applied to polyurethane foam as an alternative to conventional load building techniques. It would be further desirable if the load building technique were relatively inexpensive and/or improve other properties of the polyurethane foam (e.g. flame retardancy, anti-fogging in automotive applications and the like).

It is an object of the present invention to provide a novel polyurethane foam.

It is another object of the present invention to provide a novel process for producing a polyurethane foam.

It is yet another object of the present invention to provide a novel polyol-solids dispersion useful, inter alia, in the production of a polyurethane foam.

It is yet another object of the present invention to provide a novel process for producing a polyol-solids dispersion.

Accordingly, in one of its aspects, the present invention provides a polyurethane foam comprising a polyurethane foam matrix having disposed therein polyvinyl chloride in particulate form having an average particle size of less than about 25 μm, the polyvinyl chloride being at least partially modified.

In another of its aspects, the present invention provides a process for producing a polyurethane foam comprising reacting together:

(a) a polyol comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 40 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) an isocyanate;

(c) water; and

(d) a catalyst capable of catalysing a reaction between the polyol, the isocyanate and water.

In yet another of its aspects, the present invention provides a polyol-solids dispersion comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 70 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm.

In yet another of its aspects, the present invention provides a process for producing a polyol-solids dispersion comprising the steps of:

(a) adding from about 1 to about 70 parts by weight of a particulate solid material to from about 30 to about 99 parts by weight of a polyol to provide a mixture, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) subjecting the mixture to an energy sufficient to render the polyvinyl chloride in a substantially deagglomerated state;

(c) wetting the particulate solid material with the polyol; and

(d) maintaining the temperature of the mixture at less than about 50°C.

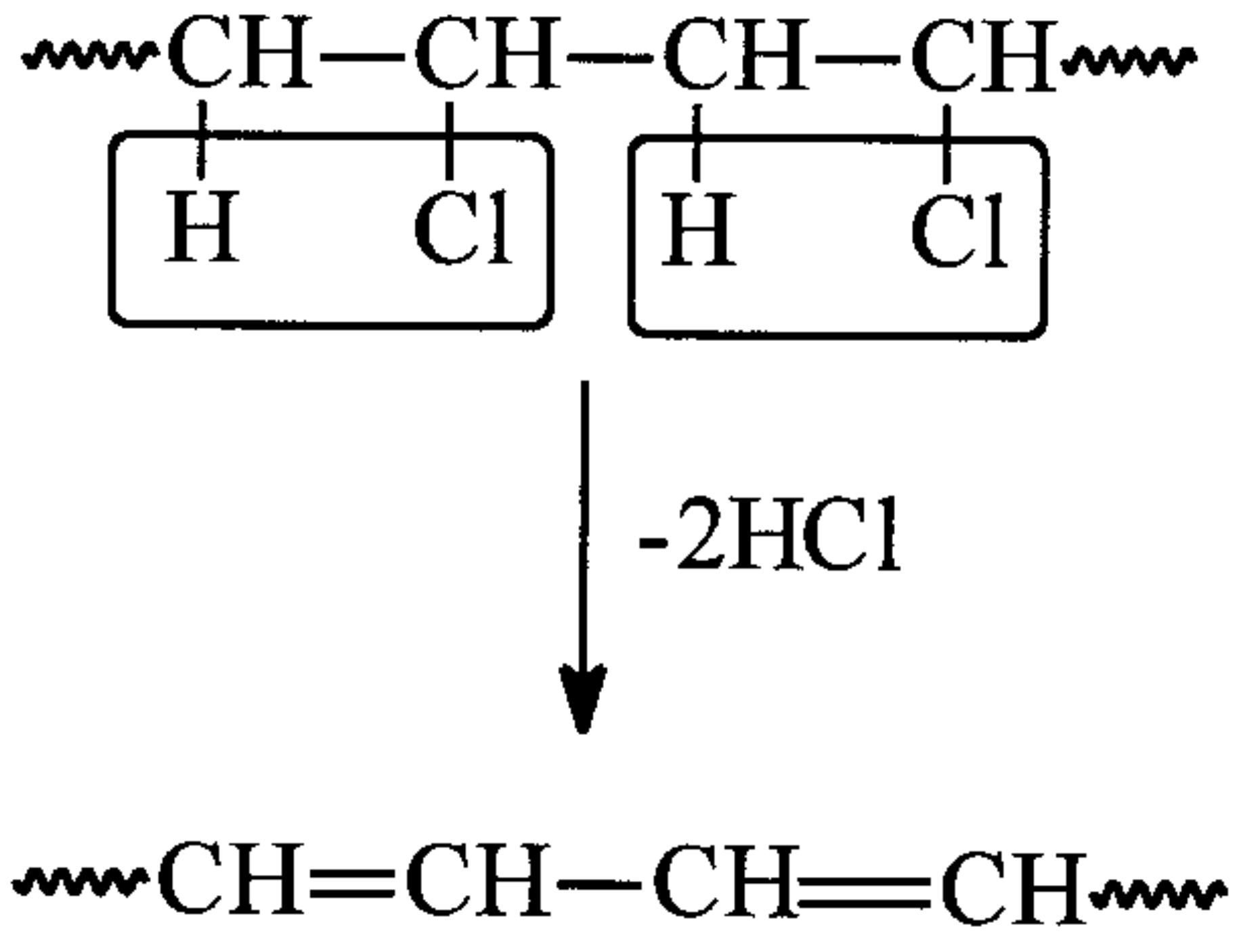
As used throughout this specification, the term "polyol-solids dispersion" is intended to encompass a liquid dispersion comprising a liquid polyol having dispersed therein a solid particulate material. Further, as used throughout this specification, the term "partially modified polyvinyl chloride" is intended to mean polyvinyl chloride wherein a portion of the polymer chains have been subjected to dehydrochlorination or the original polymer chains contain a reactive double bond. Dehydrochlorination is discussed in more detail hereinbelow.

Thus, novel polyurethane foams has been discovered. Specifically, the present polyurethane foam contains polyvinyl chloride particles. The polymer chains of the polyurethane are believed to be chemically inter-reactive with those of the polyvinyl chloride. Thus, the present polyurethane foam can be considered to be "inter-reacted polymer network" (IRPN). The present polyurethane foam is characterized by improved hardness. Under certain circumstances, this property is very important in the manufacture of moulded, flexible polyurethane foams.

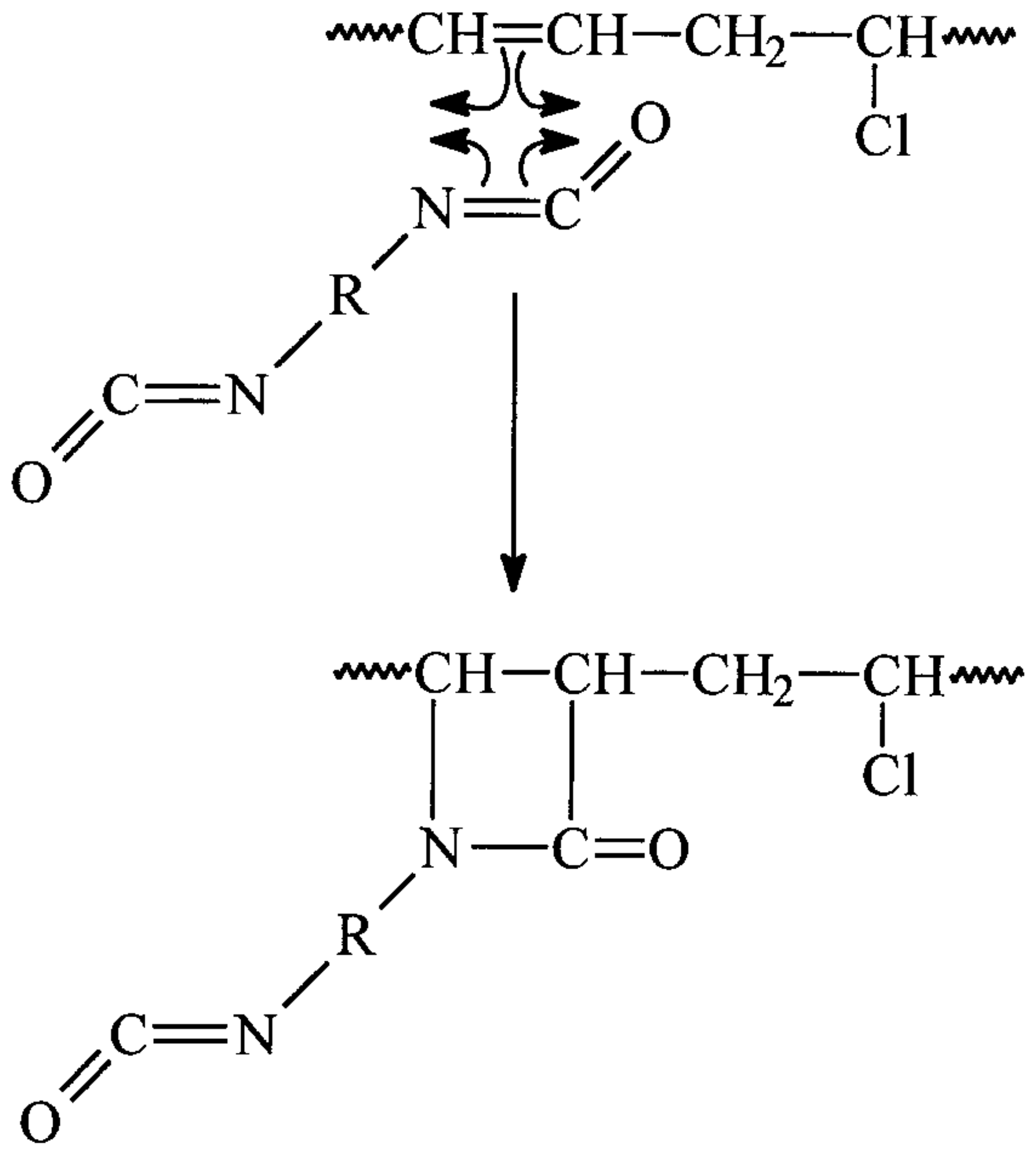
In one of its aspects the present invention relates to a polyurethane foam. As used throughout this specification the term "polyurethane foam" is intended to have a broad meaning and encompasses polyurethane and urea-modified polyurethane. As is known in the art, the term "modified", when used in conjunction with a polyurethane means that up to 50% of the polymer backbone forming linkages have been substituted.

Thus, the present inventors have discovered that, in certain circumstances, it is possible improve the hardness of a polyurethane foam in a novel manner by incorporating therein partially modified polyvinyl chloride. While not wishing to be bound by any theory or mode of action, it is believed that a reason for the ability to confer improved hardness to a polyurethane foam in accordance with the present invention results primarily from a chemical bond between the polymer chain, i.e. the polymeric chains of polyurethane and those of polyvinyl chloride.

While the precise nature of the interaction between the polymer chains of polyurethane and polyvinyl chloride are not clear, it is believed that the interaction proceeds in the following manner. As is known in the art, upon exposure to heat (temperatures greater than about 50°C), ultraviolet light or gamma radiation, polyvinyl chloride is susceptible to degradation (or modification) via dehydrochlorination pursuant to the following reaction:



It is known that up to about 15 “adjacent” conjugated double bonds can be formed in this manner along a given portion of the polymer chain. While dehydrochlorination of a single monomer unit is illustrated, those of skill in the art will recognize that dehydrochlorination of adjacent monomer units will result in production of a conjugated double bond structure. Such dehydrochlorination results in partial degradation (or modification) of the polyvinyl chloride. As is known in the art, dehydrochlorination of polyvinyl chloride is typically accompanied by one or more of the following: discolouration of the polyvinyl chloride to dark brown and rapid deterioration of the original mechanical and electrical properties of polyvinyl chloride homopolymer. While the polyvinyl chloride art has strived to deal with this problem by stabilization of the polymer against dehydrochlorination, it is believed that partially modified polyvinyl chloride can be used advantageously to confer load building to a polyurethane foam. In the context of the present invention, it is believed to be important to control this reaction such that the partially modified polyvinyl chloride species is made available to react with free isocyanate functions in the nascent polyurethane system. It is believed that this interaction occurs, via a 1,2-cycloaddition reaction, in the following manner:



wherein R can be the hydrocarbon backbone of the isocyanate group used to produce the polyurethane group or the backbone of a growing polyurethane chain. The 1,2-cycloaddition product is a relatively unstable intermediate. In either case, the result is formation of covalent bonds between polyurethane and polyvinyl chloride during chemical formation of the former. It is believed that the resulting 1,2-cycloaddition product is stabilized by carbon dioxide, the blowing agent formed <u>in situ</u> during the formation of polyurethane.

Since the formation of the 1,2-cycloaddition product appears to be dependent on the present of dehydrochlorinated polyvinyl chloride, controlled formation of the latter is important. In other words, if the polyvinyl chloride is permitted to undergo premature dehydrochlorination (i.e. prior to reaction with the reactants forming polyurethane), the chains of dehydrochlorinated polyvinyl chloride will likely react with one another thereby forming crosslinks between adjacent chains and minimizing or even eliminating the possibility of interaction with chains of polyurethane.

The enhanced hardness of the present polyurethane foams is believed to be the direct result of formation of bonds between the chains of polyurethane and polyvinyl chloride (i.e. the 1,2-cycloaddition product postulated hereinabove). This is believed to be the first discovery of a chemical bond between a nascent polyurethane foam matrix and partially modified polyvinyl chloride disposed in the polyurethane foam matrix to produce improved polyurethane foam products.

For practical purposes, it has been found that the use of a particular polyol-solids dispersion is a preferred manner by which the present polyurethane foams can be produced. This dispersion contains particulate polyvinyl chloride and is prepared in a manner which mitigates or obviates occurrence of the dehydrochlorination reacction of the polyvinyl chloride. This dispersion can contain polyvinyl chloride in a partially modified state (see Examples 5-10 hereinbelow) or in a relatively unmodifed state (see Examples 3-4 hereinbelow).

Thus, in one of its aspects, the present invention relates to a polyol-solids dispersion comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 70 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm.

The choice of polyol is not particularly restricted and is within the purview of a person skilled in the art. For example, the polyol may be a hydroxyl-terminated backbone of a member selected from the group comprising polyether, polyester, polycarbonate, polydiene and polycaprolactone. Preferably, the polyol is selected from the group comprising hydroxyl-terminated polyhydrocarbons, hydroxyl-terminated polyformals, fatty acid triglycerides, hydroxyl-terminated polyesters, hydroxymethyl-terminated polyesters, hydroxymethyl-terminated perfluoromethylenes, polyalkyleneether glycols, polyalkylenearyleneether glycols and polyalkyleneether triols. More preferred polyols are selected from the group comprising polyethylene glycols, adipic acid-ethylene glycol polyester, poly(butylene glycol), poly(propylene glycol) and hydroxyl-terminated polybutadiene - see, for example, British patent No. 1,482,213. The most preferred polyol is a polyether polyol. Preferably, such a polyether polyol has a molecular weight in the range of from about 200 to about 20,000, more preferably from about 2,000 to about 10,000, most preferably from about 2,000 to about 8,000.

The polyol-solids dispersion contains a particulate solid material in an amount in the range of from about 1 to about 70 percent by weight of the polyol-solids dispersion. Preferably, the particulate solid material is present in an amount in the range of from about 20 to about 50, more preferably from about 30 to about 40, percent by weight of the polyol-solids dispersion.

The particulate solid material consists essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid.

Preferably, the polyvinyl chloride in the particulate solid material is selected from the group consisting of homopolymer polyvinyl chloride, compounded polyvinyl chloride and mixtures thereof. If the polyvinyl chloride is compounded, it is preferred that it be selected from compounded polyvinyl chloride which is virgin or has been recycled. Of course, mixtures of such compounded polyvinyl chloride could also be used.

The choice of second solid (i.e. polyvinyl chloride is the first solid), if present, in the polyol-solids dispersion is not particularly restricted. Of course, it will be recognized by those of skill in the art that the second solid should not be capable of poisoning or otherwise adversely affecting the polyurethane condensation/foaming reaction. Thus, the second solid may an inorganic material. A non-limiting examples of such a material may be selected from the group consisting of calcium carbonate, barium sulfate, carbon, clay, talc, titanium dioxide, natural silicates, synthetic silicates, zeolites, mica, ceramics, aluminas, titanias and mixture thereof. Alternatively, the second solid may be an organic material. A non-limiting example of such a material may be selected from the group consisting of acrylonitrile, styrene-acrylonitrile, polyisocyanate polyadditon polymer, polyurea, polyurethane, polystyrene, polypropylene, polyethylene, melamine, urea, starch, rubber, lignin and mixtures thereof. Of course, those of skill in the art will recognize that mixtures of inorganic and organic materials are possible.

If the second material is a polymer, it is possible and, it certain cases, preferred that the polymer be a recycled polymer.

When a second solid is used in the present polyol-solids dispersion, it is preferred that the polyol and second solid in the present polyol-solids dispersion be in the form of a graft copolymer polyol. As is known in the art, graft copolymer polyols are polyols, preferably polyether polyols, which contain other organic polymers. It is known that such graft copolymer polyols are useful to confer hardness to the resultant polyurethane foam compared to the use of polyols which have not been modified by incorporating the organic polymers. Within graft copolymer polyols, there are two main categories which may be discussed: (i) chain-growth copolymer polyols, and (ii) step-growth copolymer polyols.

Chain-growth copolymer polyols generally are prepared by free radical polymerization of monomers in a polyol carrier to produce a free radical polymer dispersed in the polyol carrier. Conventionally, the free radical polymer can be based on acrylonitrile or styrene-acrylonitrile (SAN). The solids content of the polyol is typically up to about 60%, usually in the range of from about 15% to about 40%, by weight of the total weight of the composition (i.e. free radical polymer and polyol carrier). Generally, these chain-growth copolymer polyols have a viscosity in the range of from about 2,000 to about 8,000 centipoise. When producing such chain-growth copolymer polyols, it is known to induce grafting of the polyol chains to the free-radical polymer.

Step-growth copolymer polyols generally are characterized as follows: (i) PHD (Polyharnstoff Disperion) polyols, (ii) PIPA (Poly Isocyanate Poly Addition) polyols, and (iii) epoxy dispersion polyols. PHD polyols are dispersions of polyurea particles in conventional polyols and generally are formed by the reaction of a diamine (e.g. hydrazine) with a diisocyanate (e.g. toluene diisocyanate) in the presence of a polyether polyol. The solids content of the PHD polyols is typically up to about 50%, usually in the range of from about 15% to about 40%, by weight of the total weight of the composition (i.e. polyurea particles and polyol carrier). Generally, PHD polyols have a viscosity in the range of from about 2,000 to about 6,000 centipoise. PIPA polyols are similar to PHD polyols but contain polyurethane particles instead of polyurea particles. The polyurethane particles in PIPA polyols are formed in situ by reaction of an isocyanate and alkanolamine (e.g. triethanolamine). The solids content of the PIPA polyols is typically up to about 80%, usually in the range of from about 15% to about 70%, by weight of the total weight of the composition (i.e. polyurethane particles and polyol carrier). Generally, PIPA polyols have a viscosity in the range of from about 4,000 to about 50,000 centipoise. See, for example, United States patents 4,374,209 and 5,292,778. Epoxy dispersion polyols are based on dispersions of cured epoxy resins in conventional based polyols. The epoxy particles are purportedly high modulus fillers with improved hydrogen bonding characteristics.

Further information regarding useful graft copolymer polyols may be found, for example, in Chapter 2 of "Flexible Polyurethane Foams" by Herrington and Hock (1991) and the references cited therein. When a graft copolymer polyol is used in the present polyol-solids dispersion, it is convenient to substitute a portion of the solids normally present in the specific graft copolymer polyol with a portion by weight of polyvinyl chloride.

Preferably, the particulate solid material used in the present polyol-solids dispersion consists solely of polyvinyl chloride.

The polyvinyl chloride present in the present polyol-solids dispersion has an average particle size of less than about 25 μm. Preferably the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 7.0 μm, more preferably from about 0.05 to about 3.0 μm, most preferably from about 0.05 to about 1.5 μm.

Preferably, the present polyol-solids dispersion has a viscosity at about 25°C in the range of from about 2,500 to about 10,000 mPa·sec, more preferably from about 2,500 to about 8,000 mPa·sec, most preferably from about 2,500 to about 6,000 mPa·sec.

As is known in the art of polyurethane foam production it is conventional to refer to the polyol stream as the resin stream. This resin stream is conventional mixed and reacted with an isocyanate stream. In this regard, it is conventional to mix into the resin stream, prior to contact with the isocyanate stream, with other additives (e.g. catalyst, blowing agent, etc.) necessary to effect polymerization and foaming of the reaction mixture.

Thus, the present polyol-solids dispersion encompasses the presence of a catalyst capable of catalysing the polymerization reaction. Such catalysts are known, and the choice and concentration thereof is within the purview of a person skilled in the art. See for example United States patents 4,296,213 and 4,518,778. Non-limiting examples of suitable catalysts include tertiary amines and/or organometallic compounds. Additionally, as is known in the art, when the objective is to produce an isocyanurate, a Lewis acid must be used as the catalyst, either alone or in conjunction with other catalysts. Of course it will be understood by those skilled in the art that a combination of two or more catalysts may be suitably used.

The present polyol-solids dispersion also encompasses the presence of an aqueous blowing agent for foaming the polyurethane reaction mixture. Preferably, the aqueous blowing agent is water. It is known in the art that the amount of water used as a blowing agent in the preparation of a foamed isocyanate-based polymer is conventionally in the range of from about 0.5 to as high as about 40 or more parts by weight, preferably from about 1.0 to about 10 parts by weight, based on 100 parts by weight of the total polyol content in the reaction mixture. Since the amount of water used in the production of polyurethane foam is limited, at least in part, by the fixed properties expected in the foamed polymer and by the tolerance of the expanding foam towards self structure formation, it may be necessary, in certain circumstances, to utilize a substantially inert liquid extender when high loadings of solid particulate material are contemplated. Non-limiting examples of suitable liquid extenders include high molecular weight halogenated hydrocarbons, high molecular weight hydrocarbons and polyols.

The present polyol-solids dispersion also encompasses the presence of conventional additives used in the polyurethane foam art. Non-limiting examples of such additives include: surfactants (e.g. organo-silicone compounds available under the tradename L-540 Union Carbide or DC 5043 from Air Products), cell openers (e.g. silicone oils), extenders (e.g. halogenated paraffins commercially available as Cereclor™ S45), cross linkers (e.g. low molecular weight reactive hydrogen-containing compositions), pigments/dyes, flame retardants (e.g. halogenated organo-phosphoric acid compounds), inhibitors (e.g. weak acids), nucleating agents (e.g. diazo compounds), anti-oxidants, and plasticizers/stabilizers (e.g. sulphonated aromatic compounds).

The present polyol-solids dispersion may be produced by a process for producing a polyol-solids dispersion comprising the steps of:

(a) adding from about 1 to about 70 parts by weight of a particulate solid material to from about 30 to about 99 parts by weight of a polyol to provide a mixture, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) subjecting the mixture to an energy sufficient to render the polyvinyl chloride in a substantially deagglomerated state;

(c) wetting the particulate solid material with the polyol; and

(d) maintaining the temperature of the mixture at less than about 50°C.

Step (a) comprises adding a solid particulate material to a polyol. The solid particulate material and the polyol are as described hereinabove with reference to the present polyol-solids dispersion. The discussion of the preferred embodiments referred hereinabove with respect to the particulate material and the polyol applies equally to the process for production of the polyol-solids dispersion.

Steps (b), (c) and (d) are preferably conducted contemporaneously. The general object is to supply sufficient energy to the mixture of solid particulate material and polyol to substantially wet the solid particulate material while rendering it in a deagglomerated state. As used throughout this specification, the term “deagglomerated” when used in respect of polyvinyl chloride means that the polymer particles are disposed in a polyol in such a manner as to substantially avoid physical agglomeration of a series of particles such that the behave as a large particle. As used throughout this specification, the terms "wetting out", "wet" and "wetted", in the context of the present polyol-solids dispersion, are intended to mean that the surface of each particle of the solid particulate material is covered with the polyol carrier. Preferably, each particle of the solid particulate material is substantially, more preferably substantially completely, covered by the polyol.

The energy applied to the mixture in Step (b) is regulated to ensure that the polyvinyl chloride is rendered in a substantially deagglomerated state. This encompasses processing agglomerated polyvinyl chloride particles or maintaining deagglomerated polyvinyl chloride particles as such. Further, the temperature of the mixture is maintained at less than about 50°C. It is believed that a principal reason for this is that increased temperature would result in dehydrochlorination of the polyvinyl chloride subsequently resulting in an increased likelihood that polyvinyl chloride chains will crosslink. Maintaining the temperature of the mixture at less than about 50°C during processing of the mixture mitigates or even eliminates the occurrence of this negative effect. Preferably, the temperature of the mixture is maintained at less than about 45°C, more preferably less than about 40°C.

In most practical embodiments, Step (c) involves cooling the vessel in which the polyol-solids dispersion is being produced. The nature of the vessel is not particularly restricted and is within the purview of a person skill in the art. Preferably, the equipment used for mixing and cooling of the mixture is a high shear in-line mixer equipped with a single stage general purpose disintegration head (e.g. a Type LS275 mixer from Silverson Machine Incorporated). Such cooling can be achieved by any suitable means; this is within the purview of a person skilled in the art.

The present polyol-solids dispersion is useful in the production of a polyurethane foam. Preferably, the process for production of a polyurethane foam comprises reacting together:

(a) a polyol comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 40 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) an isocyanate;

(c) water; and

(d) a catalyst capable of catalysing a reaction between the polyol, the isocyanate and water.

Component (a) is a polyol which may comprise the polyol-solids dispersion discussed hereinabove and, for example, a base polyol to dilute the polyol-solids dispersion. The discussion hereinabove of the polyol-solids dispersion, aqueous blowing agent and catalyst, and their respective preferred embodiments, applies equally in respect of the process for producing a polyurethane foam.

The isocyanate suitable for the process for producing a polyurethane foam is not particularly restricted and the choice thereof is within the purview of a person skilled in the art. Generally, the isocyanate compound suitable for use may be represented by the general formula:

$$Q(NCO)_i$$

wherein i is an integer of two or more and Q is an organic radical having the valence of i. Q may be a substituted or unsubstituted hydrocarbon group (e.g. an alkylene or arylene group). Moreover, Q may be represented by the general formula:

$$Q^1\text{-}Z\text{-}Q^1$$

wherein Q^1 is an alkylene or arylene group and Z is chosen from the group comprising -O-, -O-Q^1-, -CO-, -S-, -S-Q^1-S- and -SO_2-. Examples of isocyanate compounds which fall within the scope of this definition include hexamethylene diisocyanate, 1,8-diisocyanato-p-methane, xylyl diisocyanate, $(OCNCH_2CH_2CH_2OCH_2O)_2$, 1-methyl-2,4-

diisocyanatocyclohexane, phenylene diisocyanates, tolylene diisocyanates, chlorophenylene diisocyanates, diphenylmethane-4,4′-diisocyanate, naphthalene-1,5-diisocyanate, triphenylmethane-4,4′,4″-triisocyanate and isopropylbenzene-alpha-4-diisocyanate.

In another embodiment, Q may also represent a polyurethane radical having a valence of i. In this case $Q(NCO)_i$ is a compound which is commonly referred to in the art as a prepolymer. Generally, a prepolymer may be prepared by reacting a stoichiometric excess of an isocyanate compound (as defined hereinabove) with an active hydrogen-containing compound (as defined hereinafter), preferably the polyhydroxyl-containing materials or polyols described below. In this embodiment, the polyisocyanate may be, for example, used in proportions of from about 30 percent to about 200 percent stoichiometric excess with respect to the proportion of hydroxyl in the polyol. Since the process of the present invention relates to the production of polyurea foams, it will be appreciated that in this embodiment, the prepolymer would be used to prepare a polyurethane modified polyurea (i.e. not an unmodified polyurethane) foam.

In another embodiment, the isocyanate compound suitable for use in the process of the present invention may be selected from dimers and trimers of isocyanates and diisocyanates, and from polymeric diisocyanates having the general formula:

$$[Q''(NCO)_i]_j$$

wherein both i and j are integers having a value of 2 or more, and Q″ is a polyfunctional organic radical, and/or, as additional components in the reaction mixture, compounds having the general formula:

$$L(NCO)_i$$

wherein i is an integer having a value of 1 or more and L is a monofunctional or polyfunctional atom or radical. Examples of isocyanate compounds which fall with the scope of this definition include ethylphosphonic diisocyanate, phenylphosphonic diisocyanate, compounds which contain a =Si-NCO group, isocyanate compounds derived from sulphonamides (QSO_2NCO), cyanic acid and thiocyanic acid.

See also for example, British patent No. 1,453,258.

Non-limiting examples of suitable isocyanates include: 1,6-hexamethylene diisocyanate, 1,4-butylene diisocyanate, furfurylidene diisocyanate, 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,4′-diphenylmethane diisocyanate, 4,4′-diphenylmethane diisocyanate, 4,4′-diphenylpropane diisocyanate, 4,4′-diphenyl-3,3′-dimethyl methane diisocyanate, 1,5-naphthalene diisocyanate, 1-methyl-2,4-diisocyanate-5-chlorobenzene, 2,4-diisocyanato-s-triazine, 1-methyl-2,4-diisocyanato cyclohexane, p-phenylene diisocyanate, m-phenylene diisocyanate, 1,4-naphthalene diisocyanate, dianisidine diisocyanate, bitoluene diisocyanate, 1,4-xylylene diisocyanate, 1,3-xylylene diisocyanate, bis-(4-isocyanatophenyl)methane, bis-(3-methyl-4-isocyanatophenyl)methane, polymethylene polyphenyl polyisocyanates and mixtures thereof. A more preferred isocyanate is selected from the group comprising 2,4-toluene diisocyanate, 2,6-toluene diisocyanate and mixtures thereof. Another more preferred isocyanate is selected from the group comprising 2,4′-diphenylmethane diisocyanate, 4,4′-diphenylmethane diisocyanate and mixtures thereof. The most preferred isocyanate is a mixture comprising from about 75 to about 85 percent by weight 2,4-toluene diisocyanate and from about 15 to about 25 percent by weight 2,6-toluene diisocyanate.

In a preferred embodiment of the process to produce the polyurethane foam, the isocyanate is used in an amount sufficient to provide an isocyanate index of at least about 1.00, preferably at least about 1.05, more preferably at least about 1.10, even more preferably at least about 1.15, most preferably at least about 1.20. Conventionally, a higher isocyanate index leads to an unstable foam matrix. It has been discovered that, when modified polyvinyl chloride is incorporated in the foam matrix as discussed hereinabove, a stable foam can be produced having load building properties beyond those achievable using a lower isocyanate index and conventional load building techniques (e.g. polymer polyols, etc.).

The manner by which the polyol-solids dispersion, isocyanate, catalyst and blowing agent are contacted is not particularly restricted and is within the purview of a person skill in the art. Thus, in one embodiment, it is possible to preblend the polyol-solids dispersion, catalyst and blowing agent to produce a resin stream which is contact with an isocyanate stream in a conventional high pressure, impingement mixhead. See, for example one or more of the following:

United States patent 4,379,122 (Taubenmann);
United States patent 4,464,056 (Schmitz et al.);
United States patent 4,497,579 (Schmitz et al.);
United States patent 4,503,014 (Bauer);
United States patent 4,510,120 (Bauer);
United States patent 4,565,511 (Ramisch);
United States patent 4,643,581 (Soechtig et al.);
United States patent 4,721,391 (Bauer);
United States patent 4,774,059 (Wagner);
United States patent 4,854,713 (Soechtig);
United States patent 4,898,714 (Urban et al.);
United States patent 5,063,027 (Schneider);
United States patent 5,157,059 (Bauer et al.);
United States patent 5,201,580 (Bauer);
United States patent 5,277,567 (Bauer et al.); and
United States patent 5,259,749 (Meixner et al.),

Alternatively, the resin stream may be contacted with the isocyanate stream in a conventional low pressure, mechanical mixhead. As is known in the art, a low pressure, mechanical mixhead includes a mixer which imparts high-shear energy between the mixing element (e.g. impeller, etc.) and the surrounding barrel. The mixer speed is conventionally in the range of from about 2,000 to about 13,000 rpm.

After the components for producing the polyurethane foam have been contacted, the polymerization reaction begins. This results in the occurrence of: (i) in situ formation of carbon dioxide which acts as a blowing agent and initiates expansion of the reacting, polymerizing mass, and (ii) an increase in the temperature of the reaction mass as a result of the exothermic reactions. The increase in temperature is believed to promote dehydrochlorination of the polyvinyl chloride present in the reacting mass thereby allowing the dehydrochlorinated polyvinyl chloride to inter-react with free isocyanate functions (i.e. -NCO) present in the form of unreacted isocyanate and/or on growing polyurethane chains.

As is known in the art of polyurethane foam, the ability to produce moulded, flexible polyurethane foam is desirable since such moulded foam is the standard in transportation seating and trim parts, as well as in some upholstered furniture, bedding, packaging and novelty items. Generally, moulded foam is complicated to produce since at least the following factors must be accounted for in moulded foam: higher reactivity formulation, pour-pattern limitations, the discrete size of each individual shot, the need to open and close a mould lid mechanically, the choice of mould release agent, mould temperature latitudes and the available curing cycles. A key advantage of the present polyol dispersion is that it may be readily utilized in to produce moulded, flexible polyurethane foam. Another key advantage of the present polyol dispersion is that it may be used to produce such a foam having improved load bearing properties (e.g. hardness, indentation force deflection, etc.). Yet another key advantage of the present polyol dispersion is that it may be used to produce such a foam having improved flame retardancy.

Another surprising and unexpected advantage of the present polyurethane foam is that it appears to have anti-fogging properties. As is known in the art, fogging of windshield interiors of vehicles is a problem. Recent investigations have identified the following materials used in polyurethane foam production as being at least partly responsible: antioxidants, siloxanes and amine catalysts. The volatility of and subsequent migration from the foam of these materials is of particular concern. While the problems with antioxidants and siloxanes have been mitigated by using reduced amounts thereof in the reactions and/or using non-volatile alternatives, the amine (particularly tertiary amine) catalysts continue to present a problem.

If the theory proffered above is correct concerning dehydrochlorination of the polyvinyl chloride as being important in the interaction between the chains of polyvinyl chloride and polyurethane, it is believed that a very important advantage of the present polyurethane foam will be reduced possibility or even elimination of fogging. As is known in the art, fogging of automobile windshields is believed to result from reaction of minute amounts of hydrochloric acid evolved from polyvinyl chloride used in the automobile with volatile amine evolved from the foam to produce the corresponding solid, amine salts. These salts form on a cold, condensing surface such as the windshield and remain adhered to this surface. Thus, it is believed that the present polyurethane foam has the potential to present a filtering effect with respect to volatile amine present in the foam thereby mitigating or obviating fogging of the interior of windshields once installed in a vehicle.

Another potential advantage of the present polyurethane foam is that it may mitigate or obviate amine-induced staining of vinyl surface in an automobile. As is known in the art, "vinyl staining" occurs, for example, when a white vinyl seat cover comes into contact with volatile amine evolved from the foam. This is believed to results in staining of the white (or light-coloured) vinyl seat cover. As described in the previous paragraph, it is believed that the polyurethane foam of the present invention may act as a filter with respect to volatile amine present in the foam.

Embodiments of the present invention will now be described with reference to the following Examples which should not be construed as limiting the scope of the invention. The term "pbw" used in the Examples refers to parts by weight.

In the Examples the following compounds were used:

1. ARCOL E-700, a polyol (triol) commercially available from Arco Corporation;
2. ARCOL E-788, a polymer polyol containing approximately 38% SAN solids and commercially available from Arco Corporation;
3. ARCOL E-814, a polyether polyol (molecular weight of about 6,000) commercially available from Arco Corporation;
4. DEOA-LF™, diethanolamine (crosslinker);
5. DABCO-33LV, an amine polymerization catalyst commercially available from Air Products and Chemicals Inc.;
6. ZF-22, a diaminoethyl ether catalyst commercially available from Huntsman Corporation;

7. DC5043, a silicone surfactant commercially available from Air Products and Chemicals Inc.;

8. DC5169, a silicone surfactant commercially available from Air Products and Chemicals Inc.;

9. OXY 625, polyvinyl chloride homopolymer having an average particle size of 1.2 μm commercially available from Occidental Chemicals; and

10. Isocyanate, a commercially available TDI.

<u>EXAMPLES 1-4</u>

In these Examples, various foams were made pursuant to the formulations provided in Table 1. As will be apparent to those of skill in the art, the amount of isocyanate used in Examples 1 and 3 corresponds to an isocyanate index of 1.10 whereas the amount of isocyanate used in Examples 2 and 4 corresponds to an isocyanate index of 1.20. Further, Examples 1 and 2 contained no polyvinyl chloride and thus are provide for comparative purposes only.

<u>Table 1</u>

Ingredient	Example 1	Example 2	Example 3	Example 4
ARCOL E-700	25.00	25.00	41.32	41.32
ARCOL E-788	75.00	75.00	48.68	48.68
H_2O	4.07	4.07	4.07	4.07
DEOA-LF	1.41	1.41	1.45	1.45
DABCO-33LV	0.39	0.39	0.30	0.30
ZF-22	0.08	0.08	0.08	0.08
DC-5043	0.45	0.45	0.45	0.45
DC-5169	0.20	0.20	0.20	0.20
OXY 625	0.00	0.00	10.00	10.00
Isocyanate	53.57	58.44	53.57	58.44

Foam samples were produced by preblend all ingredients except the isocyanate. The polyvinyl chloride (OXY 625) was mixed into the preblend without the use of a high shear mixer and the temperature of the preblend was maintained below 50°C. The preblend was mixed with the isocyanate and the resulting reaction mixture was poured into an aluminum mould heated to 65 ± 2°C. Demould time was about 5 minutes for Examples 1 and 3, and about 10 minutes for Examples 2 and 4.

The resulting foam samples were crushed in a roller crusher immediately after demoulding and aged for about 72 hours. The aged foam samples were subjected Indentation Force Deflection (IFD) testing pursuant to ASTM D-3574-95 (Test B1). The results of IFD testing are provided in Table 2. The values reported in Table 2 are an average of testing of two samples for each Example. The results in Table 2 demonstrate that improved load bearing properties are conferred to the resulting polyurethane foam when a portion (approximately one third) of the SAN in one of the based polymer polyols in the formulation is replaced with polyvinyl chloride which is incorporated into the resin preblend at a temperature which does not promote dehydrochlorination.

Table 2

	Example 1	Example 2	Example 3	Example 4
25% IFD (N)	261	289	285	340
50% IFD (N)	509	560	527	632
65% IFD (N)	824	899	816	969
25% Return (N)	165	182	180	209

EXAMPLES 5-10

These Examples illustrate the effect of loading bearing properties of the final foam product when temperature is not controlled during production of the polyol dispersion. The formulation of the master resin preblend used in these Examples is provided in Table 3.

Table 3

Ingredient	Amount
ARCOL E-700	25.00
ARCOL E-788	48.68
PVC Dispersion	26.32
H_2O	4.07
DEOA-LF	1.45
DABCO-33LV	0.39
ZF-22	0.08
DC-5043	0.45
DC-5169	0.20

The PVC dispersion was prepared using ARCOL E-700 with OXY 625. As will be apparent to those of skill in the art, in the formulation in Table 3, a portion of ARCOL E-788 is replaced with the PVC dispersion to provide partial replacement of a portion of the solids (i.e. SAN) in ARCOL E-788 with polyvinyl chloride.

Various PVC dispersions were produced with a SHAR high shear mixer equipped with a stainless steal container and a 3 inch impeller. The polyol and the polyvinyl chloride were initially preblended for 5 minutes at an impeller mixing speed of about 2000 rpm. There after the impeller mixing speed was increased to about 5500 rpm to provide high shear mixing of the polyol and the polyvinyl chloride for various periods of time. The particulars of the preparation of each dispersion are provided in Table 4, together with the final temperature of each dispersion and its viscosity at 25°C.

Each PVC dispersion was blended into the master resin preblend provided in Table 3 above. The master resin preblend was then mixed with isocyanate in an amount sufficient to provide an isocyanate index of 1.10 to produce a foam same using the same procedure described above for Examples 1-4.

Table 4

	Example					
	5	6	7	8	9	10
Polyol	E-700	E-700	E-700	E-814	E-814	E-814
Mixing time (min.)	10	20	30	10	20	30
Temperature (°C)	65	90	111	74	104	135
Viscosity (cps)	5950	6150	7750	8640	10500	16750
25% IFD (N)	270	279	296	256	243	248
50% IFD (N)	515	532	556	507	472	484
65% IFD (N)	796	823	852	820	776	780
25% Return (N)	167	173	184	154	151	157

The resulting foam samples were subjected IFD testing pursuant as discussed above for Examples 1-4. The results are provided in Table 4. For comparison a control foam was produced using a formulation similar to that used in Example 1 (i.e. no polyvinyl chloride). The IFD results for this foam were as follows:

25% IFD:	252 N
50% IFD:	504 N
65% IFD:	819 N
25% Return:	156 N

As will be apparent to those of skill in the art, these Examples demonstrate that partial modification of the polyvinyl chloride can be initiated prior to the foaming reaction to produce foams which have similar or enhanced load properties compared to a foam containing no polyvinyl chloride. Further, when temperature control of the dehydrochlorination (or chemical stabilization of the polyvinyl chloride) is achieved, the properties of the end foam product are more predictable and other changes in the properties (e.g. colour) are mitigated.

What is claimed is:

1. A polyurethane foam comprising a polyurethane foam matrix having disposed therein polyvinyl chloride in particulate form having an average particle size of less than about 25 μm, the polyvinyl chloride being at least partially modified.

2. The polyurethane foam defined in claim 1, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 7.0 μm.

3. The polyurethane foam defined in claim 1, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 3.0 μm.

4. The polyurethane foam defined in claim 1, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 1.5 μm.

5. The polyurethane foam defined in any one of claims 1-4, wherein the polyvinyl chloride is selected from the group consisting of homopolymer polyvinyl chloride, compounded polyvinyl chloride and mixtures thereof.

6. The polyurethane foam defined in claim 5, wherein the compounded polyvinyl chloride is virgin.

7. The polyurethane foam defined in claim 5, wherein the compounded polyvinyl chloride is recycled.

8. The polyurethane foam defined in any one of claims 1-7, further comprising a second solid material.

9. The polyurethane foam defined in claim 8, wherein the second solid is a recycled polymer.

10. The polyurethane foam defined in claim 8, wherein the second solid material is an inorganic material.

11. The polyurethane foam defined in claim 10, wherein the inorganic material is selected from the group consisting of calcium carbonate, barium sulfate, carbon, clay, talc, titanium dioxide, natural silicates, synthetic silicates, zeolites, mica, ceramics, aluminas, titanias and mixture thereof.

12. The polyurethane foam defined in claim 8, wherein the second solid material is an organic polymer.

13. The polyurethane foam defined in claim 8, wherein the second solid material is selected from the group consisting of acrylonitrile, styrene-acrylonitrile, polyisocyanate polyadditon polymer, polyurea, polyurethane, polystyrene, polypropylene, polyethylene, melamine, urea, starch, rubber, lignin and mixtures thereof.

14. A process for producing a polyurethane foam comprising reacting together:

(a) a polyol comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from about 1 to about 40 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) an isocyanate;

(c) water; and

(d) a catalyst capable of catalyzing a reaction between the polyol, the isocyanate and water.

15. The process defined in claim 14, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 7.0 μm.

16. The process defined in claim 14, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 3.0 μm.

17. The process defined in claim 14, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 1.5 μm.

18. The process defined in any one of claims 14-18, wherein the polyvinyl chloride is selected from the group consisting of homopolymer polyvinyl chloride, compounded polyvinyl chloride and mixtures thereof.

19. The process defined in claim 18, wherein the compounded polyvinyl chloride is virgin.

20. The process defined in claim 18, wherein the compounded polyvinyl chloride is recycled.

21. The process defined in any one of claims 14-20, wherein the second solid is a recycled polymer.

22. The process defined in any one of claims 14-20, wherein the second solid is an inorganic material.

23. The process defined in claim 22 , wherein the inorganic material is selected from the group consisting of calcium carbonate, barium sulfate, carbon, clay, talc, titanium dioxide, natural silicates, synthetic silicates, zeolites, mica, ceramics, aluminas, titanias and mixture thereof.

24. The process defined in any one of claims 14-20, wherein the second solid is an organic polymer.

25. The process defined in any one of claims 14-20, wherein the second solid is selected from the group consisting of acrylonitrile, styrene-acrylonitrile, polyisocyanate polyadditon polymer, polyurea, polyurethane, polystyrene, polypropylene, polyethylene, melamine, urea, starch, rubber, lignin and mixtures thereof.

26. The process defined in any one of claims 14-25, wherein the particulate solid material consists of polyvinyl chloride.

27. The process defined in any one of claims 14-26, wherein the particulate solid material is present in an amount in the range of from about 1 to about 20 percent by weight of the polyol dispersion.

28. The process defined in any one of claims 14-26, wherein the particulate solid material is present in an amount in the range of from about 1 to about 15 percent by weight of the polyol dispersion.

29. The process defined in any one of claims 14-28, wherein the polyol is a hydroxyl-terminated compound selected from the group comprising polyethers, polyesters, polythioethers, polycarbonates, polydienes and polycaprolactones.

30. The process defined in any one of claims 14-28, wherein the polyol is selected from the group comprising adipic acid-ethylene glycol polyester, polyalkylene glycol, poly(butylene glycol), poly(propylene glycol) and hydroxyl-terminated polybutadiene.

31. The process defined in any one of claims 14-28, wherein the polyol is a polyether polyol.

32. The process defined in claim 31, wherein the polyether polyol has a molecular weight in the range of from about 200 to about 20,000.

33. The process defined in any one of claims 14-32, wherein the isocyanate is represented by the general formula:

$$Q(NCO)_i$$

wherein i is an integer of two or more and Q is an organic radical having the valence of i.

34. The process defined in any one of claims 14-32, wherein isocyanate is selected from the group comprising 1,6-hexamethylene diisocyanate, 1,4-butylene diisocyanate, furfurylidene diisocyanate, 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,4′-diphenylmethane diisocyanate, 4,4′-diphenylmethane diisocyanate, 4,4′-diphenylpropane diisocyanate, 4,4′-diphenyl-3,3′-dimethyl methane diisocyanate, 1,5-naphthalene diisocyanate, 1-methyl-2,4-diisocyanate-5-chlorobenzene, 2,4-diisocyanato-s-triazine, 1-methyl-2,4-diisocyanato cyclohexane, p-phenylene diisocyanate, m-phenylene diisocyanate, 1,4-naphthalene diisocyanate, dianisidine diisocyanate, bitoluene diisocyanate, 1,4-xylylene diisocyanate, 1,3-xylylene diisocyanate, bis-(4-isocyanatophenyl)methane, bis-(3-methyl-4-isocyanatophenyl)methane, polymethylene polyphenyl polyisocyanates and mixtures thereof.

35. The process defined in any one of claims 14-32, wherein the isocyanate is selected from the group comprising 2,4-toluene diisocyanate, 2,6-toluene diisocyanate and mixtures thereof.

36. The process defined in any one of claims 14-32, wherein the isocyanate is selected from the group consisting essentially of (i) 2,4′-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate and mixtures thereof; and (ii) mixtures of (i) with an isocyanate selected from the group comprising 2,4-toluene diisocyanate, 2,6-toluene diisocyanate and mixtures thereof.

37. A polyol-solids dispersion comprising a particulate solid material dispersed in a polyol, the particulate solid material being present in an amount in the range of from

about 1 to about 70 percent by weight of the polyol-solids dispersion, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm.

38. The polyol dispersion defined in claim 37, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 7.0 μm.

39. The polyol dispersion defined in claim 37, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 3.0 μm.

40. The polyol dispersion defined in claim 37, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 1.5 μm.

41. The polyol dispersion defined in any one of claims 37-40, wherein the dispersion has a viscosity at about 25°C in the range of from about 2,500 to about 10,000 mPa·sec.

42. The polyol dispersion defined in any one of claims 37-40, wherein the dispersion has a viscosity at about 25°C in the range of from about 2,500 to about 8,000 mPa·sec.

43. The polyol dispersion defined in any one of claims 37-40, wherein the dispersion has a viscosity at about 25°C in the range of from about 2,500 to about 6,000 mPa·sec.

44. The polyol dispersion defined in any one of claims 37-43, wherein the polyvinyl chloride is selected from the group consisting of homopolymer polyvinyl chloride, compounded polyvinyl chloride and mixtures thereof.

45. The polyol dispersion defined in claim 44, wherein the compounded polyvinyl chloride is virgin.

46. The polyol dispersion defined in claim 44, wherein the compounded polyvinyl chloride is recycled polyvinyl chloride.

47. The polyol dispersion defined in any one of claims 37-46, wherein the second solid is a recycled polymer.

48. The polyol dispersion defined in any one of claims 37-46, wherein the second solid is an inorganic material.

49. The polyol dispersion defined in claim 48, wherein the inorganic material is selected from the group consisting of calcium carbonate, barium sulfate, carbon, clay, talc, titanium dioxide, natural silicates, synthetic silicates, zeolites, mica, ceramics, aluminas, titanias and mixture thereof.

50. The polyol dispersion defined in any one of claims 37-46, wherein the second solid is an organic material.

51. The polyol dispersion defined in any one of claims 37-46, wherein the second solid is selected from the group consisting of acrylonitrile, styrene-acrylonitrile, polyisocyanate polyadditon polymer, polyurea, polyurethane, polystyrene, polypropylene, polyethylene, melamine, urea, starch, rubber, lignin and mixtures thereof.

52. The polyol dispersion defined in any one of claims 37-51, wherein the particulate solid material consists of polyvinyl chloride.

53. The polyol dispersion defined in any one of claims 37-52, wherein the particulate solid material is present in an amount in the range of from about 20 to about 50 percent by weight of the polyol dispersion.

54. The polyol dispersion defined in any one of claims 37-52, wherein the particulate solid material is present in an amount in the range of from about 30 to about 40 percent by weight of the polyol dispersion.

55. The polyol dispersion defined in any one of claims 37-54, wherein the polyol is a hydroxyl-terminated compound selected from the group comprising polyethers, polyesters, polythioethers, polycarbonates, polydienes and polycaprolactones.

56. The polyol dispersion defined in any one of claims 37-54, wherein the polyol is selected from the group comprising adipic acid-ethylene glycol polyester, polyalkylene glycol, poly(butylene glycol), poly(propylene glycol) and hydroxyl-terminated polybutadiene.

57. The polyol dispersion defined in any one of claims 37-54, wherein the polyol is a polyether polyol.

58. The polyol dispersion defined in claim 57, wherein the polyether polyol has a molecular weight in the range of from about 200 to about 20,000.

59. A process for producing a polyol-solids dispersion comprising the steps of:

(a) adding from about 1 to about 70 parts by weight of a particulate solid material to from about 30 to about 99 parts by weight of a polyol to provide a mixture, the particulate solid material consisting essentially of from about 1 to 100 percent by weight of polyvinyl chloride and from 0 to about 99 percent by weight of a second solid, the polyvinyl chloride having an average particle size of less than about 25 μm;

(b) subjecting the mixture to an energy sufficient to render the polyvinyl chloride in a substantially deagglomerated state;

(c) wetting the particulate solid material with the polyol; and

(d) maintaining the temperature of the mixture at less than about 50°C.

60. The process defined in claim 59, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 7.0 μm.

61. The process defined in claim 59, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 3.0 μm.

62. The process defined in claim 59, wherein the polyvinyl chloride has an average particle size in the range of from about 0.05 to about 1.5 μm.

63. The process defined in any one of claims 59-62, wherein the polyvinyl chloride is selected from the group consisting of homopolymer polyvinyl chloride, compounded polyvinyl chloride and mixtures thereof.

64. The process defined in claim 63, wherein the compounded polyvinyl chloride is virgin.

65. The process defined in claim 63, wherein the compounded polyvinyl chloride is recycled.

66. The process defined in any one of claims 59-65, wherein the second solid is a recycled polymer.

67. The process defined in any one of claims 59-65, wherein the second solid is an inorganic material.

68. The process defined in claim 67, wherein the inorganic material is selected from the group consisting of calcium carbonate, barium sulfate, carbon, clay, talc, titanium

dioxide, natural silicates, synthetic silicates, zeolites, mica, ceramics, aluminas, titanias and mixture thereof.

69. The process defined in any one of claims 59-68, wherein the second solid is an organic polymer.

70. The process defined in any one of claims 59-68, wherein the second solid is selected from the group consisting of acrylonitrile, styrene-acrylonitrile, polyisocyanate polyadditon polymer, polyurea, polyurethane, polystyrene, polypropylene, polyethylene, melamine, urea, starch, rubber, lignin and mixtures thereof.

71. The process defined in any one of claims 59-68, wherein the particulate solid material consists of polyvinyl chloride.

72. The process defined in any one of claims 59-71, wherein the particulate solid material is present in an amount in the range of from about 20 to about 50 percent by weight of the polyol dispersion.

73. The process defined in any one of claims 59-71, wherein the particulate solid material is present in an amount in the range of from about 30 to about 40 percent by weight of the polyol dispersion.