Monobenzoates useful as a plasticizer in adhesive preparations
CA 2864252 C

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A unique monobenzoate useful as a plasticizer in polymeric dispersions, such as adhesives, comprising 3-phenyl propyl benzoate, a monobenzoate ester used as a flavor and fragrance additive, but not heretofore utilized as a plasticizer for polymeric dispersions, such as adhesives, caulks and sealants. The inventive monobenzoate provides a suitable non-phthalate, lower VOC alternative plasticizer that is compatible with a wide variety of polymers. Advantages rendered by the use of the inventive monobenzoate include, among other things, excellent viscosity response, low viscosity, viscosity stability, improved rheology, good film formation and comparable or better adhesion, peel strength, set time, open time, chalk point and MFFT, compared with that achieved by traditional plasticizers. The inventive monobenzoate also has an excellent health, safety and environmental profile and provides a viable alternative for adhesives used in food contact applications, such as packaging, where migratory concerns are an issue.

BESCHREIBUNG (OCR-Text kann Fehler enthalten)

MONOBENZOATE USEFUL AS A PLASTICIZER IN ADHESIVE PREPARATIONS

HELD OF THE INVENTION

This invention is directed to a monobenzoate found to be unexpectedly useful as a plasticizer in a variety of polymer applications, including but not limited to adhesives, caulks, sealants and the like. In particular, this invention is directed to the use of a monobenzoate ester, 3-phenyl propyl benzoate, in adhesive applications or adhesive products. The inventive monobenzoate has comparable or better rheology, viscosity stability, compatibility, processability, open time, set time, peel strength and water reduction, among other advantages, over traditional plasticizers. The invention is also directed to polymeric compositions comprising the inventive monobenzoate, such as water-based adhesives, non-aqueous based adhesives, caulks and sealants.

BACKGROUND OF THE INVENTION

[0002] Adhesives are widely used in a number of applications, including without limitation envelopes; labeling; bonding, sealing and assembly of components and other materials; remoistener; stenciling; laminating; packaging; electronics manufacturing; high speed adhesive application; construction; transportation and the like. Certain polymers or polymer blends are well known, useful adhesives. By way of example only, copolymers of ethylene and vinyl acetate are useful for adhesives.

Adhesives are formulated in both water (waterborne) and solvent-based (non-aqueous) systems. Generally, solvent-based adhesives work more predictably and effectively under a wide range of conditions. Water-based systems are substantially or entirely free of most inherent toxic and hazardous properties of solvents, but do not always work in less than ideal conditions. There is a need for water-based systems that perform better or equivalent to solvent-based adhesives.

ANSPRÜCHE (11)

Claims:

1. A plasticizer for use in polymeric compositions, consisting of a monobenzoate, 3-phenyl propyl benzoate, wherein the polymeric compositions are aqueous or non-aqueous adhesives, latex, glues, caulks or sealants.

2. An adhesive composition comprising:
   a. a polymeric dispersion; and
   b. a plasticizer that is 3-phenyl propyl benzoate, wherein the polymeric dispersion is waterborne or non-aqueous and the polymer is selected from the group consisting of acrylics, polyvinyl acetate, vinyl acetate ethylene, methacrylates, styrene acrylates, polyurethanes, nitriles, polysulfides, epoxies, and polyamides, and wherein the 3-phenyl propyl benzoate is used to provide viscosity response, improved open and set times, minimum film formation temperature (MFFT), and Tg suppression and facilitates formation of the adhesive bond, whether used alone or in combination with other plasticizers in the adhesive composition.

3. The plasticizer as set forth in claim 1, wherein the polymeric composition is a waterborne latex glue.

4. The plasticizer as set forth in claim 1, wherein the polymeric composition is a caulk composition.

5. The plasticizer composition of claim 1, wherein the polymeric composition is a sealant composition.

6. A waterborne adhesive composition comprising:
   a. a polymer selected from the group consisting of waterborne acrylics, polyvinyl acetate, vinyl acetate ethylene, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.

7. A non-aqueous adhesive composition comprising:
   a. a polymer selected from the group consisting of acrylics, polyvinyl acetate, vinyl acetate ethylene, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.

8. A waterborne adhesive composition comprising:
   a. a polymer selected from the group consisting of waterborne acrylics, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.

9. A non-aqueous adhesive composition comprising:
   a. a polymer selected from the group consisting of acrylics, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.

10. A waterborne adhesive composition comprising:
    a. a polymer selected from the group consisting of waterborne acrylics, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.

11. A non-aqueous adhesive composition comprising:
    a. a polymer selected from the group consisting of acrylics, methacrylates, styrene acrylates, polyurethanes, nitriles, and b. a plasticizer that is 3-phenyl propyl benzoate.
formed by the dried adhesive. Plasticizers facilitate the formation of an adhesive bond and prevent failure of the bond after aging. Plasticizers soften the polymer and add flexibility to the adhesive bond, without adversely affecting the degree of adhesion, lower the glass transition temperature (Tg) of the adhesive film making the polymer more flexible and the glue more efficient, and enhance film formation by lowering the minimum film formation temperature (MFFT). Plasticizers may also act as a fluid carrier for the polymeric component. In all applications, the plasticizer should be compatible at least partially with the base polymer. Plasticizers should possess chemical stability, non-flammability, low toxicity and low volatilities. Finally, plasticizers should also be economically feasible.

10,0061 Dibenzoate plasticizers, such as diethylene glycol dibenzoate (DEGDB) and dipropylene glycol dibenzoate (DPGDB), are well known as general purpose plasticizers for latex adhesive applications. Blends of dibenzoates are also known and available. A high polarity blend of DEGDB, DPGDB and triethylene glycol dibenzoates (TEGDB) is available. More recently, a new dibenzoate blend, comprising a blend of three dibenzoate plasticizers, DEGDB, DPGDB and 1,2-propylene glycol dibenzoate (PGDB), in various ratios, was introduced as a lower VOC plasticizer/coalescent alternative for use in plastisol, adhesives, coatings, and polishes, among other polymer applications.

[0007] Other plasticizers useful for latex adhesives are the phthalates, i.e., benzyl phthalate (BBP), Di-n-butyl phthalate (DBP) and dibutyl phthalate (DBP). Although not necessarily high solvating plasticizers, other examples of non-phthalate, high solvating, plasticizers useful in adhesive compositions include some glycols, citric acid esters, alkyl sulfonic acid esters, and certain phosphates.

[0008] In addition to the dibenzoates discussed above, monobenzoates known to be useful as plasticizers include: isodecyl benzoate, isononyl benzoate, and 2-ethylhexyl benzoate. Isononyl benzoate has been described as a useful coalescent agent for paint compositions and for use in the preparation of plastisols in U.S. Patent No. 5,236,987 to Arendt. The use of isodecyl benzoate has also been described in U.S. Patent No. 7,629,133 to Godwin et al, as a useful secondary plasticizer in combination with phthalate plasticizers for PVC plastisols. The use of 2-ethylhexyl benzoate in a blend with DEGDB and diethylene glycol monobenzoate is described in U.S. Patent No. 6,989,839 to Arendt et al. The use of isononyl esters of benzoic acid as film-forming agents in compositions such as emulsion paints, mortars, plasters, adhesives, and varnishes is described in U.S. Patent No. 7,638,569 to Grass et al.

[0009] “Half ester” non-phthalones include dipropylene glycol monobenzoate and diethylene glycol monobenzoate, which are byproducts of the production of dibenzoates, but which, most of the time, are not objects of production. Half esters are compatible with emulsions polymers, such as acrylic and/or vinyl ester polymers.

There remains a need for non-phthalate, lower VOC plasticizers for use in adhesive applications as alternatives to traditional plasticizers. Non-phthalate alternatives are particularly desirable in view of environmental, health and safety issues associated with many of the traditional plasticizers. In particular, in the food packaging industry, there is increasing concern for migratory issues associated with the use of packaging adhesives. There is, therefore, a need for a plasticizer for use in adhesive applications, which is environmentally safe, non-hazardous and non-toxic in use.

[0011] It has been discovered that an entirely different monobenzoate, 3-phenyl propyl benzoate (3 PPB), is a surprisingly effective lower VOC plasticizer alternative to other monobenzoates and certain phthalates for use in adhesives, caulks and sealants.

Advantages of this monobenzoate are its excellent health, safety and environmental profile and handling properties, which are better than most dibenzoates and monobenzoates previously used. This new monobenzoate is not classified as hazardous under any hazard class, and no hazard labeling elements are required.

[0012] The monobenzoate, 3 PPB, has not been utilized in polymeric applications of the type discussed herein in the past. It has been used and continues to be used in flavoring and fragrance applications, making it an ideal candidate in applications where there are migratory concerns. It has also been used as a solubilizer for certain active or functional organic compounds in personal care products as described in U.S. Patent Publication 2005/0152855.

[0013] It is an object of the invention to provide an alternative non-phthalate plasticizer having excellent compatibility with a wide variety of polymers, with improved handling and a superior toxicological profile over traditional plasticizers, for use alone or in combination with other plasticizers in adhesive applications.

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SUMMARY OF THE INVENTION

This invention is directed to a non-phthalate monobenzoate plasticizer useful as a plasticizer for polymeric dispersions, such as adhesives, including but not limited to viscosity response, Tg suppression, set time, open time, peel strength, water reduction and chalk point (MFFT).

Still another object of the invention is to provide waterborne or non-aqueous adhesive compositions comprising the inventive monobenzoate having comparable or better properties than adhesive compositions utilizing traditional plasticizers.

A further object of the invention is to provide other inventive compositions comprising the inventive monobenzoate, including but not limited to caulks and sealants, for use in a wide variety of applications.

Other objects of the invention will be apparent from the description herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the volatility characteristics determined for the neat plasticizers evaluated, using the Oven Volatility test, one hour, at 110 C.

FIG. 2 shows the One Day Viscosity responses obtained in Pace 383 polyvinyl acetate (PVAc homopolymer) at 10 wt. % of each of the plasticizers evaluated.

FIGS. 3 (a) and (b) show one day Viscosity responses obtained in polyvinyl acetate ethylene (PVA/E) copolymers, Copolymer A (Elvace 735) (FIG. 3a) and Copolymer B (Vinnapas 400) (HG, 3 (b)), at 5 wt. % of each of the plasticizers evaluated.

FIG. 4 shows water reduction results (to 2000 mPa's) of the PVAc homopolymer obtained at concentrations of 5, 10, 15 and 20 wt. % of each of the plasticizers evaluated.

FIGS. 5 (a) and (b) show water reduction results (to 2000 mPa's) of the two [NNE copolymers, A and B, respectively, obtained at concentrations of 5, 10 and wt. % of each of the plasticizers evaluated.

FIG. 6 reflects Tg results obtained for plasticizer concentrations of 5, 10, 15 and 20 wt. % in PVAc homopolymer.

FIGS. 7 (a) and (b) reflect Tg results obtained for plasticizer concentrations of 5, 10, 15 and 20 wt. % in the two copolymers, A and B, respectively.

FIG. 8 shows set times obtained for the various plasticizers at 10 % concentration in PVAc homopolymer.

FIGS. 9 (a) and (b) show set times obtained for the various plasticizers at wt.% concentration in copolymers A and B, respectively.

FIG. 10 shows open times obtained for the various plasticizers at 10 Wt.% concentration in PVAc homopolymer.

FIGS. 11(a) and (b) show open times obtained for the various plasticizers at 5 wt.% concentration in copolymers A and B, respectively.

FIGS. 12 (a) and (b) show peel strength results obtained for the various plasticizers at 5 wt.% concentration in PVA/E copolymer, dry and after one hour water soak, respectively, using the T-Peel Cotton to Cotton Test.

FIGS. 13 and 14 show initial and one day Brookfield Viscosity results, respectively, of PVAc homopolymer at concentrations of 5, 10, 16 and 20 wt.% of each of the plasticizers evaluated.

FIGS. 15 and 16 show three and seven day Brookfield Viscosity results, respectively, of PVAc homopolymer at concentrations of 5, 10, 15 and 20 wt.% of the each of the plasticizers evaluated.

FIGS. 17 and 18 show four week and eight week Brookfield Viscosity results, respectively, of PVAc homopolymer at concentrations of 5, 10, 15 and 20 wt.% of each of the plasticizers evaluated.

In one embodiment, the invention is a plasticizer useful for adhesive compositions comprising 3 PPB.

In a second embodiment, the invention is a waterborne adhesive composition comprising the inventive plasticizer, including but not limited to waterborne latex glues and waterborne acrylics.

In a third embodiment, the invention is a caulk composition comprising the inventive plasticizer. In a fourth embodiment, the invention is a sealant composition comprising the inventive plasticizer, in a fifth embodiment, the invention is a non-aqueous based adhesive composition comprising the inventive plasticizer.

In a sixth embodiment, the invention is a blend of traditional plasticizers with the inventive plasticizer.

In still other embodiments, the invention relates to the use of the inventive plasticizer and adhesive compositions in applications.

Use of the inventive monobenzoate in the same or similar amounts as traditional plasticizers results in comparable or better performance and handling properties than that achieved with traditional plasticizers. The inventive monobenzoate is non-toxic, as is evident by its past and continued use as a flavor and fragrance additive. As such, it does not have the environmental, health and safety issues associated with traditional plasticizers.

In a seventh embodiment, the invention is a waterborne adhesive composition comprising the inventive plasticizer and copolymer A of vinyl acetate and ethylene (PVA/E) or vinyl acetate and isobutylene (PVA/I).

In a fifth embodiment, the invention is a non-aqueous based adhesive composition comprising the inventive plasticizer.

In a sixth embodiment, the invention is a waterborne adhesive composition comprising the inventive plasticizer, including but not limited to waterborne latex glues and waterborne acrylics.

In a seventh embodiment, the invention is a caulk composition comprising the inventive plasticizer.

In an eighth embodiment, the invention is a sealant composition comprising the inventive plasticizer.

In a ninth embodiment, the invention is a blend of traditional plasticizers with the inventive plasticizer.

In still other embodiments, the invention relates to the use of the inventive plasticizer and adhesive compositions in applications.

Use of the inventive monobenzoate in the same or similar amounts as traditional plasticizers results in comparable or better performance and handling properties than that achieved with traditional plasticizers. The inventive monobenzoate is non-toxic, as is evident by its past and continued use as a flavor and fragrance additive. As such, it does not have the environmental, health and safety issues associated with traditional plasticizers.

In a tenth embodiment, the invention is a blend of traditional plasticizers with the inventive plasticizer.

In still other embodiments, the invention relates to the use of the inventive plasticizer and adhesive compositions in applications.

Use of the inventive monobenzoate in the same or similar amounts as traditional plasticizers results in comparable or better performance and handling properties than that achieved with traditional plasticizers. The inventive monobenzoate is non-toxic, as is evident by its past and continued use as a flavor and fragrance additive. As such, it does not have the environmental, health and safety issues associated with traditional plasticizers.
of each of the plasticizers evaluated.

[0042] FIGS. 19 (a), (b), (c) and (d) show shear results of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0043] FIG. 20 shows Tg results of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0044] FIG. 21 shows set time results of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0045] FIG. 22 shows open time results of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0046] FIG. 23 shows results of the 180° cotton to acrylic peel test for PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0047] FIG. 24 shows results of the second trial of the 180° cotton to acrylic peel test for PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of the plasticizers evaluated.

[0048] FIG. 25 shows a comparison of the results of the first trial and second trial 180° cotton to acrylic peel tests reflected in FIGS. 23 and 24.

[0049] FIG. 26 shows the average of the results obtained for the 180° cotton to acrylic peel test reflected in FIGS. 23 and 24.

[0050] FIG. 27 shows the results of the 180° cotton to flexible vinyl peel test for PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0051] FIG. 28 shows the results of the dry T-Peel, cotton to cotton test for PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0052] FIG. 29 shows the results of the water reduction (to 2000 mPals) test for PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0053] FIG. 30 shows the Hysteresis Loop (wet tack) results of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of each of the plasticizers evaluated.

[0054] FIG. 31 shows the chalk point data of PVAc homopolymer at 5, 10, 15 and 20 wt.% concentrations of the plasticizers evaluated.

[0055] FIGS. 32, 33 (a), 33 (b) and 34 show the initial, one, three and seven day Brookfield Viscosities, respectively, of Elvace 736 copolymer formulations using plasticizer Concentrations of 5, 10 and 15 wt.% of each of the plasticizers evaluated.

[0056] FIGS. 35, 36 and 37 show shear results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% plasticizer concentrations, respectively.

[0057] FIG. 38 shows Tg results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0058] FIG. 39 shows set time results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0059] FIG. 40 shows open time results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0060] FIG. 41 shows water reduction (to 2000cP) of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0061] FIG. 42 shows Hysteresis Loop (wet tack) results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0062] FIG. 43 shows dry 1-Peel, cotton to cotton, results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% concentrations of each of the plasticizers evaluated.

[0063] FIG. 44 shows T-Peel, cotton to cotton, results after a one hour water soak of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers evaluated.

[0064] FIG. 45 shows T-Peel cotton to cotton strength loss after a one hour water soak of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers evaluated.

[0065] FIG. 46 shows 180° Peel, Flexible PVC to Luan results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers evaluated.

[0066] FIGS. 47, 48 and 49 show the initial, one and three day Brookfield Viscosities, respectively, of Elvace 735 copolymer formulations at 5, 10, and 15 wt.% of each of the plasticizers and plasticizer blends evaluated.

[0067] FIGS. 50, 51 and 52 show the initial, one and three day Brookfield viscosities, respectively, of Pace 383 (PVAc) homopolymer formulations at 5, 10, 15 and 20 wt.% of each of the plasticizers and plasticizer blends evaluated.

[0068] FIG. 53 shows 1 week viscosity results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers and plasticizer blends evaluated.

[0069] FIG. 54 shows Tg results of Pace 383 homopolymer formulations at 5, 10, 15 and 20 wt.% of each of the plasticizers and plasticizer blends evaluated.

[0070] FIG. 55 shows Tg results of Elvace 735 copolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers and plasticizer blends evaluated.

[0071] FIGS. 56 and 57 show set and open times, respectively, of Elvace cooolymer formulations at 5, 10 and 15 wt.% of each of the plasticizers evaluated.

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The inventive monobenzoate may also be combined with or include various amounts of conventional additives such as alkyl glycol derivatives, sulfonamides, succinic acid esters, and benzoates, both mono- and di-benzoates.

Conventional plasticizers have been described herein and include, but are not limited to, phthalate esters up to C5, phosphate esters up to C4, adipates, citrates, succinates, isobutyrate, alkyl glycol esters, terephthalate esters, such as DBTP, 1,2-cyclohexane dicarboxylate esters, polyesters, alkyl glycol derivatives, sulfonamides, succinic acid esters, and benzoates, -both mono-and di-benzoates 100841

The inventive 3-PPB plasticizer be, but is not required to be, blended with various other conventional plasticizers and desired performance in the particular polymeric application. Expected that one skilled in the art would be able to arrive at additional acceptable amounts based on the intended use of the polymer (higher Tg) the more plasticizer required, 100821 Useful amounts of 3-PPB are set forth in the examples. It is expected that one skilled in the art would be able to arrive at additional acceptable amounts based on the intended use and desired performance in the particular polymeric application.

The inventive 3-PPB plasticizer can generally be utilized alone as 8 primary plasticizer or in blends with other plasticizers. Any of the known polymers that can be formulated into an adhesive can be used in combination with novel monobenzoate to prepare a lower VOC content, environmentally safe and non-hazardous composition in accordance with the present invention. The inventive Monobenzoate may be particularly useful in food packaging applications where migration of the adhesive may be an issue.

Polymer
types useful to prepare the polymeric dispersions discussed herein are known in the art. The inventive composition is expected to be useful with a wide variety of polymers, including both waterborne and non-aqueous polymer compositions.

Suitable waterborne polymers, include, but are not limited to, homopolymers and/or copolymers of: acrylics, polyvinyl acetate, vinyl acetate ethylene, polyacrylates, methacrylates, styrene acrylates, polychloroprenes, polyurethanes, and nitriles. Non aqueous based polymers useful with the inventive monobenzoate include: acrylics, polyvinyl acetates, vinyl acetate ethylene, methacrylates, styrene acrylates, polychloroprenes, thermoplastic polyurethanes, polysulfides, aminos, epoxies, and polyamides. Use of the inventive 3-PPB plasticizer is not limited to any particular polymer, and the foregoing listing is not intended to be limiting of the invention. Other polymer-based compositions useful in adhesive applications and requiring plasticizers will be known to one skilled in the art.

The novel monobenzoate of the present invention may be used as a substitute or alternative plasticizer for various traditional adhesive polymer dispersions. A typical packaging adhesive is set forth below:

Homopolymer or Copolymer 100 parts Plasticizer 0-30 parts Water 0-20 parts PV0H (88%) hydrolyzed 0-100 parts Fillers 0-100 parts Additives (wetting agents, defoamers) 0.10 to 0.5 parts 100801 The inventive 3-PPB plasticizer is particularly useful for waterborne latex glues, including those comprising natural rubber latex and synthetic latex like polymers, waterborne acrylics, and non-aqueous adhesive compositions. In addition, the inventive 3-PPB plasticizer may also be used in caulks and sealants, so called "filled" adhesives.

Dibenzoate esters are known to function well in these "filled" adhesives, Dibenzoate esters have a lower VOC content than 3-PPB; however, for these types of applications, the levels of VOC's associated with 3-PPB may be acceptable. The performance of 3-PPB is predictably in these applications based upon its performance with the polar polymers used in the adhesive market, as demonstrated by the examples, [0081] The total amount of 3-PPB used in any particular polymeric dispersion would range broadly depending on the particular polymer, the characteristics of the II polymer and other components, the -process, the application or use and the results desired. By way of example -only, in adhesives, plasticizers range in amounts from about 1 to about 50 wt.%, preferably from about 5 to about 20 wt.%, based on the weight of the wet adhesive. Preferred embodiments for an adhesive include ID wt. % in homopolymer polyvinyl acetate and 5 wt. % in vinyl acetate ethylene copolymers. As a general rule, the harder the polymer (higher Tg) the more plasticizer required, [0082] Useful amounts of 3 PPB are set forth in the .examples. It is expected that one skilled in the art would be able to arrive at additional acceptable amounts based on the intended use and desired performance in the particular polymeric application.

The inventive, 3-PPB plasticizer be, but is not required to be, blended with various other conventional plasticizers to enhance or augment properties of the adhesive compositions. Conventional plasticizers have been described herein and include, but are not limited to, phthalate esters up to C5, phosphate esters up to 0, adipates, citrates, succinates, isobutyrate, alkyl glycol esters, terephthalate esters, such as DBTP, 1,2-cyclohexane dicarboxylate esters, polyesters, alkyl glycol derivatives, sulfonamides, succinic acid esters, and benzoates, -both mono-and di-benzoates 100841

Monobenzoates, such as isononyl benzoate (INB), isodecyl benzoate.

(IB). and 2-ethyhexyl benzoate (EHB), and 2,2,4-trimethyl-1,3-pentanediol diisobutyrate, can also be blended with the inventive monobenzoate.

1.00851 The inventive monobenzoate may also be combined with or include various amounts of conventional additives such as...
polyvinyl alcohol, defoamers, humectants and the like.

[00861 The inventive monobenzoate provides comparable or better compatibility, viscosity-stability and response, rheology, water reduction, set time, open time, peel strength, adhesion, Tg suppression, and chalk point (IVIFT), among other advantages.

In many instances, the inventive monobenzoate outperforms industry standard plasticizers, regardless of VOC content, including traditional and newer dibenzoate blends. The monobenzoate is particularly useful as a plasticizer when considering the use of harder polymers as alternatives to softer polymers in a variety of low VOC formulations.

12.

The inventive monobenzoate, 3-PPB, may be used in adhesive compositions, sealants and caulks for a large variety of applications. Example applications include packaging glues, adhesive assembly, labeling, laminates;

envelopes, food packaging, wood glue; construction adhesives, transportation product assembly, electronic product assembly and pressure sensitive adhesive, (PSA) applications; although this list is by no means exhaustive. Still other uses will be evident to one skilled in the adhesives art.

100881 The invention is further described by the examples set forth herein.

100891 Examples 100901 The evaluation of the plasticizers consisted of a variety of experiments. First, VOC's of the neat plasticizers selected were determined. Then, effectiveness and efficiency of the plasticizers with basic polymeric compositions were determined versus established plasticizers.

100911 The following polymers were utilized in the evaluation formulations: Pace 383 polyvinyl acetate (PVAc); PV-VOH-protected, homopolymer; and polyvinyl acetate/ethylene copolymers (PV-A/E), 0 G Tg PVOH protected, from two suppliers designated "A" and "B". The "A" copolymer is Elvace 735 from Forbo; the "13" copolymer is Wacker's Vinnapas 400.

100921 The following plasticizers were selected for evaluation in the examples 1-9 (in whole or part):

K-Flex PG 100 1, 2 propylene glycol dibenzoate (PGDB) O X 613 the inventive monobenzoate, 3-PPB
KFlex 975 P a next generation dibenzoate blend comprising DEGDB, DPGDB and PGDB in specified proportions (80 wt% of a 4:1 DEGDB:DPGDB and 20 wt% PGDB) = K-Flex 850 S a commercial diblend of di-ethylene glycol and dipropylene glycol dibenzoates (DEG/DPG DB) µ. Ben佐flexXtm 2088 a competitive -dibenzoate plasticizer blend (TEG/DEG/DPG dibenzoate) = Disobutyl phthalate (DBP) = Triacetin Acetylated tributyl citrate (ATI3C) (Citroflee A4), a well-known plasticizer for food contact polymer applications, adhesives, inks and vinyl.

[00931 Plasticizers were utilized in various levels in the examples, For PVAc, 5, 10, and 15 wt.% levels were used, based on wet adhesive weight. For PVA/F, both A and B, 5, 10 and 15 wt.% levels were used; based on wet adhesive weight.

[0094] Various tests were employed;

On neat plasticizers EPA 24, ASTM D2369 volatility, 110°C for one hour; and a TGA isothermal scan at 110°C.

On adhesives;

Viscosity Response Tg suppression Water Reduction Set and Open Times T-Peel adhesion

Specific details of the test methods are described below:

[00961 Volatility: ASTM 1)2369 used. A TGA isothermal for one hour under air at 110°C was also employed:

[00971 Viscosity Response: Viscosity measurements were made using a Brookfield RVT at 20 RPM's for 10 revolutions at 23 2°C. The Brookfield viscosity was tested using the RVDVII-Pro Viscometer.

[0098] Tg Suppression: DSC Glass Transition Method: 10 mil (wet) films were drawn down on glass and left to dry overnight. After 24 hours, the films were removed from the plates and approximately 10 mg were placed in a closed aluminum DSC pan.

The temperature was equilibrated at -75°C, then ramped at 5°C/min to 65°C.

Glass transition was measured as the onset of Tg.

[0099] Water Reduction; 200 grams of plasticized polymer were weighed into 8 oz. jars. Small increments of water were added and viscosity was measured after each addition until the viscosity reached 2000+1-80 CP.

[0100] Set Time:

Set time determinations were made using two strips of 50 lb.

unbleached Kraft paper measuring 1" x 14" (top) and 1.5" x 14" (bottom). A small amount of adhesive was applied to the bottom strip, and a #20 wire wound rod metered the adhesive onto the bottom strip while a #18 wire wound rod (rubber banded to the #20) simultaneously pressed down the top strip. A timer was then immediately started and the strips were pulled apart until significant force was required to tear apart the strips and fiber tear was noted. Time at this point was recorded as the set time. A
50 IP, unbleached Kraft paper was placed on a glass surface, with a 1" x 14" piece of Kraft clipped to its top, rolled back so that the bottom piece was left uncovered. The top piece was sandwiched between a #0 and #14 wire wound rod with the #0 on top. A small amount of adhesive was applied to the top of the bottom strip and a #20 wire wound rod metered out the adhesive over the entire strip. A timer was started, and at a specified time interval, (with intervals of 5 seconds) the top strip was laminated to the bottom using the #0 rod. The strips were then peeled apart and assessed for adhesion and fiber tear. This process was repeated until a specific time interval was confirmed in duplicate as the last time interval to result in significant fiber tear/adorhesion. Evaluations were performed blind.

Example 7 - T-Peel Adhesion: The methodology for various peel adhesion tests is further described in connection with Examples 7 and 8.

Samples were prepared by first drawing down some emulsion on a 6" x. The strips were then peeled apart and assessed for adhesion and fiber tear. This process was repeated until a specific time interval was confirmed in duplicate as the last time interval to result in significant fiber tear/adhesion. Evaluations were performed blind.

Example 1 - VOC/Volatility of Neat Plasticizers 101041. Figure 1 illustrates the volatility characteristics determined for the neat plasticizers evaluated except for triacetin which is 100% volatile and 100%. Water soluble, the plasticizers of the evaluation were all low in volatility and, thus, would not contribute significantly to the overall VOC of an adhesive formulation at typical levels of use. The inventive monobenzoate, 3 PPB, was slightly more volatile than dibenzoate plasticizers, but still well within an acceptable range.

Example 2 - Viscosity Response [01061 The viscosity response of a Pace! 383 homopolymer (PVAc) adhesive composition with 10 wt.% plasticizer was evaluated. Viscosity response is indicative of the compatibility of the plasticizer with the polymer. Figure 2 illustrates the One Day viscosity response of the various plasticizers evaluated. All of the plasticizers showed comparable viscosity responses, reflecting compatibility with the base polymer.

Example 3 - Water Reduction Figures 3 (a) and 3 (b) show One Day viscosity responses with .5 wt.% plasticizer in PVAc/E copolymers, both A and B. Again, the viscosity responses are comparable, reflecting good compatibility with the base polymer. [01081 Example 3 Water Reduction [01091 Figures. 4 and 5 (a) and 5 (b) reflect the water reduction results, i.e. the amount of water required to get to the desired viscosity of 2000 mPa's for the homopolymer (PVAc) and copolymers (PVAcE, A & B), respectively, using plasticizer concentrations of 5, 10, 15, and 20 wt.% for the homopolymer and 5, 10, and 15 wt.% for the copolymers. The amount of water required in each was comparable among the plasticizers evaluated.

Example 4 - Glass Transition [01111 Glass transition temperatures (Tg) were obtained for plasticizer concentrations of 5, 10, 15 and 20 wt% in homopolymer (PVAc) and for plasticizer concentrations of 5, 10, and 15 wt% for the copolymers. Figure 6 reflects the Tg results for the homopolymer and demonstrates that the inventive monobenzoate, 3 PPB, was excellent in Tg suppression, thus indicating a more flexible polymer and a more efficient plasticizer. [01121 Figures 7 (a) and 7 (b) reflect the Tg results for the copolymers A and B, respectively. While there was some variability between polymers, the inventive monobenzoate, 3-PPB, performed comparable to the dibenzoate plasticizers.

Example 5 - Set Time -101141 Set Times for the various plasticizers were evaluated in the homopolymer and both copolymers. Homopolymer evaluations were conducted with 10 wt.% plasticizer levels. Copolymer evaluations (both A and B) were conducted with 5 .wt.% plasticizer levels. All of the plasticizers decreased the set time of the adhesives as expected.

Example 6 - Open Time. [01171 The inventive monobenzoate performed very well in comparison with the other plasticizers in the homopolymer, as reflected in Figure 8. Figures 9 (a) and 9 (b) show that the inventive monobenzoate performed comparable to or slightly better than the dibenzoates in the copolymers and was equivalent to ATBC. Set time results.

Example 7 - Open Time. [01181 The inventive monobenzoate performed very well in comparison with the other plasticizers in the homopolymer, as reflected in Figure 8. Figures 9 (a) and 9 (b) show that the inventive monobenzoate performed comparable to or slightly better than the dibenzoates in the copolymers and was equivalent to ATBC. Set time results.

Example 8 - Open Time. [01191 This test provides a method for determining the water resistance of an adhesive by measuring its peel strength dry and its peel strength retention after one hour of immersion in water.

Example 9 - Open Time. [01201 Samples were prepared by first drawing down some emulsion on a 6" x. 13" cotton cloth using a #10 wire wound rod. at which time a timer was started. At the end of 60 seconds, a second
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The inventive monobenzoate was compared against 1,2-propylene glycol dibenzoate, and ATBC. The results in.

Figures 12 a (dry) and 12 b (after one hour water soak) show that the inventive monobenzoate performed better than the dibenzoate blend and comparable to ATBC.

101261 Conclusions [0130] In the following examples 8-1.1, the efficacy of The inventive monobenzoate, 3-PPB (X-613), was evaluated in the identified adhesive formulations, comparing it against K-Flee-8505 (DEGDB/DPDB) as the standard, Citroflee A-4 (ATBC), and 1,2-propylene glycol dibenzoate (X,100, PGDB). Test methodologies are as described above. Methodologies for the additional tests conducted in these.

Examples are set forth below.

101241 Example 8 -- Pace 3.83 (PVAc) Homopolymer Formulation [0125] Each plasticizer was evaluated at concentrations of 5, 10, 15 and 20 wt.%, [0126] Brookfield Viscosity 101271 Testing of the plasticizer was conducted in water.

101281 The three and seven day viscosities obtained are shown in Figures 15 and 16. The viscosities followed the trend set forth with the initial and one day viscosities, with no notable increase over this time period. The four week viscosities of the Pace samples are shown in Figure 17, and the eight week viscosities are shown in Figure 18. Figure 18 reflects that all of the viscosities had increased from the previous four week reading, indicating they were all stable.

101291 The peel strength required to pull apart the bond between two cotton samples was determined on dry samples and after a one hour water soak for.

a PVAE copolymer composition having 5 wt.% plasticizer. The inventive monobenzoate was compared against 1,2-propylene glycol, a dibenzoate blend, and ATBC. The results in.

Results are shown in Figure 20. Of the four plasticizers tested, X-100 (PGDB) was the least efficient, while 3-PPB (X-613) was the most efficient and comparable to A-4. Concentrations were comparable, while 3-PPB (X613) showed an advantage at the 20 wt.% level of use. A-4 generally had the poorest set times.

101311 The results of the open time testing on the Pace samples are shown in Figure 22. The 3-PPB (X613) adhesives had consistently better open time than the other formulations at the same concentrations, even if only marginally, t01371 Tensile 1101.301 AR2000 Shear Method: A 40 Mm 1" steel cone geometry with Peltier plate was used. A dime sized amount of emulsion was placed on the Peltier plate, The shear ramp was run at 25 C from 0 to 2500 s^-1 over one minute. The results of the shear testing are shown in Figures 19 (a), (b), (c), and (d). All of the plasticizers had acceptable rheology and were fairly comparable.

101311 Glass Transition [0112] The Tg results are shown in Figure 20. Of the four plasticizers tested, X-100 (PGDB) was the least efficient, while 3-PPB (X-613) was the most efficient and comparable to A-4.

101331 The results of the set time are shown in Figure 21. The results of the 10 and 15 Wt.% plasticizer Concentrations were comparable, while 3-PPB (X613) showed an advantage at the 20 wt.% level of use. A-4 generally had the poorest set times.

101351 The results of the open time testing on the Pace samples are shown in Figure 22. The 3-PPB (X613) adhesives had consistently better open time than the other formulations at the same concentrations, even if only marginally, t01371 Tensile - 180 Peel, Cotton to Acrylic Coated 3B Leneta Charts [0138] 180' Peel, Cotton to Acrylic Coated 33 Leneta Charts Method: 1" x 14" cotton strips were laminated to Leneta 33 acrylic coated charts using a #20 wire wound rod to draw down the emulsion and one pass of a rolling pin. The cotton was pulled at a 180 angle from the 33 chart at 12"/min. The data was averaged between 1" and 5" of the pull. Five specimens of each sample were run. Data was adjusted to remove slack from the results.

10139 The results from the 180 cotton to acrylic peel are shown in Figure 23. Surprisingly, the 3-PPB (X-613) significantly enhanced the peel strength of the adhesive at all levels, with good peel strength at 5 wt.% as compared to the other plasticizers at wt.% and even 15 wt.%. This suggests that 3-PPB may be useful as an additive to adhesives to enhance adhesion to certain difficult-to-adhere surfaces, such as polar surfaces. This is predictable based upon the polarity of the plasticizer and the Tg suppression.

10140 The 180' peel of cotton to acrylic coated 3B Leneta charts was repeated to confirm the enhanced adhesion noted with the 3-PPB samples. This time, six specimens of each sample were run. The samples formulated with 3-PPB showed greatly improved adhesion to the acrylic coating than the other plasticizers that were evaluated, with peel strengths of about twice the amount of the others. In fact, the break sensitivity had to be turned down for the method, as the tensile tester several times thought it detected a break with the 15 Wt.% and 20 wt.% 3-PPB due to the large build-up of adhesion and ensuing release. Figure 24 shows the results of the 180 peel's second trial, while Figure 25 compares the results of both the first trial and the second trial 101411 The mode of loss for all of the 1800. peels was adhesive, and primarily.

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specimens, as well as in minor amounts with one wt. % A-4 mid one 20 wt. % K-Flex® 850S, had adhesive loss to the cotton, where the adhesive remained.

10142] As described above, two trials were conducted for the 'cotton to acrylic 180 peel resulting in two sets of data, which showed similar trends. The data obtained for the first and second set of samples were averaged and are shown in Figure 26.

[0143] Tensile - 180 Peel Cotton to Flexible Vinyl [0144] The cotton to flexible vinyl 180° peels were performed on the Pace homopolymer samples. Once again, the results in Figure 27 show very good performance with 3-PPB (X-613). adhesives at all levels of the test, [0145] Tensile - T-Peel, Water Resistance, Cotton to Cotton. The methodology for this test is described in example 7, above 1.01471 The data from this set had good agreement from specimen to specimen (standard deviations of 0-23%). Figure 28 shows the results of the dry T-peel, 'cotton to cotton test for the Pace homopolymer samples at 5, 10, 15 and 20 wt.% plasticizer concentrations. For most of the plasticizers, there was a climb in peel strength up to 10 wt.%, then a decline with increasing plasticizer concentration at 15 wt% and 20 Wt. %.

The X-100 (PGDB) showed a good increase in peel strength at the higher levels, had good peel strength versus the other plasticizers at low levels of plasticizer concentration, although it weakened the adhesive when used at levels greater than 10%. This is predictable as it is very efficient in softening.-


[0-149] The water reduction results (to 2000 mPa's) of the Pace homopolymer emulsions are shown in Figure. 29. The amounts of water necessary to reduce the emulsion viscosities down to 2000 cP are fairly comparable between the plasticizer types, which was expected due to the similar viscosity responses the emulsions originally had.

[0150] Hysteresis Loop/ Vet. Tack [0151] Hysteresis Loop Method: Hysteresis loop data was obtained on an AR-2000 using 20 mm steel plate geometry on a Peltier base plate at 20 C. The gap was set at 200 pm, then a small (nickel sized) amount of sample was sheared up to 1500 sl and back &MO within one Minute. Samples were tested in triplicate using a fresh specimen for each measurement.

[0152] All of the wet tack data followed the expected trend, with an increase in wet tack as the plasticizer concentrations increased; however, some of the standard deviations were greater than 25%, so additional data was gathered. On these samples in order to obtain a better average. Figure 30 shows the additional data for Pace homopolymer formulations, 101531 MFFT™ Chalk Point 101541 Chalk Point Method: A sheet of aluminum foil was taped tightly over the MUT plate and wiped down with acetone. The desired temperature range was chosen and the MFFT-90 was turned on. Cooling water was turned on, as well as an air flow of 4 Limin, The plate was left to equilibrate (about 30 minutes). A U-shaped film was drawn using the 75 pm applicator cube. All three samples were drawn down within 10 minutes. The cover was then closed and the instrument was left to run for a minimum of an hour. The samples were then examined for chalk point and photos were taken.

101551 The chalk points of the homopolymer adhesives were determined, and the results can be seen in Figure 3-3-PPB did a very good job in lowering the chalk point and was substantially similar to the results achieved with the K-Flee 850S standard. Although both X-100 and Citroflexe A-4 lowered the chalk point of the homopolymer; they were the poorer performers of the group.

1101561 Example 9 --- Elvace 735 (Vinyl Acetate Ethylene) Copolymer Formulations 101571 Each plasticizer was evaluated at concentrations of 5, 10, and15 wt. %. [0158] Brookfield Viscosity: .2,1 101591 The initial, one and three day viscosities of the Elvace: copolymer emulsions are shown in Figures 32 and 33 (a) and (b), respectively. The seven day viscosities of the Elvace copolymer emulsions are shown in Figure 34. The viscosities of all of the samples were comparable, with 3-PPB (X-613) and A-4 showing marginally better viscosity response over the dibenzoates.

101601 Shear [0161] Elvace copolymer shears were run using the cone geometry in order to obtain optimal results. The shear curves are shown in Figures 35, 36 and 37. All of the plasticizers were similar in their shear responses.

[0162] Glass Transition Temperature/fg! 101631 The Tg's of the Elvace copolymer samples were measured, and the results are shown in Figure 38. The Tg suppression of 3-PPB was very efficient and mirrored that of the A-4; both had substantial improvements in Ig suppression over the dibenzoates at all levels of test, 101641 Settine [01661 The Set time images of the Pace homopolymer samples. Once again, the results in Figure 39 show very good performance with 3-PPB (X-613) and A-4 showing marginally better viscosity response over the dibenzoates.

101601 Open Time [0167] The open times of the Elvace copolymer samples were measured, and the results are shown in Figure 40. The 3-PPB helped to extend open time slightly at lower concentrations than the other plasticizers, [01681 Water Reduction [0169] The viscosities of portions of the Elvace copolymer samples were reduced to 2000 cP with water. The results of the Water reduction are shown in Figure 41. At higher plasticizer levels, the Citroflexe A-4 samples required the most water to reduce its viscosity, followed closely by 3-FPB (X-613). The PGDB (X-100) samples consistently required the least amount of water to be reduced. More amounts of water render the formulation less expensive whereas small amounts of water to back-add will preserve solids content. Depending on the formulator's needs, either lower or higher water to back-add may be advantageous.

101701 i -hvteserito La oo "12 01711 The hysteresis loop results for the Elvace copolymer samples are shown in Figure.
very similar to each other.

[01721] T-Peel, Water Resistance, Cotton to Cotton [01731] Figures 43, 44 and 45 show the results of the water resistance T-Peel, cotton to cotton tests performed on the Elvac copolymer samples. Both the dry peel strengths and the peel strength loss after water immersion were all fairly comparable between the samples, with perhaps a slight advantage in water resistance seen with the wt.% and 10 wt.% 3-PPB (X-613) samples.

[0174] 1800 Peel, Flexible PVC to Luan f01751 180 Peel, Flexible PVC to Luan Sample Preparation: 1" x 14" strips of flexible, 12 mil thick PVC were laminated to 6" x 10" pieces of Luan plywood. The adhesive was applied using a #50 wire wound rod, and four strips were laminated to each piece of wood. Gentle pressure using a rolling pin, followed by finger pressure to wet out the PVC strips, was used to press the pieces together.

[01761] 180' Peel, Flexible PVC to Luan Method: The PVC strips were pulled from the [Alan at 12'/min, over 8". The average peel strength was determined by the data obtained between 2" and T.

f01771 The peel strength of the PVC to Luan of the Elvac copolymer samples are shown in Figure 46. Peel strengths of all samples were comparable, with no notable increase in peel Strength as the plasticizer level increased.

[0178] Example 10 Monobenzoates and Blends [0179] Due to the good adhesion results for 3-PPB (X-613) obtained in the above example, new blends of 3-PPB with K-Flex DE (DEGDB) and K-Flx PG (PGDB, X. 100) were put through a basic evaluation, along with K-Flee 1B, to provide a baseline of how typical monobenzoates behave. Samples evaluated included: 5, 10, 15 and 20 wt.% plasticizer concentrations in Pace homopolymer, and 5, 10 and 15 wt% plasticizer concentrations in Elvac copolymer, using the plasticizers and blends of plasticizers listed below 101801

Plasticizers & Blends:
25% X-613 (3-PPB)/75% X-100 (PGDB) 50% X-613/50% X-100 25% X-613/75% K-Flex DE (DEGDB) 50% X-613/50% K-Flex DE
K-Flex 1B (isodecyl benzoate) K-Flex 8505 (DEGDB/DPGDB diblend) [0181] Brookfield viscosities [0182] Figures 47, 48 and 49 show the initial, 1 and 3 day viscosities, respectively, for Elvace0 copolymer samples. The samples made with KFlex 113 had very low initial viscosity, with a gradual build over time to values near those of the dibenzoates and blends. [0183] The initial, one and three day viscosities of the Pace homopolymer samples are shown in Figures 50, 51 and 52. With the exception of the IB formulations, all of the samples showed good viscosity response. At lower levels, the 113 was equivalent, but at about 15 - 20 wt. % plasticizer concentration, the 1B viscosity response started lagging behind the others. There also did not seem to be a dramatic increase in viscosity over time with the 1B formulations in the Pace homopolymer samples, as there was in the Elvac copolymer samples.

1.01841 Figure 53 shows the 1 week viscosities for the Elvace copolymer samples. By this time, the 1B formulations had now not only caught up, but overtaken the other samples in viscosity response. This indicates very poor stability in these formulations.

[0185] Glass Transition Temperature 101861 The glass transition temperatures of the monobenzoate blends formulated with Pace homopolymer are shown in Figure 54. This figure shows the limited compatibility of K-Flex 1B with This homopolymer. Even at only 5 wt.%, 1B has the poorest Tg suppression of all of the plasticizers that were evaluated: as the IB concentration increases, the Tg stays the same, indicating its incompatibility.

[0187] As would be expected, due to their relative efficiencies, the 3-PPB blends with K-Fle DE showed the greatest Tg suppression, while the blends with X-100 (PGDB) showed slightly less Tg suppression.

2.41 101881 Figure 55 shows the TO results with the El+Jade copolymer samples. In this ease, the 1B actually showed a greater efficiency in reducing the Tg's of the copolymer than the K-Hex 8505 or the 3-PPB blends. This makes sense, as 1B's low polarity should be more compatible with the ethylene blocks of the copolymer than the other di- and mono-benzoates. For the blends, the 50:50 X-100/X-613 showed similar Tg suppression to that of the DE blends.

[0189] Set and Open Time.

f01901 Figures 56 and 57 show the set and open time of the Elvacel copolymer samples. Overall, the 75:25 X-100/X-613 samples showed the fastest set times.

With the exception of the le and the 50:50 K-Flee DE:X-613 samples, all of the open times increased with increasing plasticizer level and all of the samples appeared to be equivalent.

[01911] Example 11 Basic Packaging AO/lesiva Evaluation [01921] The following example show the efficacy of the inventive Monobenzoate with a basic packaging adhesive formulation described below:

r Material PHR
Copolymer, 0' C Tg 1 100 89%
Plasticizer 10 99/0 PV0171, 7% Solution 1 2 2%
Water Added [01931 Evaluations were performed comparing the inventive monobenzoate, PPB, to PGDB (X 100), K-Flex 8505 (DEGDB/DPGDB diblend), BenzoflexTM 2088 (TEG/DEG/DPG dibenzoate blend), and DIBP.

[01941 Figure 58 shows the initial viscosity measurements reflecting that the inventive monobenzoate, 3-PPB, has a slightly better effect on viscosity than the dibenzoates and comparable to DIBP a phthalate plasticizer.

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3-PPB has among the highest amount of water add back (among the non-phthalates) to achieve the desired viscosity reduction.

01961 Set Times for Kraft to Kraft and Kraft to Mylar samples, respectively, unreduced and water reduced, are shown in Figures 60 and 61. The results reflect that in some instances the inventive monobenzoate enhanced the set time and in others performed comparably to other plasticizers.

1101971 Open Time results for unreduced and water reduced samples are shown in Figure 62. These results reflect that 3-PPB performed quite well when water reduced and comparable to other plasticizers when unreduced.

110198:1 The foregoing examples reflect that the inventive monobenzoate plasticizer, 3 PRO, functions well in adhesives, performing comparably or better than traditional plasticizers used in adhesives, including the diberizoates. The inventive monobenzoate is an alternative to phthalate plasticizers and has the potential to improve upon the safety of plasticizer technology for the adhesive industry.

In accordance with the patent statutes, the best mode and preferred embodiments have been set forth; the scope of the invention is not limited thereto, but rather by the scope of the attached claims.

Klassifizierungen

Internationale Klassifikation: C08J3/18, C09K3/10, C09J11/06, C08K5/101, C09D5/34
Unternehmensklassifikation: C08K5/0016, C09D11/00, C09J131/04, C09D7/1233, C08L91/00, C08K5/12, C08K5/0008, C08K5/101

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