REACTIVE HOT MELT ADHESIVE COMPOSITIONS CONTAINING MULTI-FUNCTIONAL POLYOLS AND POLYMERIC ISOCYANATE COMPOUNDS, AND METHOD OF MANUFACTURE THEREOF

TECHNICAL FIELD

Particular aspects of the present disclosure are directed to reactive hot melt (RHM) adhesive compositions containing a combination of di-functional and tri-functional polyols in conjunction with a combination of an isocyanate compound and a polymeric isocyanate compound. Particular aspects of the present disclosure are also directed to a method of manufacturing such RHM adhesive compositions involving a two-step addition of the polymeric isocyanate compound.

BACKGROUND

Most conventional reactive hot melt (RHM) adhesives or adhesive compositions are polyurethane based materials, which cure upon exposure to moisture. A given RHM adhesive composition typically contains an isocyanate compound (e.g., methylene diphenyl diisocyanate, known as MDI); crystalline, amorphous, and/or liquid polyols (e.g., polyether and/or polyester polyols); reactive and/or non-reactive thermoplastic components (e.g., acrylic, EVA, and/or polystyrene components); moisture-curing catalysts; and various non-reactive additives. Prior to exposure to water, a RHM adhesive is considered to be a solid thermoplastic substance that can be melted repetitively during processing. This type of adhesive is generally melted and used at a temperature range between 85 – 130^{0}C.

Prior to curing, a RHM adhesive ideally exhibits a relatively high degree of adhesion to the substrate to which it is applied on. This pre-cured adhesion is commonly referred to as a RHM adhesive's set strength, green strength, or hot tack. With respect to curing, when exposed to moisture (e.g., ambient moisture), a RHM adhesive is converted into a thermoset substance over time. This moisture curing mechanism is triggered once water reaches the terminal and free isocyanate groups within the RHM adhesive. As a result, chain-extension is induced, thus forming a larger network of polyurethane polymers. Such a crosslinked adhesive composition provides high strength, toughness, creep resistance, and heat resistance to the final bond. Hot

Claims

1. A reactive hot melt (RHM) adhesive composition comprising:
a di-functional polyol compound;
a tri-functional polyol compound;
a non-polymeric isocyanate compound having an isocyanate functionality of two or more;
one or more reactive or non-reactive and/or functional or nonfunctional polymer compounds; and
a polymeric isocyanate compound having an isocyanate functionality greater than two,
wherein a mass fraction of the polymeric isocyanate compound in the RHM adhesive composition is between 10 – 20%, inclusive; and
wherein the one or more polymer compounds comprise a high molecular weight polymer compound having a weight average molecular weight between 20,000 – 100,000 g/mol.

2. The RHM adhesive composition of claim 1, wherein the tri-functional polyol compound has a molecular weight between 1,000 and 3,600 g/mol.

3. The RHM adhesive composition of claim 2, wherein the mass fraction of the tri-functional polyol compound plus the mass fraction of the polymeric isocyanate compound is up to 46% of the mass of the RHM adhesive composition.

4. The RHM adhesive composition of claim 2, wherein the tri-functional polyol compound comprises a polyether triol.

5. The RHM adhesive composition of claim 2, wherein the RHM adhesive composition exhibits a melt stability as indicated by a rate of increase of in-melt RHM adhesive composition viscosity of less than 20% per hour across a time period of at least two hours.

6. The RHM adhesive composition of claim 2, wherein a ratio of the mass fraction of the tri-functional polyol compound to the mass fraction of the polymeric isocyanate compound in the RHM adhesive composition is between 50% - 128%.

7. The RHM adhesive composition of claim 6, wherein a ratio of the mass fraction of the tri-functional polyol compound to the mass fraction of the polymeric isocyanate compound in the RHM adhesive composition is between 50% - 80%, and wherein the RHM adhesive composition exhibits a melt stability as indicated by a rate of increase of in-melt RHM adhesive composition viscosity of less than 12% per hour across a time period of at least two hours.

8. The RHM adhesive composition of claim 6, wherein a ratio of the mass fraction of the tri-functional polyol compound to the mass fraction of the polymeric isocyanate compound in the RHM adhesive composition is between or approximately between 110 – 122%, and wherein the RHM adhesive composition exhibits a melt stability as indicated by the rate of increase of in-melt RHM adhesive composition viscosity of less than 17% per hour across a time period of at least two hours.

9. The RHM adhesive composition of claim 1, wherein the di-functional polyol compound comprises a polyether diol or a polyester diol.

10. The RHM adhesive composition of any one of claims 1 – 5, wherein the RHM adhesive composition exhibits a post-melt free % NCO content of less than 3.5.

11. A process for producing the reactive hot melt (RHM) adhesive composition of any one of claims 1 - 10, the process comprising:

a first process portion comprising:

adding the non-polymeric isocyanate compound and optionally adding the polymer isocyanate compound to a melt containing the di-functional polyol compound and the tri-functional polyol compound to form an intermediate RHM adhesive composition in the melt; and allowing the free % NCO of the melt to reach and not exceed a first free % NCO target value;

and

a second process portion initiated subsequent to the free % NCO of the melt reaching or falling below the first free % NCO target value, the second process portion comprising:

adding or further adding the polymer isocyanate compound to the melt; and

allowing the free % NCO of the melt to reach and not exceed a second free % NCO target value distinct from the first free % NCO target value,

wherein the second free % NCO target value is less than or equal to 3.5, such that produced RHM adhesive composition exhibits a post-melt free % NCO of less than 3.5.

12. The process of claim 11, wherein the first free % NCO target value is less than or equal to 2.5.