Title: HIGH-STRENGTH GLUE STICK FORMULATION WITH COLOR INDICATOR

Abstract:
A high-strength, solid adhesive formulation is provided. This formulation includes polyvinylpyrrolidone; at least one polymer dispersion that further includes polyurethane and that is capable of withstanding high mixing temperatures; casein for conferring lubricity to the formulation; and sodium stearate, which is operative to facilitate formation of a glue stick product for use in for joining paper or non-paper items.
ABSTRACT

A high-strength, solid adhesive formulation is provided. This formulation includes polyvinylpyrrolidone; at least one polymer dispersion that further includes polyurethane and that is capable of withstanding high mixing temperatures; casein for conferring lubricity to the formulation; and sodium stearate, which is operative to facilitate formation of a glue stick product for use in for joining paper or non-paper items.
TITLE OF THE INVENTION

HIGH-STRENGTH GLUE STICK FORMULATION WITH COLOR INDICATOR

DETAILED DESCRIPTION OF THE INVENTION

[0001] This patent application is a continuation-in-part of U.S. Patent Application Serial No. 13/154,755 filed on June 07, 2011, and entitled “High-Strength Glue Stick Formulation”, the disclosure of which is hereby incorporated by reference herein in its entirety and made part of the present U.S. utility patent application for all purposes.

BACKGROUND OF THE INVENTION

[0002] The described invention relates in general to an adhesive formulation, and more specifically to a formulation for a high-strength glue stick that includes polyvinylpyrrolidone and one or more polyurethane dispersions.

[0003] Commercially available glue sticks typically include either polyvinylpyrrolidone (PVP) or modified polyvinyl alcohol (modified-PVOH) polymers. While generally effective for their intended purpose, such glue stick formulations usually only provide consistent adhesion to paper and wood substrates, which limits their overall usefulness. Waterborne acrylic polymers are useful for a variety of adhesives because such polymers typically adhere to a much greater variety of surfaces than polyvinyl acetate (PVAc) and PVP-based products. However, mixing and processing waterborne polymers is often difficult because latex emulsions may become destabilized when exposed to high temperatures for sustained periods of time. Production of glue sticks typically requires high temperatures for dissolving some of the other materials commonly included in glue sticks. Therefore, there is an ongoing need for a glue stick formulation that is useful for providing consistent adhesion to a variety of substrates such as wood, metal and plastic; that maintains a high degree of lubricity when applying the glue from the stick; and that can be formulated in a relatively easy manner, particularly with regard to stability at high mixing temperatures.
SUMMARY OF THE INVENTION

[0004] The following provides a summary of certain exemplary embodiments of the present invention. This summary is not an extensive overview and is not intended to identify key or critical aspects or elements of the present invention or to delineate its scope.

[0005] In accordance with one aspect of the present invention, a high-strength solid/semi-solid adhesive formulation is provided. This formulation includes polyvinylpyrrolidone; at least one polymer dispersion that further includes polyurethane and that is capable of withstanding high mixing temperatures; casein; and sodium stearate, which is operative to facilitate formation of a glue stick product for use in joining paper or non-paper items. The polyurethane dispersion may include Sancure 2710; Sancure 20025F; Sancure 12929, and/or Sancure 843.

[0006] In accordance with another aspect of the present invention, a high-strength solid adhesive formulation is also provided. This formulation includes at least two polymer dispersions that further include polyurethane and that are capable of withstanding high mixing temperatures; casein; and sodium stearate, which is operative to facilitate formation of a glue stick product for use in joining paper or non-paper items. The polyurethane dispersions may include Sancure 2710; Sancure 20025F; Sancure 12929, and/or Sancure 843.

[0007] In yet another aspect of this invention, a high-strength solid adhesive formulation is also provided. This formulation includes at least two polymer dispersions that further include polyurethane and that are capable of withstanding high mixing temperatures; casein; and sodium stearate, which is operative to facilitate formation of a glue stick product for use in joining paper or non-paper items; and a color indicator that is operative to change the glue stick from colored to substantially uncolored as the adhesive formulation dries following deposition on a surface or a substrate. The polyurethane dispersions may include Sancure 2710; Sancure 20025F; Sancure 12929, and/or Sancure 843.

[0008] Additional features and aspects of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed
description of the exemplary embodiments. As will be appreciated by the skilled artisan, further embodiments of the invention are possible without departing from the scope and spirit of the invention. Accordingly, the associated descriptions are to be regarded as illustrative and not restrictive in nature.

**DETAILED DESCRIPTION OF THE INVENTION**

[0009] Exemplary embodiments of the present invention are now described with reference to the example. Although the following detailed description contains many specifies for the purposes of illustration, a person of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following embodiments of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

[0010] An exemplary embodiment of the high-strength glue stick formulations of the present invention includes a PVP polymer such as K-30 (International Specialty Products; Wayne, New Jersey) the polyurethane dispersions Sancure 2710; Sancure 20025F; Sancure 12929; and Sancure 843 (The Lubrizol Corporation; Wickliffe, Ohio), as well as casein for conferring lubricity, and a silane adhesion promoter such as Silquest Wetlink 78 (GE Advanced Materials; Pittsfield, Massachusetts) for improving adhesion to surfaces such as metal and glass. The combination of multiple Sancure polymers and casein provide improved adhesive strength to the formula. This high-strength glue stick formulation may also include a defoamer such as BYK-045 (BYK Additives and Instruments; Wesel, Germany), which is a silicone defoamer for aqueous systems that includes an emulsion of foam destroying polysiloxanes, hydrophobic solids and emulsifiers. The formulation may also include a bactericide, such as ethyl paraben and an oil such as glycerin. Other possible ingredients include dipropylene glycol n-butyl ether (DPnB), sodium stearate, and sodium hydroxide. Finally, in some embodiments, a color indicator such as o-cresolphthalein is added the formulation of this invention. The compound o-cresolphthalein is a pH color indicator that causes the glue stick of this invention to be colored (e.g., purple) at a high pH. However, this coloration disappears as water evaporates from the adhesive formulation,
i.e., after the adhesive has been deposited on a surface or substrate. This aspect permits the end-user of the glue stick to observe where on a substrate the adhesive has actually been applied.

[0011] Having generally described this invention, a further understanding can be obtained by reference to the specific examples detailed below, which are provided for purposes of illustration only and are not intended to be all inclusive or limiting unless otherwise specified. As indicated below, percent by weight values for each ingredient are provided in the examples.

**EXAMPLE I**

High-Strength Glue Stick Formulation

<table>
<thead>
<tr>
<th>RAW MATERIAL</th>
<th>% by WEIGHT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>8.1</td>
<td>defoamer</td>
</tr>
<tr>
<td>BYK 045</td>
<td>0.20</td>
<td>bactericide</td>
</tr>
<tr>
<td>Ethyl Paraben</td>
<td>0.10</td>
<td>oil</td>
</tr>
<tr>
<td>Glycerin</td>
<td>4.0</td>
<td>PVP polymer</td>
</tr>
<tr>
<td>K-30</td>
<td>12.2</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 2710</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 20025F</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 12929</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>DPnB</td>
<td>2.0</td>
<td>dipropylene glycol n-butyl ether</td>
</tr>
<tr>
<td>Sodium Stearate</td>
<td>4.5</td>
<td>--------</td>
</tr>
<tr>
<td>7.4% NaOH solution</td>
<td>1.60</td>
<td>--------</td>
</tr>
<tr>
<td>25% Casein Solution</td>
<td>6.30</td>
<td>--------</td>
</tr>
<tr>
<td>Silquest Wetlink 78</td>
<td>0.10</td>
<td>adhesion promoter</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

**EXAMPLE II**

High-Strength Glue Stick Formulation with Color Indicator

<table>
<thead>
<tr>
<th>RAW MATERIAL</th>
<th>% by WEIGHT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>7.8</td>
<td>defoamer</td>
</tr>
<tr>
<td>BYK 045</td>
<td>0.20</td>
<td>bactericide</td>
</tr>
<tr>
<td>Ethyl Paraben</td>
<td>0.10</td>
<td>oil</td>
</tr>
<tr>
<td>Glycerin</td>
<td>4.0</td>
<td>PVP polymer</td>
</tr>
<tr>
<td>K-30</td>
<td>12.2</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 2710</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 20025F</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>Sancure 12929</td>
<td>20.30</td>
<td>polyurethane dispersion</td>
</tr>
<tr>
<td>DPnB</td>
<td>2.0</td>
<td>dipropylene glycol n-butyl ether</td>
</tr>
</tbody>
</table>

- 4 -
Sodium Stearate 4.5
7.4% NaOH solution 1.60
25% Casein Solution 6.30
Silquest Wetlink 78 0.10 adhesion promoter
o-cresolphthalein 0.3 color indicator
100.00

[0012] With reference to the examples given above, the following exemplary stepwise process is used to prepare a high-strength glue stick with the listed ingredients: (i) using a variable speed mixer fitted with a shear mixing blade, prepare a PVP solution; add deionized water to a container and start the mixer at medium speed; add BYK-045, ethyl paraben, glycerin and PVP K-30 to the container; mix the material until the K-30 is completely dispersed; (ii) using a closed mixing vessel capable of heating/cooling and having vacuum capability, add the Sancure 2710, Sancure 200025F, and Sancure 12929 (or Sancure 843) and mix for 5-10 minutes; (iii) slowly add the PVP premix of step (i) into the closed container; continue mixing for 10-15 minutes; (iv) add DPnB and mix for 5-10 minutes; (v) add sodium stearate slowly while mixing and heat the mixing vessel to 65°-75° C; mix 5-10 minutes; (vi) add the 7.4% sodium hydroxide solution and mix until it becomes a homogeneous, even solution; (vii) prepare separately a 25% casein solution that consists of 25% casein, 5% of a 37.4% sodium hydroxide solution and 70% deionized water; (viii) add the casein solution to the mixer and continue mixing for 5-10 minutes; (ix) add the silane adhesion promoter and mix for 5 minutes; (x) vacuum the mixture at a slow speed for 10-15 minutes; and (xi) using a pressure plate, extrude the finished product into the desired size glue stick containers.

[0013] While the present invention has been illustrated by the description of exemplary embodiments thereof, and while the embodiments have been described in certain detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to any of the specific details, representative devices and methods, and/or illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.
CLAIMS

What is claimed:

(1) A solid adhesive formulation, comprising:
   (a) polyvinylpyrrolidone;
   (b) at least one polymer dispersion, wherein the at least one polymer dispersion further includes polyurethane;
   (c) casein; and
   (d) sodium stearate, wherein the sodium stearate is operative to facilitate formation of a glue stick for use in joining non-paper items.

(2) The formulation of claim 1, further comprising water.

(3) The formulation of claim 1, further comprising a defoamer.

(4) The formulation of claim 1, further comprising a bactericide.

(5) The formulation of claim 1, further comprising an oil.

(6) The formulation of claim 1, further at least one adhesion promoter.

(7) The formulation of claim 1, further comprising sodium hydroxide.

(8) The formulation of claim 1, further comprising a color indicator, wherein the color indicator is operative to change the glue stick from colored to substantially uncolored as the adhesive formulation dries following deposition on a surface.

(9) The adhesive formulation of claim 1, wherein the at least one polymer dispersion is present in the formulation at about 60-70% weight.

(10) The adhesive formulation of claim 1, wherein the at least one polymer dispersion is capable of withstanding mixing temperatures of up to about 75°C.

(11) A solid adhesive formulation, comprising:
     (a) polyvinylpyrrolidone;
(b) at least two polymer dispersions, wherein the at least two polymer dispersions both further include polyurethane;
(c) casein; and
(d) sodium stearate, wherein the sodium stearate is operative to facilitate formation of a glue stick for use in joining non-paper items.

(12) The formulation of claim 11, further comprising water, at least one adhesion promoter, dipropylene glycol n-butyl ether, and sodium hydroxide.

(13) The formulation of claim 11, further comprising a defoamer, wherein the defoamer is a silicone defoamer for aqueous systems.

(14) The formulation of claim 11, further comprising a bactericide, wherein the bactericide is ethyl paraben.

(15) The formulation of claim 11, further comprising an oil, wherein the oil is glycerin.

(16) The formulation of claim 11, further comprising a color indicator, wherein the color indicator is operative to change the glue stick from colored to substantially uncolored as the adhesive formulation dries following deposition on a surface.

(17) The adhesive formulation of claim 11, wherein the at least two polymer dispersions combined are present in the formulation at about 60-70% weight.

(18) The adhesive formulation of claim 11, wherein the at least two polymer dispersions are capable of withstanding mixing temperatures of up to about 75°C.
(19) A solid adhesive formulation, comprising:
   (a) polyvinylpyrrolidone;
   (b) at least two polymer dispersions, wherein the at least two polymer dispersions both
       further include polyurethane, and wherein the at least two polymer dispersions are
       capable of withstanding mixing temperatures of up to about 75°C;
   (c) casein;
   (d) sodium stearate, wherein the sodium stearate is operative to facilitate formation of a
       glue stick for use in joining non-paper items; and
   (e) a color indicator, wherein the color indicator is operative to change the glue stick from
       colored to substantially uncolored as the adhesive formulation dries following deposition
       on a surface.

(20) The formulation of claim 1, further comprising water, at least one adhesion promoter,
    sodium hydroxide, a defoamer, ethyl paraben, dipropylene glycol n-butyl ether, and
    glycerin.