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FLUID PAPER COATING EMULSION COMPRISING ETHYL ACRYLATE-ACRYLONITRILE COPOLYMER, MELAMINE-FORMALDEHYDE RESIN, AND SODIUM DI-(C_5-C_8) BRANCHED CHAIN ALKYL SULFOSUCCINATE

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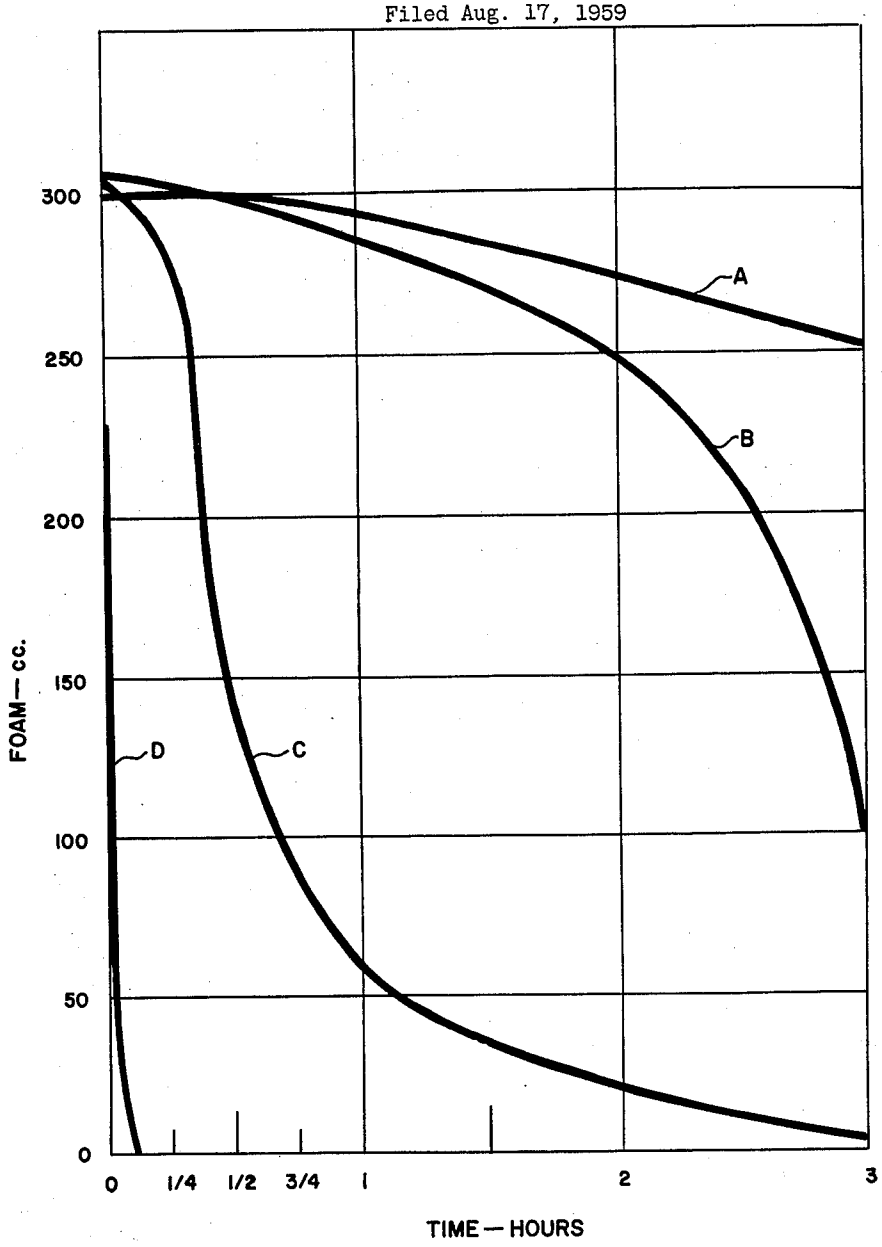

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FLUID PAPER COATING EMULSION COMPRISING ETHYL ACRYLATE-ACRYLONITRILE COPOLYMER, MELAMINE-FORMALDEHYDE RESIN, AND SODIUM DI-(C_5–C_8) BRANCHED CHAIN ALKYL SULFOSUCCINATE

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The present invention relates to paper coating compositions. More particularly, the invention relates to a paper coating composition which when aerated or when applied to paper by a high speed coating machine develops a foam of short persistency and which, when dried, yields a lustrous flexible non-blocking, recoatable water- and grease-resistant coating.

The manufacture of paper carrying a water- and grease-resistant film is an important specialty of the papermaking art. Such paper is used as book and menu covers and for the packaging of greasy foods (particularly bakery products).

Extensive laboratory work has demonstrated that paper which is resistant to penetration both by grease and water can be produced by applying to coating raw stock an aqueous emulsion of a vinyl polymer composed of a major amount of ethyl acrylate and a minor amount of acrylonitrile; see Ritson U.S. Patent No. 2,889,299.

A serious difficulty which occurs when the foregoing emulsion is applied commercially is that the emulsion is whipped up into a persistent foam by the high-speed roller system which transfers the emulsion from the coating color supply pan to the paper. It was found that the foam developed by this and other methods of aeration usually amounts to several times the volume of the emulsion and that the foam is so stable that 90% of it persists for more than one hour. Paper coated with a foamy emulsion tends to develop a coating which is rough and non-lustrous when dry and which may contain pinholes or other discontinuities. Pinholes, despite their small diameter, seriously impair the grease resistance of the product.

The dispersing agents present in the emulsions described above are fatty soaps and, up to the present, these soaps have not been regarded as specifically objectionable in paper coating emulsions. The soaps are the sodium salts of the higher fatty acids, the sodium salts of the half esters of sulfuric acid with a higher fatty alcohol or the sodium soaps of higher alkyl sulfonic acids. They are characterized by the presence of aliphatic chains containing 12 or more carbon atoms.

The discovery has now been made that the coating composition consisting essentially of an emulsion of an ethyl acrylate and acrylonitrile copolymer in an aqueous phase containing a lower branched chain alkyl sulfosuccinate as principal dispersing agent for the copolymer and a water-soluble non-ionic thermosetting melamine formaldehyde condensation product as anti-blocking and recoating agent forms a foam when aerated which breaks or disappears in a fraction of the time heretofore considered usual, while developing a uniform lustrous, flexible, non-blocking recoatable grease- and water-resistant coating when applied to paper and dried.

In a number of instances, we have found that 90% of the foam developed by such compositions according to a standard laboratory test disappears in less than five minutes and that substantially all of the foam breaks within 10 minutes.

As a result of the short life of the foam, emulsions of the present invention are suitable for use in modern high

speed coating machines working at rated capacity and yield a high quality product. The dry paper produced has an affinity for the liquid emulsions and therefore is recoatable so that uniform coatings of any desired thickness without development of wrinkles or discontinuties may be readily built up by successive applications of the emulsion with intermediate drying.

The invention is further illustrated by the drawing which shows the foaming which results when a series of paper coating emulsions within and without the invention are subjected to a standard foaming test.

The test is performed by agitating for one minute 100 cc. of each emulsion at 44% solids, using a Hamilton-Beach high speed drink machine equipped with a stainless steel cup 1¾" in diameter and 3" high having a flared top, transferring the contents of the cup to a glass graduate and recording the initial level of the foam and the level of the foam at it sinks with passage of time. The amount of foam present in each instance was assumed to be equal to the volume of the contents of the graduates (foam plus liquid) minus 100 (the volume of the liquid initially taken).

The emulsions used were prepared as follows:

Emulsion A.—Ethyl acrylate and acrylonitrile in 2.5:1 weight ratio were emulsion copolymerized using a redox catalyst system in water containing a higher soap dispersing agent (Duponol C). "Duponol C" is a higher alkyl sulfate (molecular weight 350) containing 10.3% Na_2SO_4 and 3.4% moisture.

Emulsion B.—This emulsion was a sample of emulsion A to which had been added 50% of hydroxymethyl-di-(methoxymethyl) melamine (or low polymer thereof) based on the weight of the copolymer therein.

Emulsion C.—This emulsion was prepared in the same way as emulsion A, except that the dispersing agent was sodium di-(dimethylbutyl) sulfosuccinate.

Emulsion D.—This emulsion was a sample of emulsion C to which had been added 50% based on the weight of copolymer, of the substituted melamine used in the preparation of emulsion B.

Emulsions A, B and C developed foams of long persistence, the amount of foam remaining after the passage of one hour in the case of emulsion C being equal to about 50% of the initial volume. On the other hand, practically all of the foam developed by emulsion D disappeared within two or three minutes and substantially all of the remainder disappeared within five minutes.

The discontinuous phase of the emulsion of the present invention is a hydrophobic vinyl polymer substantially composed of ethyl acrylate and acrylonitrile copolymerized in weight ratio between 4:1 and 6:5. Too little ethyl acrylate results in a coating which is hard and brittle, and too much results in loss of grease resistance. The optimum weight ratio between the two appears to be 2.5:1. The polymer may contain minor reacted amounts, up to about 5%, of other copolymerizable vinyl compounds, for example, acrylamide, acrylic acid, other acrylic acid esters, acrylonitrile, and corresponding methacrylic compounds; vinyl chloride, vinyl acetate, and styrene. The amount of such supplementary materials should be insufficient to detract significantly from the grease- and water-resistance, flexibility and recoatability of the films which result.

The continuous phase is essentially an aqueous solution of a non-ionic melamine-formaldehyde condensation product containing a small but effective amount of a water-soluble sodium di-(C_5–C_8 branched chain alkyl) sulfosuccinate as principal dispersing agent for the emulsified copolymer.

Suitable dispersing agents are of the type formed by esterifying maleic acid with two moles of 2-ethylbutanol, 3,3-dimethyl hexanol, etc., and then reacting with sodi-

um or other water-soluble metal bisulfate. The agents are present as needed, in amounts between about 1% and 5% of the weight of the vinyl polymer.

Melamine-formaldehyde condensation products useful in the practice of the present invention include trimethylol melamine, the methoxy derivatives thereof. A sufficient amount of these products should be present to impart desired anti-blocking and recoating properties to the film, and generally between 20% and 100% thereof, based on the weight of the vinyl polymer, is sufficient for these purposes.

The emulsions of the invention are fluid, so that they may be pumped and transferred and applied as desired by roller. Their viscosities may be decreased by adding water, and may be increased by adding carboxymethyl cellulose or other compatible thickeners.

The novelty of the composition of the invention does not primarily depend upon the proportion of reagents present or upon the solids content thereof.

The following examples constitute specific embodiments of the invention and are not to be construed as limitations thereon.

Example

To 418 lbs. of water at 85° C. are added 13 lbs. of sodium di-(dimethylbutyl) sulfosuccinate, 3.25 lbs. of sodium bicarbonate, and 10% of the catalyst solution made by dissolving 2.17 lbs. of ammonium persulfate in 106 lbs. of water. To the resulting solution is then added slowly with agitation over 3 hours a mixture of 313 lbs. of ethyl acrylate and 127 lbs. of acrylonitrile, together with 70% of the catalyst solution. The remainder of the catalyst solution is then added and the temperature of the colloidal emulsion which forms is maintained at 85° C. for an additional hour. There is then added a small amount of ammonium persulfate and potassium metabisulfite solutions to polymerize any unreacted monomer material present.

There is then added 500 lbs. of a 44% by weight solution of dimethoxymethyl hydroxymethyl melamine (or low polymer thereof).

The product is a fluid white emulsion having a solids content of 44% by weight Brookfield viscosity of 30 cp. at 25° C. When the emulsion is subjected to the foam test described above, about 90% of the foam which is formed breaks within 2 minutes and the remainder of the foam breaks within 8 minutes.

The emulsion was coated on 50 lb. basis weight

(25" x 40"/500 ream) coating raw stock at a thickness equivalent to 1.5 lb. of resin solids per 1,000 square feet of paper surface by means of a 0.0005" Bird applicator. The sheets were air dried and then oven dried at 300° F. for two minutes which caused the polymer particles to fuse and the melamine-aldehyde product to thermoset. The paper was flexible, lustrous and grease resistant (using colored turpentine as the test fluid).

The paper was recoated in the same manner as described. After oven drying the coating was uniform, smooth and lustrous and free from wrinkles, "holidays" or "fish eyes."

We claim:

1. A fluid paper coating emulsion which when aerated develops foam of short persistency and which, when applied to paper and dried, yields a water- and grease-resistant recoatable coating, which consists essentially of an emulsion of a hydrophobic vinyl paper coating polymer, substantially ethyl acrylate and acrylonitrile copolymerized in weight ratio between 4:1 and 6:5, as discontinuous phase in a continuous aqueous phase containing a sodium di-(C_5–C_8 branched chain alkyl) sulfosuccinate as principal dispersing agent, and an effective amount of a water-soluble non-ionic thermosetting melamine-formaldehyde condensation product as anti-blocking and recoating agent.

2. A composition according to claim 1 wherein the paper coating polymer is ethyl acrylate: acrylonitrile copolymerized in weight ratio is 2.5:1.

3. A composition according to claim 1 wherein the sulfosuccinate is sodium di-(dimethylbutyl) sulfosuccinate.

4. A composition according to claim 1 wherein the melamine formaldehyde condensation product is hydroxymethyl-di-(methoxymethyl) melamine.

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