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HEAT-REFLECTIVE FABRICS AND METHOD OF PRODUCTION

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This invention relates to the printing of materials and more particularly to compositions containing a leafing metallic powder which may be employed to print on textile fabrics such as wool, cotton, nylon, etc.; and the product obtained thereby.

The present invention is closely associated with a recent development in the textile field, namely, decreasing the infrared transmission of a light-weight fabric by bonding a heat-reflective leafing metallic powder to one surface. Such coated fabrics have found wide commercial acceptance as linings for coats and other wearing apparel where the combination of warmth and light weight is greatly desired.

There were, however, a number of technical difficulties that had to be solved before the production of such a coated fabric could be considered practical. It was early recognized that a bright leafing metallic powder such as aluminum, might give the desired infrared reflectance and research was instituted to determine the best method of binding this finely divided metal to the fabric. Economic considerations indicated that a printing process should be used, as spray application resulted in high losses and low output (about 20 yards per minute as compared with 60 to 80 yards per minute using a printing process). Moreover, it was difficult to keep the metallic pigment suspended in the vehicle at spraying viscosities.

We also investigated the possibility of knife-coating, but discovered that the fabric so treated was heavier and much too stiff.

One object of our invention is to produce a fabric coated on one side that will pass the following rigid specifications: (1) Infrared transmission less than 10% of the uncoated fabric; (2) Good hand—coated fabric should retain flexibility; (3) No strike-through—fabrics coated on one side only; (4) Improved dry cleaning characteristics—minimum increase in infrared transmission as the result of dry cleaning; (5) Improved crock resistance—firm bonding of reflective pigment to the fabric; and (6) Light weight—about 2.5 g. of metallic pigment per square yard.

A second and more specific object of this invention is to produce fabric having the properties specified above by a printing process at a rate in excess of 40 yards per minute.

Another object of this invention is a leafing metallic powder printing base which when emulsified and printed on a fabric, will result in a product as described above.

To obtain this end result according to our invention, it is necessary to control the amount and type of resin in the printing base and to keep the vehicle-to-pigment ratio within narrow limits.

The predominant resin in our printing base is an amino plastic of the urea or triazine type which has been condensed with an aldehyde in the presence of an aliphatic primary alcohol of 4 to 8 carbon atoms to form a more or less polymerized ether-type product that has appreciable solubility in organic solvents. The most representative members of this class of materials are the butylated melamine-formaldehyde and urea-formaldehyde resins. These resins are plasticized by oil-modified phthalic glyceride resins and when applied as a water-in-oil emulsion may be readily, rapidly and thoroughly cured to produce strong, flexible, discontinuous films.

The alkyd resins which may find use as plasticizers in our composition may be of many types, all being esters,

most commonly, esters of polyhydric alcohols such as glycerine, with mixtures of monobasic and polybasic acids. Other polyhydric alcohols may also be used in the preparation of these alkyd plasticizers, such as pentaerythritol, polyallyl alcohol and glycols. Some alkyds are prepared by the esterification of a single polyol; in others, a mixture of alcohols may be employed.

The most common polybasic acids are phthalic and maleic acid, commercially available in the form of their anhydrides. The monobasic acids usually employed in modifying these alkyd resins are the high-molecular weight fatty acids. The unsaturation of these fatty acids will largely determine the drying characteristics of the various alkyd resins. Thus, fatty acids of drying oils such as those of tung oil, linseed oil, and dehydrated castor oil yield alkyds having air-drying properties. On the other hand, when employing fatty acids of semi-drying oils, such as sunflower oil and soya bean oil, the alkyds obtained may be semi-drying alkyds which dry slowly or only at elevated temperatures. In considering the nature of the alkyds which are applicable to the present invention, it might further be mentioned that these resins are sometimes classified according to their oil length. The long oil alkyds have excellent flexibility and contain about 24–27% phthalic anhydride. The short oil alkyds are very tough but much less flexible than the longer oil resins. They contain about 39 to 42% phthalic anhydride. The medium oil alkyds are intermediate in toughness and flexibility and may contain about 32 to 34% phthalic anhydride.

For the printing base of this invention we prefer to use a non-drying type of alkyd resin, such as a coconut oil alkyd of medium oil length.

The amount of alkyd present in our printing base may be varied and to some extent is related to the amount of phthalic acid and the type of fatty acid (drying or non-drying) in the resin. In general, we prefer a ratio of about 2 parts of aminoplast resin to 1 part of a non-drying alkyd resin. When the amount of alkyd is decreased to less than 1 part of alkyd resin and 9 parts of aminoplast, the coated fabric will begin to show undesirable stiffness and poor hand. As the amount of alkyd is increased to equal the aminoplast (1 to 1) the resistance to dry cleaning of the printed fabric will decrease. We have found that as the ratio of aminoplast to alkyd approaches 1 to 1, there is an advantage in employing a short-drying oil alkyd. A long oil alkyd should be used to give the vehicle flexibility when operating in the range of 6 to 9 parts aminoplast to 1 part alkyd resin.

The amount of leafing metallic powder present in our resin printing base should be about equal to the total resin solids. While we prefer a resin solids-to-pigment ratio of about 1 to 1, it may be varied between about 1 to 1 and 1 to 2. If the amount of metal powder exceeds twice the resin content, there is not sufficient binder to propery cement the metal to the fabric, and crocking tendencies appear. As the resin-to-pigment ratio is increased beyond 1 to 1, the additional resin does not appreciably improve the adhesion of the pigment to the fabric, but results in poor hand and increases the weight and cost of the coating. Another disadvantage of using too much resin is that the metallic powder will settle out of the print base under these circumstances.

It is an important advantage of the present invention that it is not necessary to prepare finished emulsions which would require the shipment of a product containing a considerable amount of water; on the contrary, the present invention may be applied to the production of a pigmented resin base containing little or no water, which can be stored practically indefinitely and can be rapidly dispersed in a water-in-oil emulsion by the printer to form printing pastes of various strengths. It is a further advantage of the present invention that pastes thus prepared can be diluted by using suitable clear reducing emulsions so that different strengths of pigmentation can be obtained without departing from the desired consistency of the emulsion.

In general, it is desirable to effect dispersion of the resin print base (formation of a water-in-oil emulsion) with the aid of emulsifying agents, because in this man-

ner it is easy to prepare homogeneous emulsions with the printing base herein described. This invention is not limited, however, to the use of any paricular emulsifying agent. In the following examples we have employed a styrenated alkyd resin as an emulsifying agent.

It is an advantage of the printing bases described herein that they can be transformed into stable emulsions by simple mixing without the use of expensive equipment such as a colloid mill.

The printing paste that is obtained by reduction of the resin base is a water-in-oil emulsion in which the outer continuous water-immiscible resin phase is thickened by inner aqueous droplets having a size of less than 50 microns.

When textile fabrics are printed with the extremely fine water-in-oil emulsions of the present invention, uniform coatings are obtained, but the dispersing medium is so uniformly separated by minute droplets of water that on drying the resin does not tend to bridge from fiber to fiber and product stiff material having the feel of a painted fabric, but instead appears to coat individual fibers so that the printing or coating material is still sufficiently flexible to be used for all normal purposes and does not have a harsh or unpleasant hand.

The viscosity of the resulting emulsion will be determined to a great extent by the ratio of water to water-immiscible organic liquid. This enables the printer to use various printing bases and properly control the viscosity of the printing paste in accordance with the type of fabric being coated and the character of engraving on the printing roll.

In some of the earlier water-in-oil printing emulsions, the organic solvents and film-forming substances were carefully chosen to form a clear, true solution; that is to say, the oil phase was homogeneous except for the pigment which was dispersed therein. It was believed that a homogeneous oil phase was required to obtain satisfactory emulsion prints. For the purposes of the present invention this is not the case, and while our printing bases do not preclude the production of emulsions in which the oil phase is homogeneous, excellent results may be obtained with oil phases which are not homogeneous and which are not true lacquers.

Due to the stability of our emulsion system, we have found it possible to add to the inner disperse aqueous phase small quantities of a butadiene acrylonitrile copolymer which has the property of plasticizing and rendering flexible the resinous film printed on the fabric. The amount of this elastomer must be limited, however, to approximately 67% or less of the total resin solids. An excess of elastomer in the print will decrease the resistance of the coating to abrasion and dry cleaning.

When the print base of our invention is dispersed in a water-in-oil emulsion and applied to water-absorbent fabrics with the conventional intaglio rollers used for printing fabric with a dye paste, a discontinuous, non-penetrating film is obtained which is unusually flexible, soft and uniform and has a high infrared reflectance. Because of the consistency of the emulsion, the film produced does not strike through or completely surround the individual fibers, but is confined largely to the portions of the fibers adjacent to the printed side.

Since the present invention does not depend on any apparent chemical reaction with the material coated or physical or chemical affinity of the pigment therefor, it is usable with success on a wide variety of materials; thus, for example, fabrics of glass, cotton, rayon, pigmented rayon, cellulose acetate, saponified acetate, silk, wool and other basic nitrogenous fibers or cellulosic fibers may be employed. The invention may also be used in coating paper which may be sized or unsized. The fact that the process of the present invention is substantially independent of the nature of the surface to which the coating is to be applied makes its field of usefulness very wide and puts an important tool into the hand of the printer as well as other technologists having problems involving the coating of various materials with an infrared-reflecting pigment.

After the fabric is printed it may be dried and finished in accordance with the usual practice. The emulsions of this invention contain resins which may be readily rendered insoluble on the fabric after being applied thereto by heating the fabric to a temperature of approximately 250–400° F., depending upon the heat resistance of the fabric and the total curing time. Some mills have driers which generally heat the fabric to this temperature, in which event the printed coating is insolubilized without the necessity of a separate intermediate drying operation.

The reason for the improved results obtained has not been completely determined and the present invention is not intended to be limited to any theory of action, however, we believe that at least one factor is the decreased penetration obtained with the emulsions of the present invention. The metal leaflets do not penetrate into the fiber or spread laterally on the surface, but appear to be fastened to the individual fibers as individual overlapping plates at the surface of the fabric. This localization of the pigment on the surface seems to result in greater printing strength and reflectance.

The invention will be described in detail in conjunction with a number of specific examples illustrating its applicability to various resin combinations and resin-to-pigment ratios. In the following examples, Examples 1 through 14 illustrate the production of a print base and Examples 15 through 20 describe the emulsification of the printing base to form a paste of the correct consistency for the printing process.

Example 1

	Parts
Aluminum powder	30
Xylene	17
Melamine resin (55%)	36
Alkyd resin (60%)	17

Resin:pigment 1:1; melamine resin:alkyd 1.94:1

In the above example, the melamine resin was a condensation product of melamine with formaldehyde having a Gardner-Holdt viscosity of O to R at 55% solids in 25% butanol and 20% xylene. The alkyd resin was a medium oil non-drying alkyd containing 37% phthalic anhydride having an acid number of 6–10 and a Gardner-Holdt viscosity of Y to Z_2 at 60% solids in xylene.

Example 2

	Parts
Aluminum powder	30
Xylene	14
Melamine resin (55%)	36
Alkyd resin (50%)	20

Resin:pigment 1:1; melamine resin:alkyd 1.98:1

The melamine resin of this example was identical with that of Example 1 above. The alkyd resin was a dehydrated castor resin containing 39% phthalic anhydride having an acid number of 4–10 and a Gardner-Holdt viscosity of X to Z_1 at 50% solids in xylene.

Example 3

	Parts
Aluminum powder	30
Xylene	24
Melamine resin (55%)	36
Alkyd resin	10

Resin:pigment 1:1; melamine resin:alkyd 1.98:1

The melamine resin used in this example was identical with that of Example 1. The alkyd resin was a non-drying alkyd containing 9% phthalic anhydride and having an acid number of 13–19. The Gardner-Holdt viscosity was W to Y at 100% solids.

Example 4

	Parts
Aluminum powder	40
Pine oil	10
Xylene	12
Melamine resin (50%)	30
Alkyd resin (60%)	8

Resin:pigment 1:2; melamine resin:alkyd 3.13:1

The melamine resin used in the above example was obtained by condensing melamine with formaldehyde in the presence of butanol. It had a Gardner-Holdt viscosity of L to O at 50% solids in 30% butanol and 20% xylene. The alkyd resin used in this example was identical with that of Example 1.

Example 5

	Parts
Aluminum powder	40
Pine oil	10

	Parts
Xylene	12
Melamine resin (55%)	26
Alkyd resin (60%)	12

Resin:pigment 1:1.86; melamine resin:alkyd 1.99:1

The melamine resin used in this example was identical with that used in Example 1. The alkyd was a non-drying oil resin containing 43% phthalic anhydride having an acid number of 4–8 and a Gardner-Holdt viscosity of Z_2 to Z_5 at 60% solids in xylene.

Example 6

	Parts
Aluminum powder	30
Xylene	17
Melamine resin (55%)	36
Alkyd resin (60%)	17

Resin:pigment 1:1; melamine resin:alkyd 1.94:1

The melamine resin used in this example was the same as that used in Example 1. The alkyd resin used in the example was identical with that used in Example 5.

Example 7

	Parts
Aluminum powder	30
Xylene	14
Melamine resin (55%)	36
Alkyd resin (50%)	20

Resin:pigment 1:1; melamine resin:alkyd 1.98:1

The melamine resin used in this example was identical with that used in Example 1. The alkyd resin used in the example was the same as that used in Example 2.

Example 8

	Parts
Aluminum powder	30
Xylene	17
Melamine resin (55%)	36
Alkyd resin (60%)	17

Resin:pigment 1:1; melamine resin:alkyd 1.94:1

The melamine resin used in this example was the same as that used in Example 1. The alkyd resin used in the example was the same as that used in Example 5.

Example 9

	Parts
Aluminum powder	40
Pine oil	10
Turpentine	10
Melamine resin (50%)	30
Alkyd resin (50%)	10

Resin:pigment 1:2; melamine resin:alkyd 3:1

The melamine resin used in the above example was identical with that used in Example 4. The alkyd resin of the example was a soya oil alkyd containing 32% phthalic anhydride cooked to an acid number of 3 to 8 and having a Gardner-Holdt viscosity of U to W at 50% solids in mineral spirits.

Example 10

	Parts
Aluminum	30
Urea resin (50%)	39.8
Alkyd resin (60%)	17.0
Xylene	13.2

Resin:pigment 1.03:1; urea resin:alkyd 1.95:1

The urea-formaldehyde resin used in this example was obtained by condensing approximately 2 mols formaldehyde with 1 mol urea in the presence of butanol and contained more than 0.5 mol of combined butanol per mol of urea. This resin had a Gardner-Holdt viscosity of V to Y at 50% solids in 30% butanol and 20% xylene. The alkyd resin used in the example was identical with that used in Example 5 above.

Example 11

	Parts
Bronze powder	30
Melamine resin (55%)	36
Alkyd resin (60%)	17
Xylene	17

Resin:pigment 1:1; melamine resin:alkyd 1.95:1

The melamine resin used in this example was identical with that used in Example 1. The alkyd resin used in the example was identical with that of Example 5.

Example 12

	Parts
Aluminum powder	40
Melamine resin (55%)	36.4
Alkyd resin (50%)	40
6% cobalt	.10
24% lead	.25

Resin:pigment 1:1; melamine resin:alkyd 1:1

The melamine resin used in this example was identical with that used in Example 1 and the alkyd resin was a linseed oil alkyd containing 35% phthalic anhydride and cooked to an acid number of 4–10. It had a Gardner-Holdt viscosity of Z to Z_3 at 50% solids in mineral spirits.

Example 13

	Parts
Aluminum powder	30
Urea resin (50%)	54
Alkyd resin (50%)	6
Xylene	10

Resin:pigment 1:1; urea resin:alkyd 9:1

The urea resin used in this example was identical with that of Example 10 and the alkyd resin was identical with that of Example 2.

Example 14

	Parts
Aluminum powder	30
Urea resin (50%)	48
Alkyd resin (50%)	12
Xylene	10

Resin:pigment 1:1; urea resin:alkyd 4:1

The alkyd and urea resins used in this example were those employed in Example 13.

An alkyd resin was used to aid in dispersing the resin bases described above. Sixty-four (64) parts of a styrenated alkyd copolymer containing between 30–40% styrene and from 20–30% phthalic anhydride and having a Gardner-Holdt viscosity of W to Z_1 at 50% solids in a mixture of equal parts of mineral spirits and xylene, was diluted with 8 parts of xylene and stirred with a high speed mixer. Eight (8) parts of ammonium sulfate were then dissolved in 20 parts of water and added to the styrene alkyd copolymer solution to form a water-in-oil emulsion. The ammonium sulfate has an acid reaction and its function is to accelerate the conversion of the aminoplast.

Two and one-half (2.5) parts of the reduction concentrate prepared above were mixed with 3.5 parts xylene and 19.5 parts of mineral spirits. This mixture was then stirred with a high speed stirrer during the addition of 74.5 parts of water to form a smooth water-in-oil emulsion. The water-in-oil print thickener so prepared may be used to reduce the resin bases of Examples 1 through 14 as illustrated in the following examples:

Example 15

	Parts
The base of Example 8	20
Reducing emulsion	70
Butadiene copolymer (40%)	10

Aluminum 6%; resin:pigment 1:1; resin:elastomer 1.5:1

A printing emulsion was obtained by mixing the above ingredients in the proportions indicated with a high speed stirrer. The butadiene acrylonitrile copolymer used in this example was a 40% latex dispersed in water and stabilized by fatty acid soaps. The printing emulsion so obtained was applied to nylon cloth by means of a pin-pad or cover roll, having 48 rows of 48 pins each per square inch having a depth of 0.010 inch. This coating decreased the infrared transmission of the nylon cloth to approximately 10% of the amount originally transmitted.

Example 16

	Parts
The base of Example 9	10
Reducing emulsion	80

Butadiene copolymer ---------- 10
Aluminum 4%; resin:pigment 1:1; resin:elastomer 1:2

This printing emulsion was obtained by simple stirring according to the process of Example 15. The butadiene acrylonitrile resin was identical with that of Example 15. This printing emulsion was applied to an acetate warp rayon-filled fabric by means of a blotch roll on a printing machine. The printed fabric was then dried at about 80° C. and cured for 5 minutes at about 150° C. The infrared transmission of the treated fabric was less than 10% of that exhibited by the untreated fabric. The dry cleaning resistance of this fabric was satisfactory but not as good as that of Example 15 above. We attribute this to the large excess of butadiene acrylonitrile elastomer over aminoplast resin.

Example 17

	Parts
The base of Example 6	10
Reducing emulsion	80
Butadiene copolymer	10

Aluminum 3%; resin:pigment 1:1; resin:elastomer 1:1.33

The above printing paste was applied by means of a blotch roll to 60–40 wool rayon shirting. The pigment did not strike through to the backside of the fabric, but the face was colored a bright silver and the infrared transmission of the treated fabric was similar to that described above in Example 15. The printed cloth was not quite as flexible as that of Example 15.

Example 18

	Parts
The base of Example 6	10
Reducing emulsion	90

Aluminum 3%; resin:pigment 1:1

This printing paste was applied to an all-viscose lining and cured at 150° C. The infrared transmission was similar to that of Example 15 and was not appreciably increased after repeated dry cleaning. The treated fabric had an excellent hand and drape and there was a minimum tendency toward crocking even after repeated dry cleaning.

Example 19

	Parts
The base of Example 8	10
Reducing emulsion	80
Butadiene copolymer	10

Aluminum 3%; resin:pigment 1:1; resin:elastomer 1:1.33

The butadiene acrylonitrile copolymer used in this example was identical with that of Example 15 above. The printing emulsion was applied to cotton cloth by a blotch roll. The infrared reflectance of the treated fabric was satisfactory, but the crocking was objectionable and the fabric was much stiffer than that treated with the printing emulsion of Examples 15 or 18.

Example 20

	Parts
The base of Example 12	15
Reducing emulsion	85

Aluminum 5.16%; resin:pigment 1:1

A printing emulsion obtained by mixing the above ingredients in the proportions indicated with a high speed stirrer was applied to a 12-ounce wool gabardine. The infrared transmission of the coated fabric was less than 10% of that exhibited by the untreated fabric.

The final prints from the pastes described above are of excellent quality and have a bright shiny surface. The printing emulsions may be allowed to stand for a considerable time before use and the metallic pigments are not even tarnished as the dispersed pigment is inert to both the water and vehicle.

We claim:

1. A fabric coated with a water-in-oil emulsion the continuous phase of which comprises from about one to two parts of a leafing metallic pigment dispersed in a vehicle containing one part of a mixture of one part of a fatty oil acid-modified alkyd and from one to nine parts of an aminoplast selected from the group consisting of urea-formaldehyde and melamine-formaldehyde resins.

2. A fabric according to claim 1 in which the leafing metallic pigment is aluminum powder.

3. A fabric according to claim 2 in which the aminoplast is a butylated melamine-formaldehyde resin.

4. A fabric according to claim 3 in which the ratio of butylated melamine-formaldehyde resin to alkyd resin is about 2 to 1 and the alkyd resin is a medium oil non-drying alkyd.

5. A fabric according to claim 2 in which the aminoplast is a butylated urea-formaldehyde resin.

6. A fabric according to claim 5 in which the ratio of butylated urea-formaldehyde resin to alkyd resin is about 2 to 1 and the alkyd resin is a medium oil non-drying alkyd.

7. A method of decreasing the infrared transmission of a fabric which comprises printing on one side of said fabric a water-in-oil emulsion which has dispersed in the continuous outer phase a leafing metallic pigment; one part of a fatty acid oil-modified alkyd and from one to nine parts of an aminoplast selected from the group consisting of urea-formaldehyde and melamine-formaldehyde resins; said emulsion containing from 1 to 2 parts of pigment for each part of total resin solids.

8. A method of decreasing the infrared transmission of a fabric which comprises printing on one side of said fabric a water-in-oil emulsion, the oil phase of said emulsion consisting of 1 part fatty oil acid-modified alkyd resin and from 1 to 9 parts of a butylated melamine-formaldehyde resin and said oil phase having dispersed therein an amount of aluminum powder approximately equal in weight to the total resin solids in the oil phase.

9. A method of decreasing the infrared transmission of a fabric which comprises printing on one side of said fabric a water-in-oil emulsion, the oil phase of said emulsion consisting of 1 part fatty oil acid-modified alkyd resin and from 1 to 9 parts of a butylated urea-formaldehyde resin and said oil phase having dispersed therein an amount of aluminum powder approximately equal in weight to the total resin solids in the oil phase.

10. A method according to claim 8 in which the inner aqueous phase of said emulsion represents more than 55 percent of the total emulsion and the total solids present are less than 17 percent by weight.

11. A method according to claim 9 in which the inner aqueous phase of said emulsion represents more than 55 percent of the total emulsion and the total solids present are less than 17 percent by weight.

12. A water-in-oil emulsion, the oil phase of said emulsion consisting of one part fatty oil acid-modified alkyd resin and from one to nine parts of a butylated condensate of formaldehyde with a member of the group consisting of urea and melamine and said oil phase having dispersed therein an amount of leafing metallic powder approximately equal in weight to the total resin solids in the oil phase.

13. A water-in-oil emulsion, the oil phase of said emulsion consisting of one part fatty oil acid-modified alkyd resin and from one to nine parts of a butylated melamine-formaldehyde resin, and said oil phase having dispersed therein an amount of aluminum powder approximately equal in weight to the total resin solids in the oil phase.

14. An emulsion according to claim 13 in which the inner aqueous phase of said emulsion represents more than 55% of the total emulsion and the total solids present are less than 17% by weight.

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