

UNITED STATES PATENT OFFICE

2,184,293

ABRASIVE

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No Drawing. Application October 8, 1936, Serial No. 104,734. Renewed September 30, 1938

10 Claims. (Cl. 51—280)

This invention relates to abrasive materials and more particularly to abrasive sheet materials having improved compositions to bond the abrasive in place on the flexible base.

Various materials have been used to bond the abrasive in place on the flexible base. Glue or other water soluble binder may be used to increase the strength of the flexible base and to hold the abrasive in place particularly where resistance to wear is not important or necessary. To produce water resistant abrasive material heat treated drying oils, oleoresinous varnishes, and varnishes containing asphalt, have been used. Synthetic resin compositions such as phenol aldehyde resins and alkyd type resins and mixtures of these with cellulose derivative solutions have also been used, but of the numerous known synthetic resins a relatively few can be satisfactorily used and none in so far as I am aware are capable of producing the improved abrasive products described herein.

The present types of abrasive sheet materials possess various disadvantages which are desirable to overcome. Some of the materials lack sufficient pliability which does not allow them to conform readily to the surface on which they are used. Under these conditions the paper base cracks after a short period of use. Some binders may lack sufficient strength and hardness to hold the abrasive grits in place on the base even though the material may possess sufficient flexibility. Some of the binders are not as water resistant as desirable and become soft so that that material becomes ineffective as an abrasive when used in the presence of water as in wet sanding operations.

This invention has as an object the provision of an abrasive system having an improved coating for bonding the abrasive to the base. Another object is the provision of an improved abrasive sheet material possessing satisfactory pliability in conjunction with a binder which is hard and tough. A further object is the provision of an improved abrasive sheet material whose binder system will retain its flexibility with age, is substantially unaffected after long contact with water and oil and which will not soften from the heat generated during its use and thus hold the dust which makes the abrasive surface ineffective. A still further object is the provision of a method of making the improved abrasive material. Other objects will appear hereinafter.

These objects are accomplished by the following invention in which a urea-aldehyde-alcohol resinous product preferably with a blending

and/or softening agent is used as the binding material for holding the grits to the flexible base material in an abrasive system as outlined above.

The binder used in the manufacture of our improved abrasive is a composition comprising the resinous reaction product of ingredients consisting solely or essentially of ureas, formaldehyde, and an aliphatic monohydric alcohol. The preparation of this resin and the binder composition therefrom will be described in more detail hereinafter.

Generally the resin used in the binder is made by reacting in the presence of an acid or other catalyst (mercuric, aluminum, ferric, or stannic chlorides, acid resins, halogens, etc.) ingredients consisting solely or essentially of urea, formaldehyde, and a monohydric aliphatic alcohol. The heating of the reaction product of the urea and formaldehyde with the alcohol is continued in the presence of a hydrocarbon such as benzene or toluene with separation of water of reaction from the condensed hydrocarbon and return of the latter to the reaction mixture until substantially two molecules of water for each molecule of urea are eliminated and a product is obtained which contains an amount of combined monohydric alcohol equivalent from one-half to about one molecule of alcohol for each molecule of urea. In accordance with this procedure a mixture containing all the ingredients may be reacted, or the alcohol may be heated, accompanied by the mentioned separation of water, with preformed urea-aldehyde reaction product. With the use of some alcohols it may not be necessary to use in addition a hydrocarbon since the water may be satisfactorily removed by other means, as for instance by the use of silica gel in the separation, or by the use of an auxiliary fractionating column to separate the water from the alcohol before the latter is returned to the reaction vessel. These resins yield upon treatment with zinc chloride and acetic anhydride the acetate of the alcohol.

The following is illustrative of the procedure that may be used in making the abrasive sheet material of this invention:

A suitable (preferably a kraft) paper is impregnated with the above mentioned binder solution. This impregnation is carried out by passing the paper through a bath of the binder material and then passing the impregnated paper through squeeze rolls to remove the excess of the binder material. The paper should retain between approximately 10 and 25% of its weight of saturant. The impregnated paper is then dried at a tem-

perature of between 150 and 250° F. for a period of from 30 minutes to two hours. This drying or hardening operation may be carried out by festooning the impregnated sheet material and drying in a suitably heated oven or by any other suitable means. To one face of the impregnated and dried paper is then applied preferably by means of roller coating, a coating of the binder composition the amount being governed largely by the size of the grits or abrasive to be deposited on the base. While this coating is still wet the grits or abrasive material is sprinkled on or applied by other devices known in the art. A coating of the same binder composition is then applied as a sand size coating over the grits or abrasive containing surface. The material is then festooned in a suitable chamber and dried by heating at approximately 160° F. for 24 hours. After this drying the material is subjected to an additional drying at approximately 280° F. for a period of three hours. This last drying is optional depending on the particular weight of material being prepared.

The preparation of the resin used in the binder composition is preferably according to the following procedure:

1600 parts by weight of aqueous formaldehyde containing approximately 37% of formaldehyde in solution are placed in a suitable container and 19 grams of sodium acid phosphate (NaH_2PO_4) added. The resulting solution is adjusted to a pH of 7.6 by the addition of a solution of sodium hydroxide, the amount required depending upon the acidity of the formaldehyde solution used. 540 parts by weight of urea are then dissolved in the formaldehyde solution and the mixture allowed to stand for approximately 96 hours, the temperature being maintained below 30° C., preferably between 20 and 30° C., by means of a cooling coil placed in the liquid or other suitable means. Crystallization of the reaction material sets in usually within from 12 to 24 hours and after a period of 96 hours the container will be found to contain a practically solid mass of crystals. The crystals are filtered and dried. This dried reaction product of urea and formaldehyde is used as the intermediate A in the next step of the process.

1500 parts by weight of isobutyl alcohol are placed in a still or reaction vessel. 100 parts by weight of toluol are then added, followed by the addition of 750 parts by weight of the intermediate product (A) referred to above and then 15 parts by weight of phthalic anhydride are added. Heat is then applied to the reaction vessel and the distillation allowed to proceed at a fairly rapid rate. The liquid which is condensed in the condenser is passed into a separator where it separates into two layers with the organic solvent material forming the upper layer. This material is returned to the reaction vessel and the water layer discarded. Distillation is continued until substantially two molecules of water have been eliminated from the mass in the reaction vessel. The distillation is then continued beyond this point and the distillate not returned to the reaction vessel but removed from the separator as the water is in the early stage of the process. This continued distillation results in practically complete removal of water from the reaction vessel and also in a concentration of the solution in the reaction vessel.

The urea-formaldehyde-alcohol reaction product may be prepared if desired by reacting e. g. normal butyl alcohol, paraformaldehyde (which

is brought into solution with a small amount of alkali as sodium hydroxide) and urea together with the necessary catalyst in the same or a similar apparatus as used in the first procedure described, the heating and distillation being carried out in the same manner.

The urea-aldehyde-alcohol composition is then combined with softening and/or blending agents according to the following examples in which the parts are by weight:

Example I

Urea-aldehyde-alcohol resin (solids)	52	
Blown castor oil	13	
Volatile solvent	35	15
	100	

The volatile solvent in this composition is comprised of isobutyl alcohol used in the preparation of the urea-aldehyde-alcohol composition and aromatic hydrocarbons. The blown castor oil is the type known as pale blown castor oil. The ingredients of the composition are mixed according to procedures well known in the art. The urea-aldehyde-alcohol resin may vary between 30 and 50 parts and the blown castor oil between 10 and 40 parts, the remainder of the composition being volatile solvent.

Example II

Urea-aldehyde-alcohol resin (solids)	40	
Blown castor oil-ester gum varnish	40	
Volatile solvent	20	35
	100	

The blown castor oil-ester gum varnish is prepared by heating two parts of blown castor oil and one part of rosin ester gum at 300° F. until the mass becomes homogeneous, which is usually in about five minutes. After cooling somewhat, solvent naphtha is added with stirring until the solids content has been reduced to approximately 80% solids.

The volatile solvent in this example is the same as that in Example I. The urea resin may vary between 40 and 75 parts and the blown castor oil-ester gum varnish between 25 and 50 parts.

Example III

Urea-aldehyde-alcohol resin (solids)	44	50
Castor oil modified polyhydric alcohol-polybasic acid resin	36	
Volatile solvent	20	
	100	55

The castor oil modified polyhydric alcohol-polybasic acid resin is a 45% castor oil modified resin and is prepared according to the following procedure: 428.0 parts by weight of phthalic anhydride, 189.0 parts of 95% glycerol and 422.0 parts of castor oil are heated at $205 \pm 5^\circ \text{C}$. preferably in an aluminum kettle with stirring for such a time as is necessary to produce a product having an acid number of 40 ± 5 .

A 60% castor oil modified alkyd resin may be used in place of the 45% modified resin. Such a resin is prepared in a manner described as above with the ingredients being phthalic anhydride 309 parts by weight, 95% glycerol, 138 parts and 70 castor oil 600 parts.

The urea resin in this example may vary between 35 and 50 parts and the castor oil modified alkyd resin between 35 and 50 parts.

Other blending and/or softening agents may be

used with the urea-aldehyde-alcohol resin e. g. other oil modified alkyd type resins, other types of synthetic resins, oleoresinous varnishes, cellulose derivatives, natural and synthetic waxes, natural resins, solvent plasticizers as tricresyl phosphate, butyl tartrate, dicyclohexyl phthalate, dibutyl phthalate, etc.

Other types of paper than kraft may be used as the base material in producing flexible abrasive sheets. Also woven or unwoven fabrics of suitable construction are satisfactory.

Our invention is applicable to the production of a paper, fabric and other suitable base coated with abrasive materials for use in grinding, polishing and similar operations. It is further applicable as the bonding agent in the manufacture and production of abrasive wheels, discs, etc.

The use of the urea-formaldehyde-alcohol resinous material as such or in combination with blending and/or softening agents as the binding material in the production of abrasive sheet materials produces a product which is sufficiently pliable to readily conform to surfaces which are being abraded or polished. This pliability is retained on aging so that the sheet material does not become stiff and subsequently crack and tear when used as do many materials made according to the present state of the art. The product made according to the present disclosure possesses the property of better and more sustained cutting since the grits are more firmly held in place by the binder used. Further since the binder is not unduly softened by heat the tendency to collect dust from the surface being abraded or polished, thus reducing the effectiveness of the abrading surface is reduced to a minimum or eliminated. The products of the present invention present the further advantage over those now in common use of being highly water resistant thus making the product admirably adapted for wet sanding of polishing operations. In this respect the products are decidedly superior to products made with a glyceryl phthalate resin. A further advantage is the reduced time required for the manufacturing operation as compared to products made according to the present state of the art, the time for the latter being between four and five days whereas the time for the former is from one and one-half to two days.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that we do not limit ourselves to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. Abrasive sheet material comprising a base, abrasive material and a coating to bind said abrasive material to said base, said coating comprising in substantial amount the resinous reaction product of urea, formaldehyde, and an aliphatic monohydric alcohol, said resinous product containing said alcohol in combined form in amount of from about one-half to about one molecule of alcohol for each molecule of urea, said product yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

2. Abrasive sheet material comprising a base, abrasive material and a coating on said base comprised of a urea-formaldehyde-alcohol resin in admixture with a material from the group comprising blending and softening agents, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of

urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

3. Abrasive sheet material comprising a base, said base having adhered thereto an abrasive, the adhesion of the abrasive to the base material being secured by means of a composition comprising a urea-formaldehyde-alcohol resin and a material from the group comprising blending and softening agents, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

4. A flexible abrasive sheet comprising a base, a binder coating on said base, an abrasive anchored in said binder, and a sandsize coating over said binder coating, the binder coating and the sandsize coating being a composition comprising a urea-formaldehyde-alcohol resin and a material from the group comprising blending and softening agents, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

5. An abrasive sheet comprising a flexible base, said base being impregnated with a composition comprising a urea-formaldehyde-alcohol resin and a softening agent, said impregnated base having upon one face thereof a binder coat, an abrasive material anchored in said binder coat and a sandsize coating over said binder coat, the binder coating and the sandsize coating being a composition comprising a urea-formaldehyde-alcohol resin and a softening agent, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

6. The abrasive sheet of claim 4 in which the softening agent is selected from the group containing oil modified alkyd type resins, oleoresinous varnishes, cellulose derivatives, natural and synthetic waxes, natural resins and solvent plasticizers.

7. The abrasive sheet of claim 2 in which the softening agent is blown castor oil.

8. Abrasive sheet material comprising a base carrying abrasive material and a coating to bind said abrasive material to said base, said coating comprising from 30 to 50 parts urea-formaldehyde-alcohol resin and 10 to 40 parts blown castor oil, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

9. Abrasive sheet material comprising a base carrying abrasive material and a coating to bind said abrasive material to said base, said coating comprising from 40 to 75 parts urea-formaldehyde-alcohol resin and 25 to 50 parts blown castor oil-ester gum varnish, said resin containing aliphatic monohydric alcohol in combined form in amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

10. Abrasive sheet material comprising a base

carrying abrasive material and a coating to bind said abrasive material to said base, said coating comprising from 30 to 50 parts urea-formaldehyde-alcohol resin and 35 to 50 parts castor oil modified alkyd resin, said resin containing aliphatic monohydric alcohol in combined form in

amount of from one-half to about one molecule of said alcohol for each molecule of urea, said resin yielding upon treatment with zinc chloride and acetic anhydride the acetate of said alcohol.

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