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METHOD OF MAKING AN ADHESIVE AND
THE PRODUCT THEREOFCharles N. Cone and Harry Galber, Seattle,
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Our invention relates to the method of making an adhesive and to the product thereof. More particularly, our invention will be described in connection with the problems arising in the art of making veneer panels, but it is to be understood that it is not to be restricted to any such specific application, but is co-extensive in all fields where like problems and conditions are met.

- 10 More particularly, our invention relates to the method of making glues or adhesives having jellying properties by utilizing the reactions of oil seed residue flours, blood, caustic alkali and formaldehyde, and in some instances with the addition of copper salts; and even the reactions of blood, caustic alkali and formaldehyde without the addition of the oil seed residue flours.

- 15 It is heretofore known that oil seed residue flours may be so treated as to produce jelly-like glues. The process in general consists of treating oil seed residue flours with caustic soda and adding formaldehyde.

- 20 Such a glue was adapted to be spread on either wet or dry veneer with subsequent pressing in the hot press. These jelly glues were characterized by having a high water requirement in the neighborhood of 5½ parts of water to one part of seed residue flour and this high water requirement gave a low spread, that is a small amount of dry adhesive per unit of area glued. They are further characterized by being very free from foam and being of a jelly-like consistency, necessitating spreading by spreaders with different grooving from the usual spreader which was adapted to spread glues in a liquid syrupy-like condition.

- 25 The jelly-like condition of these glues enabled them to be used on wet veneer. A syrupy glue cannot be used on wet veneer since the liquid is readily diluted with the water of the veneer and the glue consequently becomes so thin that it is lost in the wood, due to excessive penetration. A jelly-like glue, on the other hand, is not readily diluted and will stay on the glue line without excessive penetration.

- 30 It has also been known heretofore to make adhesives using blood or blood albumin with weak alkalies. Such adhesives, while having an advantageous characteristic of functioning quickly, have a concomitant drawback of a tendency to excessive penetration. Deficient glue films and starved joints are thus prone to occur to a very detrimental extent in manufacturing operations where such a glue is employed. Formaldehyde

has been used with these blood albumin-weak alkali glues, but without the advantages inherent in our invention.

By the term oil seed residue flours we mean to include the flours or meals resulting from the grinding of cakes and/or meals remaining after the natural oil has been removed in whole or in part by whatever means from soya beans, peanuts, linseed, cottonseed, sesame seed, castor seed, hemp seed and other oil seeds of classes represented by the above named varieties. These flours are all characterized by having a similarity of composition in that they are practically free from starch or contain minor percentages of starch, contain varying small amounts of oil, are relatively high in protein ranging from approximately 25 to approximately 50%, a relatively low cellulose content and a considerable content of hemicelluloses approximately 10% to 20%.

While in the examples given in this specification we have used formaldehyde, we have also used hexamethylenetetramine and para-formaldehyde with advantageous results and these chemicals are considered as equivalents of formaldehyde for our purposes. We prefer to use formaldehyde as it is cheap and effective.

When we speak of blood, we mean the various forms in which blood is found in commerce, such as blood albumin, dry blood or even as noted hereafter, fresh blood, which products are obtained from cattle, sheep and hogs.

We have discovered that the oil seed residue jelly glues heretofore referred to may be modified to very great advantage by the introduction of blood, either as the dry blood albumin or even as fresh blood.

When blood is admixed with the oil seed residue flours and the mixture is dispersed by the use of caustic soda, and formaldehyde, or its equivalent, is added, a mixture of very remarkable properties results, which properties are not predictable from the behavior of either the oil seed residue flours or the blood by themselves, or from behavior of mixtures of oil seed residue flours and blood without formaldehyde.

The mixture made up as above described has a better spreading consistency than either seed residue jellies or blood jellies. Furthermore, it has a high water requirement and consequently gives a low spread with great economy. The glue is readily mixed taking only a matter of a few minutes to mix and can be used at once after mixing.

It has been proposed by previous inventors to

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1,976,435

use blood by itself in jelly form or at least when thickened by the use of formaldehyde. These previous proposals, however, have produced a mixture which carried only a small amount of water, hence were uneconomical to use. The preparation of these previous glues has taken a long time and hence they were not very practical for veneer glues where the glue must be made in a short time and become immediately usable. Many of these proposals also use heat in the preparation of the glue and it will be noted that we avoid heat in the preparation of our improved glue.

We have found that blood alone, when dispersed with caustic soda, and the formaldehyde added realizes some of the advantages of the mixture of blood and seed residue flours.

For example, the following formula

	Parts
Blood albumin	100
Lime	7
Caustic soda	4
Silicate of soda	30
Formaldehyde	1/2
Water	650

gives a glue which in an hour or so thickens to a jelly-like consistency. We have found that mixtures of blood with strong alkalies like caustic soda or potash, and formaldehyde, have the great advantage of holding a large amount of water, and still retaining a spreadable consistency for a plywood glue. Weak alkalies like ammonia, etc. do not have this property. The strong alkali glues are therefore economical. In spite of the high dilution this glue when used on plywood with hot pressing gives high adhesion and water resistance with a low spread. This is contrary to what has hitherto been thought possible in gluing plywood.

As compared with oil seed residue jelly glues of the kind heretofore known our improved oil seed residue-blood glue has the advantage of being much easier spread and enabling the panels to be removed from the press in a much quicker time. For example, with three panels of three-ply each in one opening in the hot press, we find that the bond is set so as to permit removal from the press in as short a time as two or three minutes. This could not be realized with the straight oil seed residue jelly glue.

We find that we can incorporate in these blood seed residue glues a very considerable amount of foam and that this foam actually has considerable beneficial effect. We know that foam in previous gluing practise has been stringently avoided, so that it has been an aim of all glue manufacturers to make glue that would be as free as possible from foam. Nevertheless, we find that when properly handled foam is not only not a detriment but can be a positive advantage. In the case of the glue under discussion we find that by incorporating a considerable amount of foam the spread is cut down, that is, it is necessary to spread less adhesive per unit of area, and that the spreading properties of the glue are improved.

In the ordinary liquid glue when foam is incorporated accidentally the spreading properties are seriously impaired, for a liquid syrupy glue when foam is incorporated with it tends to become of a consistency something like mayonnaise or whipped cream, which is very difficult to handle on the usual glue spreader. With this combination of blood and seed residue flours that we have discovered, however, the reverse is true. The incorporation of foam actually improves the spreading properties, as well as decreasing the amount

necessary to spread, without material detriment to the strength or water resistance of the final product. Thus it will be seen that the foam is a great practical advantage. We find in this glue that we can incorporate as much as 50% by volume of foam.

As an example of the blood-seed residue glue, we give the following formula:—

	Parts
Soya bean flour	50
Blood albumin	50
Lime	7
Caustic soda	4
Sodium silicate	30
Formaldehyde	1/2
Water	630

The soya bean flour is finely ground, for example through 80 or 100-mesh, although we do not limit ourselves to this fineness. The blood albumin is also of about the same fineness preferably. Wood flour can be incorporated to the extent of 25% without any impairment of strength of the glue and it thus helps to cut down the spread cost. The lime can be either dry mixed with the other ingredients or can be added as a suspension of lime and water. The four parts of caustic soda are first put in solution in part of the water and added as a solution. The sodium silicate is the variety ordinarily known as water glass. Formaldehyde is used as the ordinary formaldehyde of commerce. The lime and the silicate of soda improve the water resistance.

In this type of glues that we have discovered, caustic soda may be replaced by caustic potash. Ammonia is not, however, an equivalent as it gives a totally different kind of a glue, the water requirement being far less and the ammonia furthermore failing to properly disperse the seed residue part of the composition. The caustic soda or caustic potash do not need to be used as such in these glues for it appears that in this combination they may be replaced by a mixture of lime and sodium fluoride, for example, which combination may be dry mixed with the glue and when freshly mixed appears to have the same effect in this composition as the use of caustic soda as such. We have not, however, kept such dry mixture in storage for any length of time to see whether it would behave in the same ways as do straight oil seed residue glues kept in storage, in which lime and a sodium salt such as sodium fluoride is mixed. For this reason we prefer to use caustic soda as such but do not limit ourselves in this application to the use of caustic as such.

In mixing the above formula, the dry mixed ingredients are first added to the water, stirred until thoroughly mixed, and then the liquid ingredients, including the caustic soda, silicate and formaldehyde, are added, usually in the order named, giving glue which is ready for use immediately, the whole operation of mixing taking but from ten to twenty minutes.

This glue can be spread by the usual type of glue spreader and gives an especially strong and water resistant bond, after a very short time in the hot press; the time in the hot press varies somewhat depending on the thickness of the panels and the kind of wood, but when spreading this glue on dry 1/4 inch birch veneer with three assemblies in one opening of a hot press the panels may be removed in from two to three minutes. The strength of these panels by the

standard plywood shear test is around 400 pounds per square inch. The water resistance, that is the strength of a test-piece after soaking it for 48 hours in water, is around 250 pounds to 300 pounds per square inch. Such results as these, are obtained by a spread of less than 10 pounds of the dry glue material per thousand square feet of three-ply panel. This is a remarkably low spread when it is considered that the usual amount of glue spread per thousand square feet of three-ply panel is from 25 to 40 pounds or more. Such adhesion results as the above are also obtained when the wet glue mixture consists of 50% or even more of foam by volume.

We have found that a further improvement can be made on glues of the type described, that is the combination of blood-seed residue flours with caustic soda and formaldehyde by the addition of a small amount of copper sulphate. The addition of copper sulphate makes a further improvement in consistency, giving a jelly of a stringy character which makes it easier to spread and furthermore by the use of copper sulphate it holds this consistency for as long as three days without material change in either consistency or viscosity. This improvement in the keeping qualities is of considerable importance practically as it enables a batch of glue to be completely used up without having to throw any away.

A typical formula is as follows:

	Parts
Soya bean flour-----	50
Blood albumin-----	50
Wood flour-----	25
Copper sulphate-----	2
Lime-----	7
Caustic soda-----	4
Silicate of soda-----	30
Formaldehyde-----	1/2
Water-----	650

It will be understood that the advantages of all of the foregoing formulæ are realized to a high degree in the gluing of veneer by means of hot presses.

We do not limit ourselves to the above formula or proportions as we have found combinations with other oil seed flours and other proportions of ingredients noted and other soluble alkali metal salts to give excellent results, the said other soluble alkali metal salts including trisodium phosphate, sodium carbonate, sodium silicate, sodium borate, etc., all being salts of strong bases and weak acids, which, together with hydrated lime in aqueous medium, form caustic soda. Further we have successfully used oil seed meals and blood in relative dry weight proportions ranging from 10% blood-90% oil seed flour to 100% blood-0% oil seed flour, formaldehyde and caustic soda being used in all cases.

We claim:—

1. A method of making glue, which consists of treating mixtures of oil seed residue flours and blood albumin with caustic alkali in aqueous solution and adding formaldehyde.

2. A method of making glue, which consists of treating mixtures of soya bean flour and blood albumin with caustic alkali in aqueous solution and adding formaldehyde.

3. A method of making glue which consists of treating oil seed residue flours and blood albumin with hydrated lime and caustic alkali in aqueous solution and adding formaldehyde.

4. A method of making glue which consists of treating oil seed residue flours and blood al-

bumin with hydrated lime and caustic alkali in aqueous solution and adding formaldehyde and copper sulphate.

5. A method of making glue which consists of treating oil seed residue flours and blood albumin with hydrated lime and caustic alkali in aqueous solution and sodium silicate and adding formaldehyde.

6. A method of making glue, which consists of treating mixtures of oil seed residue flours and blood albumin with caustic alkali in aqueous solution and adding formaldehyde and copper sulphate.

7. A method of making glue, which consists of treating mixtures of soya bean flour and blood albumin with caustic alkali in aqueous solution and adding formaldehyde and copper sulphate.

8. A method of making glue which comprises treating blood albumen with caustic alkali in aqueous solution and formaldehyde.

9. A method of making glue which consists of treating mixtures of oil seed residue flours and blood albumin with lime and water and a salt which will produce caustic soda when mixed with lime in aqueous mixture, and formaldehyde.

10. A method of making glue which consists of treating mixtures of oil seed residue flours and blood albumin with caustic soda as such in water solution and adding formaldehyde.

11. A method of making glue which consists of treating mixtures of soya bean flour and blood albumin with caustic soda as such in water solution and adding formaldehyde.

12. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali in water solution and formaldehyde.

13. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali in water solution and formaldehyde and copper sulphate.

14. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali in water solution, hydrated lime and formaldehyde.

15. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali in water solution, hydrated lime, formaldehyde and copper sulphate.

16. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali, hydrated lime and sodium silicate in water solution and formaldehyde.

17. An adhesive comprising the reaction products of oil seed residue flours, blood albumin, caustic alkali, hydrated lime and sodium silicate in water solution, formaldehyde and copper sulphate.

18. An adhesive comprising the reaction products of soya bean flour, blood albumin, caustic alkali in water solution and formaldehyde.

19. An adhesive comprising the reaction products of soya bean flour, blood albumin, caustic alkali in water solution and formaldehyde and copper sulphate.

20. An adhesive comprising the reaction products of blood, caustic alkali, hydrated lime and sodium silicate in water solution together with formaldehyde.

21. An adhesive consisting of the reaction products of oil seed residue flours, blood, caustic alkali, hydrated lime and sodium silicate in water solution together with formaldehyde and copper sulphate.

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