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ACOUSTICAL GRID PANELS

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ABSTRACT OF THE DISCLOSURE

A fibrous acoustical grid panel having improved resistance to sag at conditions of high relative humidity by coating the back surface of a dry, fibrous panel with a melamine fortified urea-formaldehyde resins system. The resin coating is cured in the presence of an acidic material to accelerate the curing rate of the resins.

This invention relates to fibrous acoustical products. More particularly, it relates to fibrous acoustical panels adapted to be mounted in a mechanical suspension system and which have improved resistance to sag at conditions of high relative humidity.

Acoustical grid panels generally are formed of a felted fibrous base material such as mineral fibers, cellulose fibers, and the like, and are porous in nature to provide them with sound absorbing properties. Frequently, the surface of the panels is opened as by perforation, fissuring or otherwise texturing the surface to expose the fibrous interior of the product, thereby greatly increasing the sound absorbing efficiency of the product. Such acoustical panels are usually relatively large in size, such as 2′ x 2′ and 2′ x 4′ in dimension with thicknesses of from ½″ to 1″ or more, and are adapted to be installed upon a grid suspension system in which the panels are supported only at the edges. While such acoustical panels are effective in absorbing sound, they suffer from certain disadvantages which tend to limit their use. Thus, when mounted in mechanical suspension systems the panels are often unsatisfactory when installed in areas of continued high humidity. In the presence of such condition of high humidity the panels tend to sag of their own weight resulting in an unsightly appearance of the ceiling surface. It is believed that this sag of the panels is due at least in part to a decrease in fiber bonding strength and to increased weight resulting from moisture pickup at these conditions. This tendency of the panels to sag when exposed to high humidity conditions is further increased when the surface of the panels has been opened as by perforating, fissuring, and the like. As a result of this poor sag resistance, the acoustical grid panels are not suitable for use in areas in which the relative humidity is above about 80%. Various methods have been suggested in order to improve the sag resistance of such panels. However, the methods suggested heretofore have not been entirely satisfactory, for they are either too high in cost, difficult to control in application, fail to achieve the necessary resistance to sag, or are otherwise objectionable.

It is therefore an object of the present invention to provide a fibrous acoustical panel which has improved resistance to sag at conditions of high relative humidity.

Another object of the invention is to provide a method of treating acoustical panels to improve the sag resistance of such panels.

Another object is to provide a method of forming cellulose fiber acoustical panels which have improved fire resistance and sag resistance.

Various other objects and advantages will appear from the following description of the invention, and the novel features will be particularly pointed out hereinafter in the appended claims.

According to the present invention, sag resistance is imparted to fibrous acoustical panels by coating one surface of the product with a melamine fortified urea-formaldehyde resins system. Thus, a finished mat of felted mineral and/or cellulose fibers is treated with a melamine fortified urea-formaldehyde resins system in such a manner that a coating of the resins is formed over one surface of the mat, the coating being keyed into the fibrous structure of the mat. Curing of the resin coating is effected within a relatively short period of time to provide a fibrous acoustical product which has excellent resistance to sag at high humidity conditions. This resins system, which is acid catalyzed to increase the rate of cure, is effective in improving the sag resistance of acoustical panels formed of mineral fibers, cellulose fibers, and the like, including mixtures of such fibers, and is effective even when the surface of the panel has been opened as by perforating, fissuring, and the like. In order to obtain a maximum improvement in sag resistance, the resins system is applied to the back surface of the panel, that is, the upper or non-exposed surface when the panel is mounted in a mechanical suspension system, with the resins system being applied in a dry-end application, that is, after the panel has been dried during fabrication. It is believed that the improved sag resistance of the present invention is due to the fact that the melamine fortified urea-formaldehyde resin coating tends to expand or grow when exposed to high humidity conditions, so that when applied to the back surface of a cellulose fiber panel the resin coating effectively reduces the sag caused by expansion of the cellulose fibers. Thus, a panel of cellulose fibers will expand when exposed to conditions of high humidity. Initially the hygrometric expansion rate of the cellulose fibers is much more rapid than that of the resin back coating so that there is an initial tendency for the panel to sag. However, after a short period, the expansion of the resin back coating causes an equilibrium to be set up and, being a stronger force than the cellulose fiber expansion, overcomes the expansion and sag of the cellulose fibers to pull the panel back to its original state where it is maintained.

The felted fibrous mat or board may be formed by any conventional method, such as on an Oliver forming machine. In this type of a machine, a dilute slurry of fibers suspended in water is deposited on a rotating screen, and a continuous felted fibrous sheet is formed from which a portion of the water is extracted. The formed sheet is then delivered to a press where additional water is removed from the sheet and the sheet is compressed to a desired thickness. The pressed sheet is then passed through an oven where it is dried. Alternatively, the fibrous sheet may be formed on a Fourdrinier machine according to conventional procedures well known in the art.

The melamine fortified urea-formaldehyde resin system of this invention is applied to the back surface of the dried fibrous sheet as an aqueous solution containing at least about 50% by weight of resin solids. Generally, the resinous back coating solution has a resin solids content of about 50% to 80% by weight, with a solids content of 60% to 70% being preferred. It has been found that the application of a resin solution containing less than about 50% by weight resin solids provides virtually no improvement in sag resistance. The aqueous resin solution may be applied to the fibrous sheet by means of a coating roll or sprayer for liquid resin compositions or by other suitable means for depositing a relatively uniform coating of the resins on the sheet. In order to improve the uniformity of application of the aqueous resin solution, a thickening agent capable of increasing the viscosity of the

solution may be incorporated in minor amounts in the solution. Excellent results have been obtained using a carboxy methyl cellulose thickener. It is to be understood, however, that it is not necessary to include such a thickening agent in the resin composition, for excellent sag resistance has been obtained by the application of aqueous resin solutions which have not been so thickened. Since the curing rate of the resins system of this invention increased in an acidic pH, it is preferred that the solution have a neutral or slightly alkaline pH to provide the resin solution with a pot life which is adequate for use in a commercial operation. A small amount, usually between about 0.5% and 2.5% by weight of the resin solution, of ammonium hydroxide preferably is included in the resin solution to buffer the solution at such a neutral or slightly alkaline pH value.

Excellent sag control has been obtained when the melamine fortified urea-formaldehyde resins system of this invention was applied to the back surface of the fibrous panels at a loading of between about 3 and 20 wet grams of resinous solids per square foot. Higher loadings may of course be used, but are not necessary to provide improved sag resistance and are not desirable for they increase the cost of the operation. A resin loading of between 8 and 16 wet grams per square foot is generally preferred.

The proportions of the resins in the resins system of this invention may vary considerably. However, it is generally preferred that the resin system contain about 25 to 45 mole percent of urea, about 50 to 70 mole percent of formaldehyde, and about 0.02 to 25 mole percent of melamine.

This resins system is cured under controlled conditions of time, temperature and pH. Thus, after application of resin coating on the fibrous sheet, the sheet is exposed to temperatures in the range of about 300° to 600° F. to dry the coating and cure the resins. However, in order to reduce the amount of time required to obtain the degree of cure needed to provide sag resistance, an acidic accelerator is used with the resins system. As noted hereinabove, the melamine fortified urea formaldehyde resins system of this invention is acid curing. Therefore, an acidic material is used in conjunction with the resin coating in order to increase the rate of cure of the resins.

Suitable acidic materials include acids such as boric acid, phosphoric acid, and the like; acid salts such as borates, sulfates, chlorides and phosphates of sodium, potassium, magnesium, calcium and ammonia; and mixtures of such acids and acid salts. Other materials which are capable of reducing the pH of the resins system to about 4.0 to 6.5 without adversely affecting the resins may, of course, also be used. The amount of accelerator used should be sufficient to cause the resins to cure within a few minutes upon exposure to temperatures of about 300° to 600° F.

The acidic accelerator may be used in conjunction with the resins system in several ways. According to one embodiment, the acidic material is incorporated in the aqueous resin solution prior to the application of the resins to the fibrous sheet. According to this technique, the sheet, after being coated with the resin solution containing the accelerator, is passed to an oven having a temperature of about 300° to 600° F. to cure the resin coating within a few minutes. According to another embodiment, the resin solution is first applied to the fibrous sheet by means of a coating roll, a sprayer, and the like, and a dilute aqueous solution of the acidic material subsequently applied on the resin coating. If desired, the resin coating may be dried to a non-tacky condition prior to the application of the acidic solution. After application of the acidic solution, which is at a concentration of about 2% to 15% and is applied at a loading of about 2 to 10 wet grams per square foot, the fibrous sheet is exposed to the temperatures mentioned above to cure the resins within a few minutes.

According to another embodiment, the acidic material is incorporated into the fibrous sheet by impregnating the wet fibrous sheet with a solution of the acidic material. This procedure is particularly effective when phosphates, borates and/or boric acid are used as the accelerator in the manufacture of cellulose fiber grid panels, for these materials are not only effective in increasing the cure rate of the resin coating but also improve the flame-resistance of the fibrous panels. Thus, after formation of the wet fibrous sheet, a solution of phosphates, borates and/or boric acid is applied to the front surface of the sheet in such a manner that the acidic materials impregnate substantially through the entire thickness of the sheet. After drying, the back surface of the sheet is coated with the resins system. In this manner the phosphates, borates and/or boric acid on the front surface of the sheet effectively improve the flame-resistance of the sheet, while the portion of these materials which impregnate through to the back surface of the sheet effectively accelerate the curing rate of the resin coating. If desired, an aqueous solution of an acidic accelerator may also be applied to the back of the panels in conjunction with the impregnation using phosphates, borates and/or boric acid.

The invention will now be described with reference to several specific examples which are intended to be illustrative only. All percentages and parts are expressed on a weight basis unless otherwise designated.

EXAMPLE I

A cellulose fiber mat was formed on an Oliver machine by forming a dilute aqueous slurry of wood fibers and depositing the fibers on the surface of a rotating screen to provide a felted fibrous mat which was then pressed to a thickness of about ½" and dried. The dried mat was then cut into panels 24" x 48" in size, and the screen (or back) surface of some of these panels coated with an aqueous solution of the melamine fortified urea-formaldehyde resins system of this invention. The front surface of some of the panels was perforated prior to the application of the resin back coating. In order to provide a basis for comparison, some of the panels were not coated with the resins system. The resins system used in this example comprised an aqueous solution of melamine, urea and formaldehyde resins, the solution having a resin solids content of about 79%, with the resins being present in the amounts of 3 mole percent of melamine, 34 mole percent of urea and 63 mole percent of formaldehyde. The resin solution also contained about 1% by weight of ammonium hydroxide. The aqueous resin solution was applied at a rate of 16 wet grams of resinous solids per square foot, by means of a coating roll, and the resin coating dried in a forced air oven at temperatures between about 360° F. and 410° F. for about one minute. A dilute solution of ammonium sulfate was then applied to the dried resin coating at a loading of about 5 wet grams per square foot, to accelerate the cure of the resins. The coated panels were then heated at a temperature of between 450° and 480° F. for about one minute in order to cure the resins. The panels were then tested for sag by mounting the panels, face down, in a suspension system, with the panels being supported along all edges. Sag of the panels was determined after exposure to 90% relative humidity at 90° F. for 72 hours, with the sag being reported in inches. The results of this test are reported in Table I.

TABLE 1

No.	Sample	Sag, in inches
1	Control, unperforated face	0.372
2	Resin back coating, unperforated face	0.006
3	Control, perforated face	0.712
4	Resin back coating, perforated face	0.189

The results of this test clearly show the marked improvement in sag resistance of fibrous acoustical panels resulting from the present invention.

EXAMPLE II

In order to show that improved sag resistance may be obtained using an aqueous resin solution having a lower solids content, a series of felted cellulose fiber panels, 12" x 24" x ½" in size, were prepared and dried, back coated with the resins system of this invention and tested to determine their sag after 72 hours at conditions of 90% relative humidity—90° F., with the panels being supported along their 12" dimension. The back surface of panel A was roll coated with an aqueous solution of the melamine fortified urea-formaldehyde resins system of this invention, the solution having a solids content of about 65%, with the resins being present in the amounts of 1 mole percent of melamine, 37 mole percent of urea and 62 mole percent of formaldehyde. The back surface of panel B was coated with the same resins system but the solution had a solids content of 51%. The resins were applied to both panels at about the same loading, i.e. 13 wet grams per square foot. A dilute ammonium sulfate solution was applied to the back of both panels to accelerate the cure of the resins. The resin coating on both panels was cured by passing the panels through an oven at 400° F. in 2.5 minutes. Panel C, which has no resin coating, was provided as a control. The results of the sag determination are reported in Table II.

TABLE II

Panel	Sample	Solids content of resin solution, percent	Sag, inches
A	Resin back coating	65	0.052
B	Resin back coating	51	0.097
C	Control		0.652

EXAMPLE III

In order to demonstrate the superiority of the resins system of this invention over other resin coatings in providing sag resistance, a number of resins were evaluated as back coatings on dry fibrous panels 12" x 24" x ½" in size. Each of the resin coatings was acid catalyzed to speed the cure of the resin by applying a dilute acid solution over the resin. A temperature of about 400° F. was used to cure the resins. Sag of the panels was determined after the panels had been exposed to 90% relative humidity at 90° F. for 72 hours. The results of this comparative test are reported in Table III.

TABLE III

Panel No.	Resin coating	Resin loading (wet gms. resin per sq. ft.)	Sag, inches
A	None		0.652
B	Methylated, trimethylol melamine.	20	0.546
C	Melamine-formaldehyde	13	0.410
D	Phenol-formaldehyde	26	0.438
E	Urea-formaldehyde	43	0.987
F	Melamine fortified urea formaldehyde.	12	0.025

EXAMPLE IV

A cellulose fiber acoustical panel having improved flame resistance and sag resistance was prepared in the following manner. A dilute aqueous slurry of wood fibers was deposited on the surface of a rotating screen of an Oliver machine to form a wet sheet of the fibers. While the sheet was still on the screen, an aqueous solution containing about 14.5% by weight boric acid and about 5% by weight borax was applied uniformly across the sheet. Flushing water was then applied over the sheet so that the boric acid-borax solution was impregnated substantially completely through the sheet. The impregnated wet sheet was then removed from the rotating screen, dried and cut into panels 2' x 4' in size. After drying, the back surface of the panels was coated with the aqueous resin solution described in Example I, the resin solution being applied at a loading of 16 wet grams of resin per square foot. The resin coating was then dried at a temperature of between 340° and 410° F. for about 1 minute, and a dilute aqueous solution of ammonium sulfate then applied over the resin coating. The coated panels were then passed through an oven at 400° to 460° F. for one minute to cure the resins. Some of the panels thus formed were tested for sag resistance by mounting the panels, face down, in a suspension system, with the panels being supported along all edges. Sag of the panels was determined after exposure to 90% relative humidity at 90° F. for 72 hours. Under these conditions the panels sagged 0.080 inch. Another group of these panels were tested for fire resistance using a tunnel test in accordance with ASTM E84–61. When tested in this manner, the panels had a flame spread value of 30. Comparable cellulose fiber grid panels prepared in the same manner, but without being impregnated with the boric acid-borax solution or coated with the resins system of this invention, had a flame spread value of 78 when tested in the same manner and sagged 0.320 inch when exposed to conditions of 90° F. and 90% relative humidity for 72 hours.

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications, and this application is intended to cover any variations, uses and adaptations of the invention. It will therefore be recognized that the invention is not to be considered as limited to the precise embodiments described, but is to be interpreted as broadly as permitted by the appended claims.

We claim:

1. A fibrous acoustical panel having improved resistance to sag which comprises

a fibrous base material having on one of its surface a cured melamine fortified urea-formaldehyde resin coating which contains from 25 to 40 mole percent of urea, from 50 to 70 mole percent of formaldehyde and from 0.02 to 25 mole percent of melamine.

2. The fibrous acoustical panel as defined in claim **1** in which the resin coating is on the back surface of the panel.

3. The fibrous acoustical panel as defined in claim **1** in which the resins are coated on the back surface of the panel at a loading of between about 3 and 20 wet grams of resinous solids per square foot of fibrous panel.

4. The fibrous acoustical panel as defined in claim **1** in which the panel is impregnated with material selected from the group consisting of phosphates, borates, boric acid and mixtures thereof in order to improve the flame resistance of said panel.

5. A method of improving the dimensional stability of fibrous acoustical panels which comprises,

applying an aqueous resin solution to the back surface of a substantially dry, fibrous panel to form a resin coating on said panel, said solution having a resins solids content of above about 50% by weight and containing as the resinous components thereof a melamine fortified urea-formaldehyde resin consisting of from 25 to 45 mole percent of urea, from 50 to 70 mole percent of formaldehyde and from 0.02 to 25 mole percent of melamine,

and curing the resins to a degree sufficient to provide the panels with sag resistance when exposed to conditions of high relative humidity.

6. A method as defined in claim **5** in which the resins are cured at a temperature in the range of from 300° F. to 600° F. in the presence of an acidic accelerator.

7. A method as defined in claim 5 in which an aqueous solution of an acidic accelerator is applied over said resin coating, said accelerator being supplied in an amount sufficient to effect cure of the resins within a few minutes when heated at a temperature of between about 300° and 600° F.

8. A method as defined in claim 7 in which said aqueous solution of an acidic material contains a material selected from the group consisting of acids, acid salts, and mixtures thereof.

9. A method as defined in claim 5 in which a solution of an acidic material selected from the group consisting of phosphates, borates, boric acid and mixtures thereof is impregnated into said fibrous panel prior to the application of said resin solution, whereby said acidic material increases the curing rate of said resins and improves the flame resistance of said panel.

References Cited

UNITED STATES PATENTS

1,937,679	12/1933	Wiener et al.	162—159 X
1,939,082	12/1933	Quinn	162—159
2,485,080	10/1949	Wohnsiedler et al.	117—155 X
2,813,046	11/1957	Lauring	117—137 X
2,919,453	1/1960	Shuttleworth	117—62.2 X
3,243,340	3/1966	Cadotte	117—155 X
3,281,252	10/1966	Fairchild	117—137 X

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