

SPECIFICATION

Solid Reactive Catalyst for Amino Resins

The present invention relates to a solid reactive catalyst for amino resins which comprises a mixture of organic and inorganic components. If this catalyst is added to amino resins used for bonding lignocellulosic materials, lower amounts of resin solids can be used while at the same time the rates of production can be increased without causing any loss in bonding strength.

The solid catalyst of the invention comprises an organic and an inorganic component. The organic component comprises an aldehyde polymer which is solid at room temperature and soluble in water, in combination with urea and/or melamine, while the inorganic component is an alkali metal halide.

It has already been suggested to replace with halide salts a part (but not more than 30%) of the resin used for bonding cellulosic particles, for example in the production of particle board. However, the rate of production could not be increased in this way, and when the higher amounts of halide salts were used, it was even decreased due to the high amount of water which had to be employed. It was therefore necessary to separately spray the cellulosic particles with an aqueous solution of the halide salt, then to dry them and finally to spray them with the amino resin solution, instead of using the conventional methods of producing particle board.

It has also been suggested to use as a catalyst a concentrated aqueous solution of a mixture of organic and inorganic components, the organic component comprising formaldehyde and urea or a non resinous condensation product of formaldehyde and urea, and the inorganic component comprising a water-soluble alkali metal halide. This catalyst solution, if employed in combination with a known catalyst for the polycondensation of amino resins used for bonding cellulosic particles, in fact increases the rate of polycondensation of the resin and at the same time allows the use of lower amounts of resin solids without causing any loss of bonding strength. However, this catalyst is only stable for two months at about 20°C and for even shorter times at higher temperatures. Therefore, it is unsuitable for application in hot climates or when it has to be transported over long distances.

Surprisingly, the solid catalyst of the invention equally increases the rate of polycondensation of amino resins and at the same time allows the use of lower amounts of resin solids without causing any loss of bonding strength, notwithstanding the fact that it shows a practically unlimited stability if its components are tightly and securely packed. Because the catalyst is solid and has a high solids content, it can easily be transported at low cost over long distances and, due to its stability, it is not subject to any restrictions in respect of climatic conditions or geographic position.

The solid reactive catalyst according to the present invention provides yet another advantage. Due to the lower quantity of resin used and improved performance achieved, the amount of free aldehyde in the production hall and in the finished products, such as particle boards, is considerably reduced and the boards resulting are nearly odourless.

By employing the solid catalyst of the invention, the curing rate of the resin may be increased at high temperatures to levels which can never be reached by adding known acid-curing catalysts only. The addition of known acid curing catalysts indeed increases the curing rate, but if a certain level is exceeded, further increase of the curing rate is associated with the degradation of the properties of the bonded cellulosic material produced.

Furthermore, the addition of the well-known acid-curing catalysts to higher levels allows the polycondensation to proceed even at room temperature (in spite of the addition of retarders such as ammonia or hexamethylenetetramine). This reduces the shelf life of the glue at room temperature, causing precuring before the introduction of the mat in the press and resulting in the well-known handicaps of such a phenomenon.

However, by using the catalyst according to the present invention it is possible to increase the curing rates even further and consequently to reduce the pressing times, without causing any degradation of the properties of the bonded material. The added catalyst of the invention only reacts at high temperatures. It therefore substantially increases the polycondensation rates of the resin at the temperature of the press without increasing it at all at room temperature, thus avoiding any precuring problems. The said catalyst is combined with, and becomes part of, the resin itself.

The combination of an organic with an inorganic component in the catalyst exhibits a synergic behaviour. If one of the components is added alone to the resin it may cause a certain increase in curing rate, but when added in combination, the two components cause an increase which is much higher than the sum of the results obtained when each component is added separately. Moreover, the catalyst of the invention allows a reduction of the amount of resin serving as a binder which is much higher than the sum of the savings obtained when each component is added separately.

The maximum reduction of the amount of resin solids that may be reached is about fifty percent. This can be achieved by using fifty percent of the usual amount of resin and adding twentyfive to thirtyfive percent of the catalyst of the invention, based on the usual amount of resin. These percentages are by weight, calculated for all products as 100% solids.

Examples of aldehyde polymers which are solid at room temperature and which can be used in the solid catalyst of the invention are the trimer of acetaldehyde, also known as paraldehyde or 2,4,6-trimethyl-1,3,5-trioxane, and the tetramer of acetaldehyde, also known as metaldehyde, the

trimer of formaldehyde, also known as trioxymethylene, the tetramer of formaldehyde, also known as tetraoxymethylene, but above all the mixture of formaldehyde polymers known as paraformaldehyde.

Examples of alkali halides which can be used in the solid catalyst of the invention are potassium chloride and lithium chloride, but the preferred alkali halide is sodium chloride.

5 The solids content of the solid catalyst of the invention may vary between 75 and 100% by weight and depends on the amount of impurities and moisture contained in the starting materials used. 5

Lignocellulosic materials can be bonded by spraying the mixture of amino resin, conventional catalyst and solid catalyst of the invention onto said materials and curing the resin at elevated temperatures and pressures according to the methods well known in the art. The catalyst may be used in all types of products where amino resins are used for bonding lignocellulosic materials, whether 10 these are wood particles for particleboard production using a flat press, continuous presses or calenders, or wood veneers such as in plywood production, or wood blocks such as in blockboard production. 10

15 The invention is illustrated but not limited by the following examples in which the parts and percentages are by weight: 15

Example

This example illustrates the advantages obtained in the production of particle board when the solid catalyst according to the present invention is added to the gluing mixture in the amounts given in the following table, which also gives the properties of the particle board product.

Table		Formulation			
Components (g)		A*	B	C	
25	Urea formaldehyde resin, aqueous solution (65% solids content)	3,000	2,250	2,100	
	Ammonium chloride (20% solution in water)	292	219	205	25
	Paraffin	25	25	25	
	Water	500	800	900	
	Paraformaldehyde 95%	—	76	95	
	Urea prills	—	112	140	
30	Sodium chloride	—	109	136	30
Total		3,817	3,591	3,601	
Property		A*	B	C	
	Density (kg/m ³)	660	655	650	
	Thickness (mm)	16.0	16.0	16.0	
35	Modulus of elasticity (kp/cm ²)	24,000	25,000	23,500	35
	Tensile strength (kp/cm ²)	5.0	5.5	5.3	
	Bending strength (kp/cm ²)	250	240	245	
	Water absorption (percent) after 24 hours immersion	13	12	14	
40	Swelling (percent increase) after 24 hours immersion	8	7	10	40

*Prior art

Formulation A is a conventional gluing mixture prepared with urea formaldehyde glue, a conventional catalyst (ammonium chloride) as the hardening agent, paraffin and water. Ammonia is 45 added in all cases in the same conventional amount. The pH of the formulations is not critical. 45

This formulation is sprayed onto wood flakes in an amount sufficient to obtain a dry glue content of 9% by weight, based on the bonded wood flakes.

Formulation B contains only 2,250 g of resin solution or 75% of the amount of resin used in formulation A. The 750 g of resin solution omitted (which contain 487.5 of resin solids) are replaced 50 by 297 g of a solid mixture of paraformaldehyde, urea and sodium chloride constituting the solid catalyst of the invention. Hence, the ratio of resin solids replaced to solid catalyst is 1.64:1. The amount of conventional catalyst or hardening agent is also reduced to 219 g or 75% of the amount used in formulation A, because the catalyst of the invention acts both as a binder and as a hardening agent. Moreover, the total weight of formulation B is only 94% of that of formulation A, so that a 55 correspondingly smaller amount of formulation B has to be sprayed. 55

Formulation C contains only 2,100 g of resin solution or 70% of the amount of resin used in formulation A. The 900 g of resin solution omitted (which contain 585 g of resin solids) are replaced by 371 g of solid catalyst of the invention. Hence, the ratio of resin solids replaced to solid catalyst is 1.57:1. The amount of conventional catalyst is further reduced to 205 g or about 70% of the amount 60 used in formulation A. The total weight of formulation C is 94.4% of that of formulation A, so that a 60

correspondingly smaller amount of formulation C has to be sprayed in order to obtain the full binder saving advantage.

Particleboards were produced using formulations A, B and C, respectively, according to the BISON system under controlled conditions which were kept constant for all the formulations at the following values:

Moisture of mat before the press	10 to 11%
Press temperature	210°C
Pressure	32 kg/cm ²

As may be seen from the table, the three boards thus prepared did not show any appreciable differences. However, the gel time of formulations B and C was shorter than that of the prior art formulation A, although the latter contains considerably more hardening agent.

Example 2

This example illustrates the use of a melamine-formaldehyde resin for the production of particleboard employing a catalyst of the invention.

The components used for the glue formulation are as follows:

		Formulation	
		1	2
20	Kauramin 540	5160 g	4386 g
	Hardener (i)	485 g	412 g
	Paraffin emulsion	190 g	190 g
	Ammonia	25 g	25 g
	Catalyst (ii)	—	289 g
	Water	50 g	50 g
		5910 g	5352 g

(i) The hardener solution is comprised of

ammonium chloride	10%
urea	30%
water	60%

(ii) The catalyst solution according to our present invention is comprised of

30	melamine monomer	38%
	sodium chloride	36%
	paraformaldehyde	26%

Two series of boards were prepared, one using formulation 1 which does not contain the catalyst according to our invention and the other using formulation 2 containing the catalyst according to our invention.

The total amount of formulation shown (in formulation 1, 5910 g, and in formulation 2, 5352 g) were sprayed each onto 25 kg of chips of the same quality.

The thickness of boards prepared was 17.5 mm, the temperature of the press was 200°C, the pressure was 35 kg/cm². The press time was 10 sec/mm.

The boards produced had the following characteristics:

Formulation	Thickness (mm)	Density (kg/m ³)	Bending strength (kp/cm ²)	Tensile strength (kp/cm ²)	Swelling (% increase) after	
					2 hrs	24 hrs
1	180	763	319	10.0	8.8	15.9
2	180	738	304	10.1	8.1	16.1

It is obvious from the above results that the boards produced in both cases are equivalent.

Example 3

This example illustrates the use of the catalyst according to the invention for the production of particleboard, the catalyst having a higher content of inorganic material as compared to that used in the previous examples.

The components used for the glue formulation are as follows:

		<i>Formulation</i>		
		1	2	
5	Urea formaldehyde resin (65% solids content)	3080 g	2310 g	
	Ammonia solution (25%)	10 g	10 g	5
	Ammonium chloride solution (15%)	300 g	225 g	
	Paraffin emulsion 65%	195 g	195 g	
	Catalyst (i)	—	362	
	Water	570 g	570 g	
10		4155 g	3672 g	10

(i) The catalyst solution according to the invention is comprised of:

	Urea	31%	
	Sodium chloride	48%	
	Paraformaldehyde	21%	
15		100%	15

Two series of boards were prepared, one using formulation 1 which does not contain the catalyst according to the invention, and the other using formulation 2 containing the catalyst according to the invention.

These formulations were sprayed each onto 25 kg of wood chips having the same quality. The gel time of formulation 1 is 75 sec.; the gel time of formulation 2 is 70 sec. Boards were prepared under the following conditions:

Press temperature:	200°C
Pressure:	35 kg/cm ²
Press Time:	10.9 and 8 secs/mm.

The boards produced had the following characteristics:

		<i>Formulation 1</i>			<i>Formulation 2</i>			
		10	9	8	10	9	8	
	Press time (sec/mm)							
	Board thickness (mm)	17.8	18.5	18.5	18.0	17.9	18.7	
	Density (kg/m ³)	673	667	665	691	671	672	
30	Bending strength (kp/cm ²)	172	167	170	174	168	194	30
	Tensile strength (kp/cm ²)	5.5	5.0	4.5	5.5	5.6	5.0	
	2 hrs swelling (% increase)	10	9.9	10.8	12.6	12.1	10.9	
	24 hrs swelling (% increase)	24.6	24.4	24.7	19.8	27.8	24.0	

It is obvious from the above results that both series of boards produced are equivalent and actually boards produced at 8 sec/mm were slightly better when produced with formulation 2.

Claims

1. A solid reactive catalyst for the polycondensation of amino resins used for bonding lignocellulosic materials, said solid catalyst, if used in combination with a known catalyst, increasing the rate of polycondensation of the resin while at the same time allowing the use of lower amounts of total resin solids without imparting any loss in bonding strength, which solid catalyst comprises an organic and an inorganic component, the organic component comprising an aldehyde polymer which is solid at room temperature and soluble in water, in combination with urea and/or melamine, while the inorganic component comprises an alkali metal halide.
2. A solid catalyst as claimed in claim 1 wherein the aldehyde polymer is paraformaldehyde.
3. A solid catalyst as claimed in claim 1 or 2 wherein the alkali metal halide is sodium chloride.
4. A solid catalyst as claimed in any one of claims 1 to 3, which contains 75 to 100% by weight of solids.
5. A solid catalyst as claimed in claim 1 substantially as hereinbefore described in Examples 1—3.
6. A binder composition suitable for binding lignocellulosic materials comprising at least the following three components:

The components used for the glue formulation are as follows:

		<i>Formulation</i>		
		1	2	
5	Urea formaldehyde resin (65% solids content)	3080 g	2310 g	5
	Ammonia solution (25%)	10 g	10 g	
	Ammonium chloride solution (15%)	300 g	225 g	
	Paraffin emulsion 65%	195 g	195 g	
	Catalyst (i)	—	362	
10	Water	570 g	570 g	10
		4155 g	3672 g	

(i) The catalyst solution according to the invention is comprised of:

15	Urea	31%	15
	Sodium chloride	48%	
	Paraformaldehyde	21%	
		100%	

Two series of boards were prepared, one using formulation 1 which does not contain the catalyst according to the invention, and the other using formulation 2 containing the catalyst according to the invention.

These formulations were sprayed each onto 25 kg of wood chips having the same quality. The gel time of formulation 1 is 75 sec.; the gel time of formulation 2 is 70 sec. Boards were prepared under the following conditions:

Press temperature: 200°C
 Pressure: 35 kg/cm²
 Press Time: 10.9 and 8 secs/mm.

The boards produced had the following characteristics:

		<i>Formulation 1</i>			<i>Formulation 2</i>			
		10	9	8	10	9	8	
30	Press time (sec/mm)	17.8	18.5	18.5	18.0	17.9	18.7	30
	Board thickness (mm)	673	667	665	691	671	672	
	Density (kg/m ³)	172	167	170	174	168	194	
	Bending strength (kp/cm ²)	5.5	5.0	4.5	5.5	5.6	5.0	
	Tensile strength (kp/cm ²)	10	9.9	10.8	12.6	12.1	10.9	
	2 hrs swelling (% increase)	24.6	24.4	24.7	19.8	27.8	24.0	
	24 hrs swelling (% increase)							

It is obvious from the above results that both series of boards produced are equivalent and actually boards produced at 8 sec/mm were slightly better when produced with formulation 2.

Claims

1. A solid reactive catalyst for the polycondensation of amino resins used for bonding lignocellulosic materials, said solid catalyst, if used in combination with a known catalyst, increasing the rate of polycondensation of the resin while at the same time allowing the use of lower amounts of total resin solids without imparting any loss in bonding strength, which solid catalyst comprises an organic and an inorganic component, the organic component comprising an aldehyde polymer which is solid at room temperature and soluble in water, in combination with urea and/or melamine, while the inorganic component comprises an alkali metal halide.
2. A solid catalyst as claimed in claim 1 wherein the aldehyde polymer is paraformaldehyde.
3. A solid catalyst as claimed in claim 1 or 2 wherein the alkali metal halide is sodium chloride.
4. A solid catalyst as claimed in any one of claims 1 to 3, which contains 75 to 100% by weight of solids.
5. A solid catalyst as claimed in claim 1 substantially as hereinbefore described in Examples 1—3.
6. A binder composition suitable for binding lignocellulosic materials comprising at least the following three components:



* C L M S *

(16)

- (i) an amino resin;
- (ii) a catalyst for the polycondensation of amino resins;
- (iii) a solid reactive catalyst as claimed in any of the preceding claims.

5 7. A method of binding lignocellulosic materials wherein there is used a binder composition as claimed in claim 6.

5

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office,
25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained



* C L M S *