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(54) **A substitute for amino and phenolic resins**

(57) A substitute for amino and phenolic resins is used in the polycondensation of such resins based on formaldehyde for bonding water penetrable cellulosic particles. The substitute comprises an aqueous solution of

- either at least one aldehyde together with at least one amide and/or together with at least one phenol, or a non-resinous condensation product of formaldehyde and urea, and
- a sugar or a sugar derivative or their by-products or a starch or its degradation products or a mixture thereof, and/or
- a raw and/or treated lignosulfonate.

This substitute also reduces the free formaldehyde of the resulting board without impairing the other properties thereof.

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SPECIFICATION

Substitute for amino and phenolic resins

- 5 The present invention relates to a substitute for amino and phenolic resins in the polycondensa- 5
tion of such resins based on formaldehyde for bonding water penetrable cellulosic particles thus
allowing lower amounts of resin solids to be used while at the same time reducing the free
formaldehyde of the resulting board without imparting any loss in bonding strength, without
requiring any extra steps in the production, without changing the curing rate of the production,
10 without causing any problem to the boilers when burning particleboard sander dust or edges 10
from cutting saws and without reducing the tack properties of the resin mixture.
- The said substitute is comprised mainly of a solution of:
- a) either an aldehyde together with an amide or together with a phenol, or a non-resinous
condensation product of formaldehyde and urea, and
- 15 b) a sugar or a sugar derivative or their by-products or a starch or a mixture thereof, and/or 15
c) a raw and/or treated lignosulfonate or similar products.
- The aldehyde is preferably formaldehyde, for example in the form of paraformaldehyde, or
acetaldehyde. The amide is preferably mainly urea or thiourea or their homologues or melamine,
benzoguanamine or dicyandiamide or their homologues. The phenol is preferably phenol itself or
20 resorcinol. 20
- Among the sugars, sugar derivatives, their by-products and mixtures thereof, molasses, dex-
trose, glucose, fructose or sucrose or mixtures thereof such as corn syrup are most preferred.
Among the starches, wheat starch, modified starches, dextrin and the like are interesting.
- Examples of raw lignosulfonates are black liquor and similar products, and examples of treated
25 lignosulfonates are sodium, calcium and ammonium lignosulfonate. 25
- The substitute of the invention preferably contains 40 to 50% by weight of water.
- The weight of a) to b) and/or c) is preferably 0.1 to 50.0:1, most preferably 1.0 to 15.0:1.
The combination of a) with b) and/or c) presents a synergistic behaviour. If the single compo-
nents are added alone to the resin they do not give good boards, but if they are added in
30 combination, they exhibit an improvement in the board properties obtained. The substitute 30
according to the present invention (calculated as 100% solids) may substitute as much as 30%
of the resin solids used. Said substitute is not added in quantities equal to the quantities
substituted. It is added in quantities from 50 to 90% of the amount of resin substituted
(calculations referred to by weight and referring to all products as 100% solids).
- 35 The substrate according to the present invention may therefore, because of its synergistic 35
behaviour, substitute the resin in quantities from 110% up to 200% of its own weight. When
added to lower amounts e.g. up to 15% there is a considerable increase in the properties of the
end product. When added to higher levels, i.e. up to 30%, no difference is imparted to the
properties of the end product but the free formaldehyde is considerably reduced and the amount
40 of resin saved is considerably increased. 40
- Bonding is effected by curing the resin mixture at elevated temperatures and pressures accord-
ing to the methods well known in the art. The substitute may be used in all types of products
where amino and phenolic resins are used for bonding lignocellulosic products, whether these
are wood particles for particleboard production using a flat press, or a calender or wood veneers
45 such as in plywood production. 45
- It is very interesting to note that the product has also good tack. This property otherwise
called "green strength" is desired in some types of particleboard plants, specially the plants
with multi opening press and in plywood factories, specially those having a pre-press.
- The quality of boards produced was controlled weekly for a period of six months and no
50 reduction in the properties was observed. This proves that no polymer degradation occurs and 50
that the ageing properties of the boards are comparable to the ones normally produced.
- The substitute of the invention can be prepared by plain mixing of the components. In order
to obtain an acceptable shelf-life of the substitute, a base is preferably added to adjust the pH
to a value in the range of 6 to 14.
- 55 Substitutes so far known in the art to substitute resin have not succeeded in substituting such 55
high levels of resin by using lower amounts of the substitute and reducing simultaneously the
free formaldehyde of the boards, without imparting any loss in bonding strength, without requir-
ing any extra steps in the production, without changing the curing rate of the production, without
causing any problems to the boilers when burning particleboard sander dust or edges from
60 cutting saws and without reducing the tack of the resin mixture. 60
- In particular, the known substituents are lignosulfonates, sodium chloride or mixtures of formal-
dehyde with urea and sodium chloride. It is well known that lignosulfonates may not be used for
quantities higher than 10%; otherwise, board properties will be reduced.
- It is also known that the addition of halide salt alone succeeds in substituting part of the resin
65 with the following limitations: 65

–High substitutions, higher than 6 to 8%, may not be obtained, otherwise the board properties will deteriorate.

–Substitution is obtained in ratios 1:1, while in the case of the substitute according to the present invention it is 1.1 to 2.0:1.

5 –When particleboard sander dust or edges from cutting saws are burnt in boilers, the latter are plugged within a few hours. 5

–Tack is reduced when sodium chloride is added to the resin mixtures.

When mixtures of sodium chloride with urea and formaldehyde are used the following shortcomings are present:

10 –The presence of salt in the mixture causes severe problems in the boilers when sander dust or cutting saw edges of boards are burnt. That is caused because the presence of salt reduces the melting point of the mixture and as a result a molten mass deposits in the boiler forming a glass like deposit which adheres on the boiler thus plugging it. 10

The other shortcoming of this product is the fact that tack is severely reduced, thus making it difficult to use in the plywood industry where there is a pre-press and in particleboard plants where a multi opening press is present requiring green strength of the mat. 15

The product according to the present invention overcomes all of the above shortcomings.

The substitute according to the present invention provides yet another advantage. Apart from substituting up to 30% of the resin by adding only 50 to 90% of the resin solids substituted, and reducing the free formaldehyde of boards, it reduces also the free formaldehyde in the production hall where workers are exposed to formaldehyde fumes. 20

The following Examples illustrate the invention and are not intended as limitations.

Example 1

25 Three samples were prepared according to the following formulations: 25

Sample No.	1	2	3	
	parts by weight			
Formaldehyde 100%	185	–	133	
30 Urea 100%	370	–	226	30
Molasses 100%	–	555	156	
Water	445	445	445	
	1000	1000	1000	

35 35

The above mentioned samples were prepared by plain mixing at room temperature until the solids were completely dissolved. The pH of the final products was adjusted to 7.5 to 8.0.

Glue formulations were then prepared as follows:

Glue formulation No.	0	1	2	3	
	parts by weight				
Urea formaldehyde resin (65% solids)	108.9	81.7	81.7	81.7	
Water	13.8	13.8	13.8	13.8	
45 Sample 1	–	27.2	–	–	45
Sample 2	–	–	27.2	–	
Sample 3	–	–	–	27.2	
Ammonium chloride (20%)	7.1	7.1	7.1	7.1	

50 No. 0: Glue formulation is the blank and does not include any of the above mentioned samples. 50

No. 1: Glue formulation includes sample 1, whereby only formaldehyde and urea are included.

No. 2: Glue formulation includes sample 2 whereby only molasses are included.

No. 3: Glue formulation includes sample 3 whereby all three ingredients are added, namely, formaldehyde, urea and molasses. Sample 3 represents the product according to the present invention. 55

These glue formulations were used separately to spray a constant quantity of dried wood chips.

The sprayed wood chips were then formed into a mat having a normal thickness of 16mm.

60 These mats were then introduced into a hot press and boards were pressed at the following conditions: 60

Press temperature 200°C

Press time 9sec/mm

Pressure 33kp/cm²

65 Boards were then tested and the results are reported in the following table. 65

Glue formulation No.	0	1	2	3	
Density (kg/m ³)	582	591	583	582	
Thickness (mm)	15.4	15.2	15.5	15.4	
5 Internal bond (kg/cm ²)	7.1	6.5	5.0	7.2	5
2 hrs thickness swelling (%)	11.1	11.3	17.5	12.1	
24 hrs thickness swelling (%)	20.3	22.5	30.3	22.3	
Free formaldehyde (mg/100g dry board)	24.1	18.3	21.8	18.7	
10 Moisture content (%)	5.5	5.0	5.4	5.0	10

It can be noticed from the above mentioned table that while all three samples reduce the free formaldehyde of boards, only sample 3 including the components according to the present invention gives boards equivalent to the blank, without deterioration of the board properties.

15 *Example 2* 15

This example proves the synergistic behaviour existing between formaldehyde, urea and lignosulfonates.

For this purpose the following samples were prepared:

Sample No.	1	2	3	
	parts by weight			
Formaldehyde (100%)	185	—	133	
Urea (100%)	370	—	266	
25 Calcium lignosulfonate (100%)	—	555	156	25
Water	445	445	445	
	1000	1000	1000	

30 The above mentioned samples were prepared by plain mixing at room temperature until the solids were completely dissolved. The pH of the final products was adjusted to 7.5 to 8.0. 30
Glue formulations were then prepared as follows:

Glue formulation No.	0	1	2	3	
35	parts by weight				35
Urea formaldehyde resin (65% solids)	108.9	81.7	81.7	81.7	
Water	13.8	13.8	13.8	13.8	
Sample 1	—	27.2	—	—	
40 Sample 2	—	—	27.2	—	40
Sample 3	—	—	—	27.2	
Ammonium chloride (20%)	7.1	7.1	7.1	7.1	

45 These formulations were used separately to spray a constant quantity of dried wood chips. 45
The sprayed wood chips were then formed into a mat having a nominal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:

Press temperature 200°C
50 Press time 9sec/mm 50
Pressure 33kp/cm²

Boards were then tested and the results are reported in the following table:

Glue formulation No.	0	1	2	3	
55 Density (kg/m ³)	580	591	590	584	55
Thickness (mm)	15.5	15.2	15.0	15.1	
Internal bond (kg/cm ²)	7.0	6.3	5.4	6.9	
2 hrs thickness swelling (%)	11.2	11.3	17.8	11.8	
24 hrs thickness swelling (%)	20.6	22.5	29.5	23.8	
60 Free formaldehyde (mg/100g dry board)	23.9	19.8	18.5	17.8	60
Moisture content (%)	5.8	5.0	4.5	4.8	

65 It will be noticed from the above mentioned figures that boards produced with plane lignosulfonates, sample 2, have the worst results. Boards obtained with all three components according 65

to out present invention, sample 3, have the best results. Actually boards of sample 3 are equivalent to the blank, 0, which is the resin mixture without any substitute, while giving at the same time a reduction in the free formaldehyde of the boards.

5 Example 3

In this example two samples are illustrated whereby the ratio of formaldehyde to urea is different from the one used in the previous examples. Also the weight ratio between components a) and b) is different from the one of examples 1 and 2.

The following samples were prepared:

Sample No.	1	2
	parts by weight	
Formaldehyde (100%)	133	133
Urea (100%)	177	177
15 Molasses (100%)	156	—
Dextrin glue (100%)	30	—
Calcium lignosulfonate (100%)	—	186
Water	504	504
20	1000	1000

The above mentioned samples were prepared by plain mixing at room temperature until the solids were completely dissolved. The pH of the final products was adjusted to 7.5 to 8.0.

Glue formations were then prepared as follows:

Glue formulation No.	0	1	2
	parts by weight		
Urea formaldehyde resin (65% solids)	108.9	87.1	87.1
30 Water	13.8	13.8	13.8
Sample 1	—	21.8	—
Sample 2	—	—	21.8
Ammonium chloride (20%)	7.1	7.1	7.1

35 These glue formations were used separately to spray a constant quantity of dried wood chips. The sprayed wood chips were then formed into a mat having a nominal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:

40 Press temperature 220°C
Press time 9sec/mm
Pressure 33 kp/cm²

Boards were then tested and the results are reported in the following table:

Glue formulation No.	0	1	2
Density (kg/m ³)	573	595	587
Thickness (mm)	15.1	15.4	15.2
Internal bond (kg/cm ²)	8.1	8.7	8.9
2 hrs thickness swelling (%)	10.5	10.0	9.8
50 24 hrs thickness swelling (%)	19.9	19.3	18.7
Free formaldehyde (mg 100g dry board)	46.6	39.2	34.3
Moisture content (%)	5.9	5.3	5.0

55 It can be noticed from the above mentioned table that samples 1 and 2 including the substitute according to the present invention give boards equivalent to the blank, sample 0, while giving a significant free formaldehyde reduction and resin saving.

Example 4

60 This is a laboratory test for plywood using a phenolic resin. The following samples were prepared:

Sample No.	1	2	
	parts by weight		
5 Phenol (100%)	180	200	
5 Formaldehyde (100%)	80	100	5
Molasses (100%)	120	180	
Ammonium lignosulfonate (100%)	200	–	
Water	420	520	
10 Total	1000	1000	10

The samples were prepared by plain mixing at room temperature until the solids were completely dissolved. The pH of final products was brought to 10.0 by means of addition of sodium hydroxide. 15

These samples were used in a glue formation as follows:

Glue formulation No.	0	1	2	
	parts by weight			
20 Phenol formaldehyde glue (100%)	100	80	80	20
Hardener (calcium carbonate: wheat flour – weight ratio 50:50)	60	60	60	
Water	107	90	90	
Sample 1	–	30.77	–	
25 Sample 2	–	–	30.77	25
Wheat flour	–	–	10	
Total	267	260.77	270.77	
30 Viscosity (mPa.s)	1200	1300	1100	30

The above mentioned glue formations were used to spread both sides of the core veneer for 3 ply boards.

Boards were then introduced in a cold press where they were pressed under the following conditions:

35

Press time 8 minutes

Pressure 10kp/cm²

All boards gave very good tack properties.

They were then pressed in a hot press under the following conditions:

40

Press temperature 130°C

Press time 3.5 minutes

Pressure 12kp/cm²

These boards were tested as follows:

45 They were immersed for 24 hours in water at 60°C. After this they were introduced in water at 20°C for one hour and then the knife test was carried out. 45

Results were as follows:

Glue formulation No.	0	1	2	
50 Grading	10/10	10/10	10/10	50

The knife test is carried out as follows:

Plywood samples are placed in water under pressure for 30 minutes and then in vacuum for another 30 minutes. Samples are then scraped with a knife on the surface until the top veneer comes off and the core shows up. The grading depends on the amount of fibers showing in the core after the top veneer was scraped off. 55

When gluing is satisfactory, the surface that appears after scraping with the knife must still be covered with fibers. When it is completely covered with fibers grading is 10 (excellent). As more clean spots appear and less fibers, grading is diminished. A grading of 8 is still satisfactory, and it means that the surface is mainly covered with fibers with only a few clean spots appearing. Lower grading is unsatisfactory. 60

Example 5

Two samples were prepared according to the following formulations:

Sample No.	1	2	
	parts by weight		
5	Formaldehyde (100%)	100	140
	Urea (100%)	140	190
	Melamine (100%)	100	110
	Molasses (100%)	—	110
	Ammonium lignosulfonate (100%)	150	—
	Water	510	450
10	Total	1000	1000

The above mentioned samples were prepared by plain mixing at 25 to 30°C until the solids were completely dissolved. The pH of the final products was adjusted to 8.5 to 10.0.

15 Glue formulations were then prepared as follows: 15

Glue formulation No.	0	1	2	
	parts by weight			
20	Kauramin 535 (63% solids)	108	92	92
	Hardener (1)	14.8	14.8	14.8
	Formic acid (20%)	4	4	4
	Paraffin emulsion	5.5	5.5	5.5
	Sample 1	—	16	—
	Sample 2	—	—	16
25	Water	13	13	13

30	(1) The Hardener solution was:	hot water	462	
		urea	384	
		ammonium chloride	154	
		Total	1000	

35 These glue formulations were used separately to spray a constant quantity of dried wood chips with 12% dry glue/dry wood. 35

The sprayed wood chips were then formed into a mat having a normal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:

40 Press temperature 200°C 40
 Press time 10sec/mm
 Pressure 35kp/cm²

45 Boards were then tested and the results are reported in the following table. 45

Glue formulation No.	0	1	2	
	Density (kg/m ³)	686	687	685
	Thickness (mm)	15.9	15.7	15.7
	Internal bond (kg/cm ²)	6.6	6.5	6.4
50	2 hrs thickness swelling (%)	3.2	3.2	2.9
	24 hrs thickness swelling (%)	9.2	9.0	8.5
	V-100 (kg/cm ²)	1.6	1.5	1.6

The V-100 test is carried out as follows:

55 The samples to be tested are placed in water at 20 ± 5°C. This water is warmed up in 1 to 2 hours to 100°C. The water temperature is kept at 100°C for 2 hours. It is important that there is a space of at least 15mm on all sides of every sample so as to make sure that water is freely introduced in the samples. The samples are then introduced for at least 1 hour in a refrigerator at 2 ± 5°C. Water is then allowed to drip and the wet samples are tested again for internal bond. 60

Example 6

The following example will illustrate the fact that products according to our present invention may be produced by means of a variety of raw materials.

65 Samples were prepared according to the following formulations: 65

	Sample No.	1	2	3		
		parts by weight				
	Paraformaldehyde	350	—	—		
5	Precondensate 80% (1)	—	50	—	5	
	Acetaldehyde 100%	—	—	130		
	Urea 100%	150	12	200		
	Sucrose 100%	50	100	—		
	Molasses 100%	50	150	—		
10	Ammonium lignosulfate 100%	—	230	210	10	
	Dextrin 100%	—	40	—		
	Water	400	418	460		
15	(1) Precondensate containing 53 parts by weight of formaldehyde, 27 parts by weight of urea and 20 parts by weight of water				15	
	The above mentioned samples were prepared by plain mixing until the solids were completely dissolved. The pH of the final products was adjusted to 7.5 to 8.0. Glue formulations were then prepared as follows:					
20	Glue formulation No.	0	1	2	3	20
		parts by weight				
	Urea formaldehyde resin (65% solids)	108.9	93	93	93	
	Water	13.8	13.8	13.8	13.8	
25	Sample 1	—	15.9	—	—	25
	Sample 2	—	—	15.9	—	
	Sample 3	—	—	—	15.9	
	Ammonium chloride (20%)	7.1	7.1	7.1	7.1	
30	These glue formulations were used separately to spray a constant quantity of dried wood chips.					30
	The sprayed wood chips were then formed into a mat having a normal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:					
35	Press temperature 200°C					35
	Press time 9sec/mm					
	Pressure 33kp/cm ²					
	Boards were then tested and the results are reported in the following table:					
40	Glue formulation No.	0	1	2	3	40
	Density (kg/m ³)	600	610	590	580	
	Thickness (mm)	15.8	15.9	15.7	15.6	
	Internal bond (kg/cm ²)	6.8	6.9	7.1	6.5	
45	2 hrs thickness swelling (%)	10.5	10.3	10.1	9.9	45
	24 hrs thickness swelling (%)	20.1	19.5	19.9	20.3	
	Free formaldehyde	22.3	18.0	16.2	17.1	
	Moisture content (%)	5.7	5.3	5.5	5.6	
50	Boards obtained with all glue formulations are equivalent.					50

Example 7

In this example four samples were prepared according to the following formulations:

Sample No.	1	2	3	4	
	parts by weight				
Formaldehyde	100	100	100	100	
5 Resorcinol	—	50	—	—	5
Thiourea	50	—	—	—	
Urea	140	150	70	70	
Benzoguanamine	—	—	80	—	
Dicyandiamide	—	—	—	80	
10 Wheat starch	—	50	—	—	10
Dextrose	—	—	—	50	
Glucose	—	50	—	—	
Fructose	—	—	50	—	
Modified starch *	50	—	—	—	
15 Corn syrup	60	—	—	—	15
Molasses	—	—	50	100	
Black liquor	—	100	—	—	
Sodium lignosulfonate	100	—	150	100	
Water	500	500	500	500	
20 Total	1000	1000	1000	1000	20

* Starch which has been hydrolysed to give a lower molecular weight and, therefore, a low viscosity

25 The above mentioned samples were prepared by plain mixing at 40 to 50°C until the solids were completely dissolved. The pH of the final products was adjusted to 8.5 to 10.0. Glue formulations were then prepared as follows: 25

Glue formulation No.	0	1	2	3	4	
	parts by weight					
30 Urea formaldehyde resin (65%)	108.9	87.1	87.1	87.1	87.1	30
Water	13.8	13.8	13.8	13.8	13.8	
Sample 1	—	21.8	—	—	—	
35 Sample 2	—	—	21.8	—	—	35
Sample 3	—	—	—	21.8	—	
Sample 4	—	—	—	—	21.8	
Ammonium chloride (20%)	7.1	7.1	7.1	7.1	7.1	

40 These glue formulations were used separately to spray a constant quantity of dried wood chips. 40

The sprayed wood chips were then formed into a mat having a nominal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:

45 Press temperature 200°C 45
Press time 9sec/mm
Pressure 33kp/cm²

Boards were then tested and the results are reported in the following table:

Glue formulation No.	0	1	2	3	4	
Density (kg/m ³)	625	617	633	631	628	50
Thickness (mm)	15.9	15.8	16.0	16.2	16.0	
Internal bond (kg/cm ²)	7.0	6.9	7.1	7.2	6.8	
55 2 hrs thickn. swelling %	12.5	12.1	13.6	13.1	12.6	55
24 hrs thickn. swelling %	22.5	20.7	24.7	24.0	20.9	
Free formaldehyde (mg/100g dry board)	28.8	22.5	21.7	23.0	21.9	
60 Moisture content %	6.1	5.7	5.9	5.9	6.2	60

It can be noticed from the above mentioned table that samples 1 to 4 including the substitute according to the present invention give boards equivalent to the blank, sample 0, while giving a significant free formaldehyde reduction and resin saving.

Three samples were prepared according to the following formulations:

Sample No.	1	2	3	
	parts by weight			
5 Formaldehyde 100%	135	135	135	5
Urea 100%	365	365	365	
Sucrose 100%	10	—	—	
Molasses 100%	—	10	—	
Calcium lignosulfonate (100%)	—	—	10	
10 Water	490	490	490	10
Total	1000	1000	1000	

The above mentioned samples were prepared by plain mixing at 25 to 30°C until the solids were completely dissolved. The pH of the final products was adjusted to 8.5 to 10.0.

Glue formulations were then prepared as follows:

Glue formulation No.	0	1	2	3	
	parts by weight				
20 Urea formaldehyde resin (65% solids)	108.9	95.9	95.9	95.9	20
Water	13.8	13.8	13.8	13.8	
Sample 1	—	13	—	—	25
Sample 2	—	—	13	—	
25 Sample 3	—	—	—	13	
Ammonium chloride (20% solution in water)	7.1	7.1	7.1	7.1	

These glue formulations were used separately to spray a constant quantity of dried wood chips.

The sprayed wood chips were then formed into a mat having a nominal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions:

35 Press temperature 200°C
Press time 8sec/mm
Pressure 35kp/cm²

Boards were then tested and the results are reported in the following table:

Glue formulation No.	0	1	2	3	
Density (kg/m ³)	575	582	579	6601	40
Thickness (mm)	15.4	15.3	15.5	15.4	
Internal Bond (kg/cm ²)	8.3	8.7	8.9	9.5	
2 hrs thickness swelling (%)	10.3	10.8	10.6	11.1	
45 24 hrs thickness swelling (%)	20.2	21.3	20.9	21.9	45
Free formaldehyde (mg/100g dry board)	60.5	39.8	41.3	38.1	
Moisture content (%)	6.0	7.1	6.8	6.5	

50 Boards obtained with all glue formulations are equivalent. Those however that include the substitute according to the present invention have lower free formaldehyde.

Example 9

Three examples were prepared according to the following formulations:

Sample No.	1	2	3	
	parts by weight			
Formaldehyde 100%	85	85	85	
5 Urea 100%	400	400	400	5
Sucrose 100%	32.3	—	—	
Molasses 100%	—	32.3	—	
Calcium lignosulfonate (100%)	—	—	32.3	
Water	482.7	482.7	482.7	
10 Total	1000	1000	1000	10

The above mentioned samples were prepared by plain mixing at 25 to 30°C until the solids were completely dissolved. The pH of the final products was adjusted to 8.5 to 10.0.

15 Glue formulations were then prepared as follows: 15

Glue formulation No.	0	1	2	3	
	parts by weight				
Urea formaldehyde resin (65% solids)	108.9	81.7	81.7	81.7	20
Water	13.8	13.8	3.8	13.8	
Sample 1	—	27.2	—	—	
Sample 2	—	—	27.2	—	
Sample 3	—	—	—	27.2	
25 Ammonium chloride (20% solution in water)	7.1	7.1	7.1	7.1	25

These glue formulations were used separately to spray a constant quantity of dried wood chips.

30 The sprayed wood chips were then formed into a mat having a nominal thickness of 16mm. These mats were then introduced into a hot press and boards were pressed at the following conditions: 30

Press temperature 200°C
35 Press time 8sec/mm 35
Pressure 35kp/cm²

Boards were then tested and the results are reported in the following table:

Glue formulation No.	0	1	2	3	
40 Density (kg/m ³)	610	590	597	615	40
Thickness (mm)	15.9	15.7	15.6	15.9	
Internal bond (kg/cm ²)	7.9	8.1	8.3	8.4	
2 hrs. thickness swelling (%)	9.8	10.2	10.5	10.9	
24 hrs. thickness swelling (%)	20.1	21.3	20.9	21.8	
45 Free formaldehyde (mg/100g dry board)	40.1	15.3	17.1	16.3	45
Moisture content (%)	7.9	7.1	7.6	8.0	

Boards obtained with all glue formulations are equivalent. Those however that include the substitute according to the present invention have a very big formaldehyde reduction and resin cost saving. 50

CLAIMS

55 1. A substitute for amino and phenolic resins in the polycondensation of such resins based on formaldehyde for bonding water penetrable cellulosic particles, characterized in that it comprises an aqueous solution of 55

a) either at least one aldehyde together with at least one amide and/or together with at least one phenol, or a non-resinous condensation product of formaldehyde and urea, and

60 b) a sugar or a sugar derivative or their by-products or a starch or its degradation products or a mixture thereof, and/or 60

c) a raw and/or treated lignosulfonate.

2. A substitute according to claim 1, characterized in that it contains 40 to 52% by weight of water.

65 3. A substitute according to claim 1 or 2, characterized in that the weight ratio of a) to b) and/or c) is 0.1 to 50.0:1. 65

4. A substitute according to claim 3, characterized in that the weight ratio of a) to b) and/or c) is 1.0 to 15.0:1.
5. A substitute according to one of claims 1 to 4, characterized in that the aldehyde is formaldehyde or acetaldehyde.
- 5 6. A substitute according to one of claims 1 to 5, characterized in that the amide is urea, thiourea, melamine, benzoguanamine or dicyandiamide. 5
7. A substitute according to one of claims 1 to 5, characterized in that the phenol is phenol itself or resorcinol.
8. A substitute according to one of claims 1 to 7, characterized in that component b) is molasses, dextrose, glucose, fructose, sucrose, corn syrup, wheat starch, modified starch or dextrin glue. 10
9. A substitute according to one of claims 1 to 8, characterized in that component c) is ammonium, sodium or calcium lignosulfonate or black liquor.
- 10 10. A process for preparing a substitute for amino and phenolic resins, characterized by dissolving in water 15
- a) either at least one aldehyde together with at least one amide and/or together with at least one phenol, or a non-resinous condensation product of formaldehyde and urea, and
- b) a sugar or a sugar derivative or their by-products or a starch or its degradation products or a mixture thereof, and/or
- 20 c) a raw and/or treated lignosulfonate. 20
11. A process according to claim 10, characterized by preparing a solution which contains 40 to 52% by weight of water.
12. A process according to claim 10 or 11, characterized in that the weight ratio of a) to b) and/or c) is 0.1 to 50.0:1.
- 25 13. A process according to claim 12, characterized in that the weight ratio of a) to b) and/or c) is 1.0 to 15.0:1. 25
14. A process according to one of claims 10 to 13 characterized in that the aldehyde used is formaldehyde or acetaldehyde.
15. A process according to one of claims 10 to 14, characterized in that the amide used is urea, thiourea, melamine, benzoguanamine or dicyandiamide. 30
- 30 16. A process according to one of claims 10 to 14, characterized in that the phenol itself or resorcinol. 30
17. A process according to one of claims 10 to 16, characterized in that the component b) used as molasses, dextrose, glucose, fructose, sucrose, corn syrup, wheat starch, modified starch or dextrin glue. 35
- 35 18. A process according to one of claims 10 to 17, characterized in that the component c) used is ammonium, sodium or calcium lignosulfonate or black liquor. 35