

SPECIFICATION

Method of making a foundry core or mould, composition for use in and product of the method.**5 Description of Invention:**

FROM A FIRST ASPECT, the present invention relates to a method of producing a foundry mould or core.

- Foundry moulds and cores are commonly prepared by mixing with sand or some other foundry aggregate a binder which comprises hydroxyl groups, a curing agent which comprises a polyisocyanate, forming the mixture to the required shape and permitting or causing the binder to cure by reaction of the polyisocyanate with the hydroxyl groups to form urethane links. The binder may be caused to cure by passing a tertiary amine catalyst through the mixture. Alternatively, a tertiary amine or organo-metallic catalyst may be mixed with the aggregate, binder and curing agent before the mixture is formed to the required shape. Examples of such a method are described in U.K. specification 1,190,644 which discloses the use of a product obtained by the condensation of a phenol with an aldehyde as the binder for reaction with the polyisocyanate. In this condensation product, successive aromatic nuclei are linked by methylene groups or by dimethylene ether links.

- According to the first aspect of the present invention, there is provided a method of producing a foundry core or mould wherein there is mixed with a foundry aggregate a polyhydroxy composition, an organic polyisocyanate and a catalyst for the reaction of the polyhydroxy composition with the polyisocyanate wherein the polyhydroxy composition includes a substituted phenol comprising at least first and second aromatic rings and a hydrocarbon group which forms a bridge between said rings, each of said first and second rings having a phenolic —OH group and one or both said first and second rings having at a position which is ortho relative to the phenolic —OH group at least one —CHR¹—O—R² group wherein R¹ is —H or a hydrocarbon radical and R² is an aliphatic radical comprising from 1 to 10 carbon atoms.

The aromatic rings of the substituted phenol are preferably linked via respective positions which are para to the phenolic —OH groups.

- The substituted phenol is preferably a bisphenol.

- The substituent group or groups ortho to the phenolic OH group of one or both of said first and second aromatic rings is preferably an alkoxymethyl group. The alkyl residue of this group may comprise 1 to 4 carbon atoms.

- The polyhydroxy composition may further comprise a phenolic resin, a bisphenol, an aliphatic polyol or a blown drying oil. Each of these materials comprises hydroxyl groups capable of reacting with polyisocyanates to form urethane links. The polyhydroxy composition may further include an organosilane.

According to a second aspect of the invention,

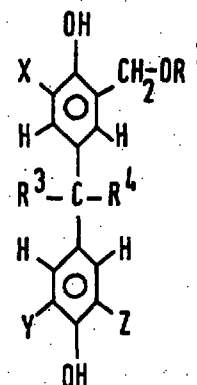
- there is provided a foundry composition comprising a foundry aggregate, a polyhydroxy composition as hereinbefore defined, an organic polyisocyanate and a catalyst for the reaction of the polyhydroxy composition with the polyisocyanate. The foundry composition may further comprise one or more solvents.

The invention also includes a foundry product made by a method in accordance with the invention.

- The catalyst may be a known catalyst for the reaction of an isocyanate with hydroxyl groups. Common catalysts for such reactions are tertiary amines and organo-metallic compounds. The catalyst may be provided in gaseous form or in liquid form, for example as a solution.

The polyisocyanate may have an average functionality somewhat greater than 2 and may be modified, prior to mixing with the polyhydroxy composition, by reaction with a drying oil.

- The substituted phenol is preferably one represented by the formula



where X, Y and Z are independently selected from —H and —CH₂—OR² groups, R² is an aliphatic residue comprising from 1 to 10 carbon atoms and R³ and R⁴ are the same or different alkyl or aryl groups or —H.

- The substituted phenol may be prepared by the condensation with a bisphenol of formaldehyde and an aliphatic mono alcohol comprising from 1 to 10 carbon atoms, preferably from 1 to 4 carbon atoms. The condensation may be carried out in two steps by reacting the bisphenol with formaldehyde and then etherifying the product of this reaction with the alcohol. Alternatively, the reaction may be carried out in a single step by reaction of an alcohol hemiformal with a bisphenol. The mole ratios of reactants are chosen to provide that the alcohol is in excess of the formaldehyde and that from 1 to 4 moles of formaldehyde are present per mole of bisphenol.

- Bisphenol-A is a representative bisphenol which is relatively inexpensive and therefore suitable for use in the preparation of a foundry binder. One example of the preparation from bisphenol-A of a substituted phenol for use in a composition in accordance with the present invention will now be described.

- To a glass reactor fitted with condenser, stirrer and thermometer, is charged 228 g diphenylol

2.

- propane (1 mole), 82.5 g paraformaldehyde (91% formaldehyde content, —2.5 moles) 222 g n-butyl alcohol (3 moles) and sodium hydroxide catalyst 6 g. The reaction mixture is stirred and heated to 5 75°C at which it is maintained for about 3 hours. After 30 minutes a clear solution is obtained. The reaction mixture may be sampled after two hours and at subsequent 10 minute intervals to determine the level of unconverted reactants.
- 10 Typically, after 3 hours the amount of free formaldehyde is reduced to 2% of its starting level. At this point the pH of the batch is adjusted to pH5 by addition of p-toluenesulphonic acid. The temperature is then raised by additional heating
- 15 until refluxing commences. The batch is held at reflux for 1 hour and then 100 g of Xylene is added to the reactor. With the apparatus set for azeotropic distillation, water is continuously removed from the reaction mixture until a total 45
- 20 g (2.5 moles) has been collected. At this point the pH of the mixture is adjusted to 7 by addition of sodium hydroxide and then, with the apparatus set for vacuum distillation, the excess solvents etc., are removed from the product under reduced
- 25 pressure.

The values of pH and temperature indicated in the immediately preceding paragraph are selected to minimise the formation of resinous bi-products and to encourage total etherification of hydroxy methyl groups. The presence of hydroxy methyl

30 groups in the product would impair the performance of the binder. The removal of water from the reaction mixture by azeotropic distillation promotes conversion of the reactants to the

35 required product by displacement of equilibria.

The product is a pale straw coloured viscous liquid and has been analysed by chromatographic and spectroscopic techniques to establish that it is principally a mixture of mono, di and tri n-

40 butoxymethyl derivatives of diphenylol propane. 80 parts of the product was agitated with 20 parts of cyclohexanone at 40°C until the product was completely dissolved to provide a polyhydroxy composition for use as foundry binder. The

45 polyhydroxy composition was then cooled to room temperature.

A polyisocyanate composition was prepared by dissolving 60 parts of a polymeric isocyanate of the polymethylenebisphenyl di-isocyanate type

50 sold by Upjohn chemicals Limited under the designation PAPI in 40 parts of xylene.

A foundry core was prepared by mixing together 25 g of the polyhydroxy composition, 25 g of the polyisocyanate composition and 2.5 kg of

55 Chelford 50 AFS grain fineness sand. The mixing was carried out in a sand muller for 2 minutes. The foundry mixture thus prepared was formed to the required core shape by blowing into a core box. dimethylethylamine catalyst was then passed

60 through the core box in a known manner to cure the binder. It was found that the core had a strength adequate for handling without deformation immediately after gassing with the

catalyst.

- 65 A further core was prepared by mixing together 25 g of the polyhydroxy composition, 25 g of the polyisocyanate composition, 0.25 g pyridine catalyst and 2.5 kg of Chelford 50 sand. The mixing was carried out for 2 minutes in a sand
- 70 muller. The mixture was then manually packed into a foundry core box and allowed to stand. After 5 minutes, it was found that the composition had attained the self-supporting stage and the core thus prepared could be removed from the box
- 75 without risk of deformation.

CLAIMS

1. A method of producing a foundry core or mould wherein there is mixed with a foundry aggregate a polyhydroxy composition, an organic polyisocyanate and a catalyst for the reaction of the polyhydroxy composition with the polyisocyanate and wherein the polyhydroxy composition includes a substituted phenol comprising at least first and second aromatic rings and a hydrocarbon group which forms a bridge between said rings, each of said first and second rings having a phenolic—OH group and one or both said first and second rings having at a position which is ortho relative to the phenolic
- 80 —OH group at least one —CHR¹—O—R² group wherein R¹ is —H or a hydrocarbon radical and R² is an aliphatic radical comprising from 1 to 10 carbon atoms.
2. A method according to claim 1 wherein said
- 95 first and second aromatic rings of the substituted phenol are linked via respective positions which are para to the phenolic —OH groups.
3. A method according to claim 2 wherein the substituted phenol is bisphenol.
- 100 4. A method according to any preceding claim wherein the or each substituent group ortho to the phenolic —OH group of one or both of said first and second aromatic rings is an alkoxy-methyl group.
- 105 5. A method according to any preceding claim wherein the polyhydroxy composition further comprises one or more materials selected from a phenolic resin, a bisphenol, an aliphatic polyol and a blown drying oil.
- 110 6. A foundry composition comprising a foundry aggregate, a polyhydroxy composition, an organic polyisocyanate and a catalyst for the reaction of the polyhydroxy composition with the polyisocyanate wherein the polyhydroxy composition includes a substituted phenol comprising at least first and second aromatic rings and a hydrocarbon group which forms a bridge between said rings, each of said first and second ring having a phenolic —OH group and one or
- 120 both said first and second rings having at a position which is ortho relative to the phenolic —OH group at least one —CHR¹—O—R² group wherein R¹ is —H or a hydrocarbon radical and R² is an aliphatic radical comprising from 1 to 10



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- The values of pH and temperature indicated in the immediately preceding paragraph are selected to minimise the formation of resinous bi-products and to encourage total etherification of hydroxy methyl groups. The presence of hydroxy methyl groups in the product would impair the performance of the binder. The removal of water from the reaction mixture by azeotropic distillation promotes conversion of the reactants to the required product by displacement of equilibria.

- The product is a pale straw coloured viscous liquid and has been analysed by chromatographic and spectroscopic techniques to establish that it is principally a mixture of mono, di and tri n-butoxymethyl derivatives of diphenylol propane. 80 parts of the product was agitated with 20 parts of cyclohexanone at 40°C until the product was completely dissolved to provide a polyhydroxy composition for use as foundry binder. The polyhydroxy composition was then cooled to room temperature.

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2. A method according to claim 1 wherein said first and second aromatic rings of the substituted phenol are linked via respective positions which are para to the phenolic —OH groups.

3. A method according to claim 2 wherein the substituted phenol is bisphenol.

4. A method according to any preceding claim wherein the or each substituent group ortho to the phenolic —OH group of one or both of said first and second aromatic rings is an alkoxy-methyl group.

5. A method according to any preceding claim wherein the polyhydroxy composition further comprises one or more materials selected from a phenolic resin, a bisphenol, an aliphatic polyol and a blown drying oil.

6. A foundry composition comprising a foundry aggregate, a polyhydroxy composition, an organic polyisocyanate and a catalyst for the reaction of the polyhydroxy composition with the polyisocyanate wherein the polyhydroxy composition includes a substituted phenol comprising at least first and second aromatic rings and a hydrocarbon group which forms a bridge between said rings, each of said first and second ring having a phenolic —OH group and one or both said first and second rings having at a position which is ortho relative to the phenolic —OH group at least one —CHR¹—O—R² group wherein R¹ is —H or a hydrocarbon radical and R² is an aliphatic radical comprising from 1 to 10



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carbon atoms.

7. A foundry product made by a method according to any one of claims 1 to 5.

8. A method of preparing a foundry core or mould substantially as herein described with reference to the example.

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