

INTERMEDIATES FOR PREPARATION OF POLYMERIC COMPOSITIONS

This invention concerns a method and materials for the production of a Stable Liquid Intermediate used in the production of improved porous polymeric compositions,
5 particularly, though by no means exclusively, suitable for use in the formation of impact absorbing surfaces for sports or children's play areas, safety tiles, compliant substrates for recreational surfaces and resin bonded stone.

Known such impact absorbing surfaces comprise of particles of natural or synthetic
10 rubber, such as styrene butadiene-rubber (SBR), and ethylene-propylene-diene-monomer-rubber (EPDM) \ for example, adhered together by polyurethane based moisture curing pre-polymer ("binder"). The moisture curing pre-polymer is in such quantity as to coat the surfaces of the particles to cause them to adhere leaving the interstices between the granules void to enable the uncured pre-polymer to come into
15 contact with airborne water.

The composition may be laid to form a sports or play surface or to form a substrate to another surface such as that provided by synthetic turf for example.

20 The compositions are prepared on site immediately before installation by accurately metering out the granules, liquid pre-polymer and, if necessary, thoroughly mixing them prior to laying.

A critical characteristic of impact absorbing safety surfaces is that they have to deform
25 when subjected to an impacting force. The amount of deformation depends on the

surface thickness and the compression modulus of the material. However, the safety surfaces must be of such a thickness that the elastic compression limit is not exceeded.

See Figure 1

- 5 Another critical characteristic of safety surfaces is that they must be strong enough to withstand every-day wear and tear and the overall stress associated with shrinkage. The strength of polymeric compositions is proportional to binder concentration - see Figure 2. However, increasing binder concentration also increases stiffness which diminishes the compositions impact attenuation properties. In practical terms this
- 10 means that the polyurethane concentration – for the wearing course at least – is 15% - 20%.

It is the object of the present invention to provide methods and materials for the production of a Stable Liquid Intermediate used to produce porous polymeric

15 composites that mitigates against the aforementioned disadvantages. This is accomplished by modifying the mechanics of polymerization to produce inherently stronger and more impact absorbing compositions that were hitherto possible.

According to a preferred aspect of the invention there is provided a material and method

20 for producing improved porous polymeric compositions comprising of the following:

Forming a Stable Liquid Intermediate comprising of polyol and/or water and/or acid and/or catalyst for the preparation of improved polymeric compositions by substantially modifying the mechanics of curing.

The polyol of the Stable Liquid Intermediate may be polyester polyol, a polyoxypropylene- or polyoxypropylene-polyoxyethelene polyol or a mixture thereof.

The polyol of the Stable Liquid Intermediate may comprise a polyether polyol or a
5 polyester polyol with a molecular weight from 100 to 9.000, preferably from 1.000 to 6.000, more preferably from 1.500 to 5.000 and especially from 2.000 to 4.000 g/Mol.

The polyol of the Stable Liquid Intermediate may have a functionality from 2 to 5 and preferably from 2 to 3.

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The acid of the Stable Liquid Intermediate may be organic or inorganic acid, preferably a P- or S-containing acid and more preferably phosphoric acid; phosphorous acid; sulphuric acid; an ester or mixtures thereof.

15 Stable Liquid Intermediate may be a reaction product of the polyol and the acid.

Stable Liquid Intermediate may be produced by reacting the polyol with 1.0% to 40.0% by weight preferably 3.0% to 20.0% by weight with the acid component at temperatures between 10.0°C and 40.0°C and more preferably at ambient temperatures.

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Stable Liquid Intermediate may be a solution of at least one acid ester, a polyol and water.

Stable Liquid Intermediate may contain catalyst and/or additives such as a pigment.

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Stable Liquid Intermediate is mixed with particulate material preferably at temperatures between 10.0°C and 50.0°C and more preferably at ambient temperatures to form a Stable Granulate Intermediate.

- 5 The invention will be further apparent from the following description, reference being made to Table 7, which concerns, by way of example only, the formation of a Stable Liquid Intermediate and its employment in the process of manufacturing an improved polymeric composition used in the installation of a recreational surface in accordance with one method thereof.

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A Stable Liquid Intermediate is formed by mixing phosphoric acid and polyether based polyol – see # 5 of Table 7.

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A Stable Granulate Intermediate is formed by mixing Stable Liquid Intermediate (2% by weight) with rubber granules size 1- 4 mm (98% by weight) - Table 8 #1.

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The Stable Granulate Intermediate (88% by weight) is mixed with moisture curing polyurethane based pre-polymer (12% by weight) to form an uncured non-coherent mass. In general, the concentration of the binder in the uncured non-coherent mass is 5<20% (by weight).

The uncured non-coherent mass is applied to a stable sub-base and allowed to cure.

Again by way of example, a Stable Liquid Intermediate is formed by mixing phosphoric acid water and polyether based polyol - #4 Table 7.

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A Stable Granulate Intermediate is formed by mixing Stable Liquid Intermediate with rubber granules size 1- 4 mm – #1 Table 8.

- 5 The Stable Granulate Intermediate (95% by weight) is mixed with moisture curing polyurethane based pre-polymer (5% by weight). In general, the concentration of the binder in the uncured non-coherent mass is $2 < 10\%$ (by weight).

An appropriate quantity of the mixture is transferred to a tile press.

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Heat and pressure is applied to the mixture to cause partial curing.

The tile so formed is de-moulded and allow to fully cure.

- 15 Again by way of example, Stable Liquid Intermediate (2%) is mixed with rubber granules (12%) at a manufacturing location to form Stable Granulate Intermediate.

Stable Granulate Intermediate is transported to site and mixed with a moisture curing polyurethane based pre-polymer to form an uncured non-coherent mass.

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The uncured non-coherent mass is applied to a stable sub-base and allowed to cure.

In order to explain the uniqueness of the invention experimental results will be hereinafter reported.

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Test tiles comprising of Stable Liquid Intermediate (2%) and moisture curing pre-polymer (12%) – #5 Table 7 were fabricated as herein described and compared with tiles comprising of the identical moisture curing pre-polymer at 14%; 16% and 18% binder concentration. The tiles were allowed to cure for seven days. Thereafter the
5 determinations of Ultimate Tensile Strength and % Elongation to Break were performed on each sample. See Figure 3.

Figure 4 shows that tiles comprising of Stable Liquid Intermediate (2%) and moisture curing pre-polymer (12%) had a tensile strength equivalent to a conventional tile
10 comprising of rubber granules bound together with >20% binder. Moreover, the Deformation Coefficient (% Elongation to Break / UTS) was almost double that of the conventional tile of similar tensile strength. See Figure 5

It will be observed that the % Elongation to Break could not be achieved by a
15 conventional porous polymeric composition. See Figure 6

This means that porous polymeric safety surfaces and tiles incorporating the Stable Liquid Intermediate herein described will deform under impact considerably more than conventional porous composites, thus absorbing far more impact energy yet still be
20 stronger than safety surfaces comprising of conventional polymeric porous compositions.

Moreover, material costs of porous polymeric compositions herein described are considerably less than those associated with conventional porous polymeric
25 compositions of similar Ultimate Tensile Strength and achieve % Elongation to Break

performance that is not achievable employing conventional porous polymeric technology.

- It will be appreciated that it is not intended to limit the invention to the
- 5 aforementioned examples only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof as defined by the appended claims. Figure 7 defines the possible permissible combinations of generic components of the Stable Liquid Intermediate.

Claims

1. Stable Liquid Intermediate, comprising of a polyol and/or an acid and/or catalyst and/or water for the preparation of polymeric compositions

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2. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol; acid; catalyst and water.

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3. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol; acid and water.

4. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol, catalyst and water.

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5. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol and water.

6. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol; acid and catalyst.

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7. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol and catalyst.

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8. Stable Liquid Intermediate, according to Claim 1 wherein the Stable Liquid Intermediate comprises of a polyol and acid.

9. A Stable Liquid Intermediate according to any of the preceding claims wherein the polyol is polyester polyol, a polyoxypropylene- or polyoxypropylene-polyoxyethelene polyol or a mixture thereof.

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10. A Stable Liquid Intermediate according to any of the preceding claims wherein the polyol comprises a polyether polyol or a polyester polyol with a molecular weight from 100 to 9.000, preferably from 1.000 to 6.000, more preferably from 1.500 to 5.000 and especially from 2.000 to 4.000 g/Mol.

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11. Stable Liquid Intermediate according to any of the preceding claims wherein the polyol has a functionality from 2 to 5 and preferably from 2 to 3.

12. Stable Liquid Intermediate according to any of Claims 1; 2; 3; 6 and 8 wherein the acid is organic or inorganic acid, preferably a P- or S-containing acid and more preferably phosphoric acid, phosphorous acid, sulphuric acid, an ester thereof or mixtures thereof.

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13. Stable Liquid Intermediate according to any of the preceding claims, wherein it is a reaction product of the polyol and the acid.

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14. Stable Liquid Intermediate according to any of the preceding claims, wherein it is a reaction product of the polyol with 1.0% to 40.0% by weight, preferably 3.0% to 20.0% by weight, with the acid component at temperatures between 10.0°C and 40.0°C and more preferably at ambient temperatures.

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15. Stable Liquid Intermediate according to any of the preceding claims wherein there is a solution of at least one acid ester, a polyol and water.
- 5 16. Stable Liquid Intermediate according to any of the preceding claims that contains catalyst and/or additives such as a pigment.
17. Stable Liquid Intermediate according to any of the preceding claims is mixed with particulate material preferably at temperatures between 10.0°C and 50.0°C and more preferably at ambient temperatures to form a Stable Granulate Intermediate.
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18. Method of use wherein Stable Liquid Intermediate is mixed with rubber granules based on butadiene-rubber (BR), styrene butadiene-rubber (SBR), isoprene-rubber (IR), styrene-isoprenbutadiene-rubber (SIBR), acrylonitrilbutadiene-rubber (NBR), chloroprene-rubber (CR), isobutene-isoprene-rubber (IIR), ethylene-propylene-diene-monomer-rubber (EPDM) and natural rubber (NR), vulcanized thermoplastic (TPV) or mixtures thereof, and preferably a recycling material.
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19. Method of use according to Claim 18 wherein a Stable Liquid Intermediate of one of the claims 1 to 16 is mixed with non-elastomeric particulate material such as pea-gravel or re-cycled glass granules.
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20. Method of use wherein the particulate material of particle size <0.5mm to 200 mm.
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21. Method of use according to any of the claims 18 – 20 wherein polymeric compositions are formed by mixing Stable Granulate Intermediate, which comprises of Stable Liquid Intermediate and particulate material, with polyurethane based binder, and allowing the mixture to set.
22. Method according to one of the claims 18 to 21 wherein the Stable Granulate Intermediate is formed at a central location and shipped to site or formed on-site immediately prior to installation.
23. Method of use according to one of the claims 18 to 22, wherein setting occurs in the presence of water to form a coherent mass
24. Method of use according to one of the claims 18 to 23 wherein the binder is moisture curing polyurethane based pre-polymer or an isocyanate with a functionality > 1.5.
25. Method of use according to one of the claims 18 to 24 wherein the binder is an aromatic pre-polymer based on MDI, TDI or a mixture thereof, or an aliphatic pre-polymer either of which may be based on polyether or polyester polyol.
26. Method of use according to one of the claims 18 to 25 wherein the binder concentration according to Claims 21 to 25 is 2% to 30% by weight.

27. Method of use according to one of the claims 18 to 26 wherein the mixture of Stable Granulate Intermediate and binder is laid on a prepared sub-base and cures to form a coherent mass that can be used as a children's playground, a running track or a sports hall floor.

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28. Method of use according to one of the claim 27 wherein the compliant coherent mass can be used as an under layer, interface layer or a base layer for artificial turf or floors, or is a moulded article or in combination with mineralic components is a stone-blended polymeric mortar floor.

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