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(54) **Material for the construction of caskets and coffins**

(57) A casket or coffin for the burial or cremation of human remains, comprises a container and a lid made of a cellular thermosetting polyurethane resin having at least one filler so as to produce a degradable rigid or semi-rigid material and/or a rigid or semi-rigid material having controlled combustibility and thus controlled smoke emission. The filler is suitably starch.

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SPECIFICATION

A casket for the burial or cremation of human remains

The present invention concerns the manufacture of materials comprising a thermosetting polyurethane resin and at least one filler which improves the degradable nature of the resultant material, and/or controls the combustability and thus the smoke emission properties thereof. More particularly, the invention concerns the manufacture of burial caskets, that is those containers used for the interment or cremation of human bodies or remains, which go under the general description of caskets or coffins.

Hitherto caskets or coffins have been made of wood which is a costly material and the labour involved in working such results in coffins being particularly expensive. Furthermore, wood is scarse and difficult to obtain in some regions. Production of caskets or coffins from synthetic materials by injection moulding of thermoplastics materials has been discounted because of the high pressures involved and the size and very expensive nature of the injection moulding machines required for such and because of the expensive and unsatisfactory nature of the resultant material for burial or cremation purposes. Coffins have been made from glass-reinforced-plastics (GRP) material but have been considered unsuitable because such do not rot in the earth and result in issuance of considerable smoke when being burnt.

Moreover, heretofore, the rendering of thermosetting resins as being degradable has not been contemplated, in view of the fact that thermosetting resins are generally required to be strong, corrosion-resistant and non-degradable.

Unexpectedly, it has now been discovered that thermosetting polyurethane resins can be rendered degradable, and/or the combustability and thus the smoke emission properties thereof controlled, by incorporation into the resin of at least one filler material which can break down, over a period of time, the polymer chains by biodegradable or physio-degradable means and/or control the smoke emission properties, which is particularly relevant in crematoriums.

According to the present invention there is provided a casket or coffin for the burial or cremation of human remains, comprising a container and a lid made of a cellular thermosetting polyurethane resin having at least one filler so as to produce a degradable rigid or semi-rigid material and/or a rigid or semi-rigid material having controlled smoke emission.

In accordance with an embodiment of the invention there is provided a casket or coffin comprising a container and lid made of a cellular thermosetting polyurethane resin having starch as a filler so as to produce a bio-degradable rigid or semi-rigid material.

In a further embodiment of the invention there is provided a casket or coffin comprising a container and lid made of a cellular thermosetting polyurethane resin having wood flour as a filler so as to produce a physio-degradable rigid or semi-rigid material or a rigid or semi-rigid material having controlled combustability and thus controlled smoke emission.

The process of the invention comprises a process for producing a coffin or casket comprising forming a cellular thermosetting polyurethane resin by the reaction of a di- or poly-isocyanate with a di- or poly-functional alcohol concurrently with a gas evolution process coupled with dosed introduction of one or more filler materials and utilising a reaction injection moulding machine, the mixture being fed, under pressure, into the mould cavity in the shape of a casket or coffin, and allowing the mixture to set and solidify to form the moulded article.

In its broadest aspect the invention provides a rigid or semi-rigid material comprising a cellular thermosetting polyurethane resin and at least one filler which improves the degradable nature of the resultant material and/or controls the smoke emission properties thereof.

The caskets or coffins are fabricated from a cellular synthetic thermosetting polyurethane resin material which acts as a binder for various organic and inorganic materials such as starch, chalk, talc, carbon black, wood flour, paper products, powdered polyurethane foam, pigments, continuous or discontinuous glass fibres and particulate fillers, continuous or discontinuous synthetic organic and inorganic fibres, mineral fillers and fillers which are used to increase combustion. A starch filler has been found to be particularly favourable to assist in the biodegradation process as described in more detail hereinafter. Wood flour has been found to be advantageous in the physio-degradation process or for controlling the smoke emission properties.

The binder is a cellular thermosetting polyurethane resin (that is, a resin with a density lower than that of the solid resin) preferably produced by the reaction of a di- or poly-isocyanate with a di- or poly-functional alcohol. The isocyanate is usually tolylene diisocyanate or 4,4'-diphenylmethane diisocyanate (MDI) although other similar substances may be used. The alcohols used include hydroxyl ended polypropylene oxides as well as hydroxyl ended polyesters, polytetramethylene oxides and short chain alcohols such as butane-1,4-diol and trimethylol propane.

Other resins which may be used as those described in U.S. Patents 3485797 and 3676392 which involve the use of a polybenzylic-ether phenolic resin system, a polyphenyl polyisocyanate and a pyridine type or tertiary amine type catalyst. These systems as described in the above patents contain excess solvent but this can be reduced to give materials with viscosities suitable for processing by means of the reaction injection moulding equipment to be described hereinafter. Conventional MDI isocyanates can be used and a blowing agent added to the components to give a foamed

system. The U.S. Patents mentioned above do not include the use of blowing agents or the formation of a foamed product but suitable blowing agents would be used to produce a material or coffin in accordance with the present invention.

The cellular thermosetting polyurethane resin is produced by forming a polyurethane based polymer concurrently with a gas evolution process. When the two processes are balanced bubbles of gas are trapped in the polymer matrix as it is formed and a cellular product results. The degree of chemical cross linking can be controlled to give products of various degrees of rigidity and by suitable chemical modification the foam can have a varying open and closed cell content.

Catalysts are used in the polyurethane foaming reaction and are usually tertiary amines which accelerate the reaction between isocyanate and water or active hydrogen compounds. Organic stannous salts may also be used as catalysts.

Surfactants are also used in the production of the polyurethane foam. These are usually polyglycol silicon polymers and are surface tension depressants with the role of reducing the energy required to form new surfaces, and thus promote bubble formation, and also of equalising surface tension on the surface of a film, imparting resilience to the film and resistance to collapse when distorted during rising of the foam.

The production of the rigid or semi rigid foams used to manufacture caskets utilises a blowing agent. This can be carbon dioxide generated by the isocyanate water reaction which takes place during polymerisation but usually low molecular weight fluorocarbons are used. Trichlorofluoromethane is one such example and is the one most commonly used.

Such rigid or semi rigid polyurethane foams can be manufactured using the reaction injection moulding process associated with the manufacture of polyurethane foam products and utilising the so called low or high pressure techniques. In these methods the isocyanate and alcohol components, including the various catalysts, surfactants, foaming agent etc., are fed to a mixing head from where the mixture is fed into a mould in which it polymerises during foaming and sets to give a product which conforms to the dimensions of the mould. Using this manufacturing technique and with control of process variables such as reactant temperature and mould temperature a product with a solid integral skin and a foamed core can be obtained, the density of the core depending upon the amount of polyurethane introduced into the mould and/or the amount of foaming agent used. The thickness of the surface skin can be affected by these variables together with the mould surface temperature.

Such technique may be used for the moulding of the previously defined caskets from foamed thermosetting polyurethane resin as a product with an integral solid surface skin and a lower density cellular core and with overall densities which can be in the range from 60 kilogram per cubic metre (60kg/m^3) to 600 kilogram per cubic metre (600kg/m^3).

The foamed product is fabricated with the incorporation of one, or a mixture of one or more, of the filler materials previously described using a reaction injection moulding machine such as those currently available which include in their design a means of introducing the fillers into the material mix preferably at high pressure into a vortex mixing head where they are intimately mixed and fed under pressure to the mould cavity and allowed to set and solidify to form the moulded article. The means of introducing fillers to the mixing head of the machine is often referred to as a dosing unit.

The amount of filler utilised will depend upon the nature of the filler material and the time period over which it is desired that the thermosetting polyurethane resin will completely degrade.

Thus, in the case of a casket or coffin which is to biodegrade in say 25 years, an appropriate amount of starch will be incorporated into the resin prior to moulding. For physio-degradation over a similar time period an appropriate amount of wood flour will be utilised.

It has also been discovered that the amount of smoke emitted when burning a polyurethane resin article can be reduced if wood flour is incorporated therein as a filler. This is particularly relevant in crematoriums where local by-laws govern the amount of smoke which may be emitted. Also materials should not be incorporated in the resin which could chemically deleteriously affect the inside of the chimney in a crematorium.

The fillers can be incorporated into the foamed product to achieve specific properties, at loadings of up to 60 parts by weight with a minimum of about 10 parts by weight. For example: glass fibres or synthetic organic and inorganic fibres may be incorporated to improve the specific strength properties of the casket. When continuous fibres are used these may be laid into a pre-set pattern in the mould before the introduction of the polyurethane mix.

Fillers such as starch, chalk, talc, paper products or powdered polyurethane foam can be used to cheapen the cost of the product and to increase its degradability. Wood flour can be added to increase the moisture absorption of the product, this affecting its degradability. The use of wood flour may also increase the combustion properties of the product. The addition of fillers which increase combustion can be used for caskets intended for cremation purposes. Carbon black and pigments may be added to the foam to effect the colour of the product. The use of fillers will reduce shrinkage and give improved dimensional stability to the product. Also, the use of fillers will tend to give a more even cell structure in the foam and greater susceptibility to degradation. Also, by using lower densities the foams become more susceptible to environmental attack because of the lower film thickness of the cell walls.

The fabrication of the casket may be carried out

in a number of mouldings which may be subsequently assembled together to give a completed casket, or may be made in two mouldings only, one for the casket main body and one for the lid. The utilisation of filler(s) in the thermosetting polyurethane resin enable less costly material to be employed. Also pressures less than would be necessary for thermoplastics materials may be utilised. Thus, the reaction injection moulding apparatus used in the invention is less costly than would be necessary for conventional injection moulding of thermoplastics resins.

The component parts of the casket are removed from the mould by means of existing techniques such as the use of mould release agent. A wood grain finish may be obtained by suitable marking of the mould surface and the moulded product may be stained, if required to an appropriate colour and/or treated with varnish or polish finish.

Another aspect of the present invention is the fact that the lid of the casket is moulded in such a way as to include a groove into which can be inserted a sealing ring made of rubber or synthetic organic material which will effectively seal the casket from the environment. Alternatively, the groove may be included in the top edges of the main body of the casket.

The lid to the casket is attached by conventional means such as by screwing or by the use of hinges.

By incorporating as filler a material such as wood flour into a low density thermosetting polyurethane foam at up to 40% loadings, degradability is ensured. Although the inherently stable polyurethane could normally maintain its integrity for a considerable period of time, the low density at which it will be moulded means that it will have a relatively large pored structure, even the so called solid skin containing micropores. Such a structure over a period of time will be subject to water diffusion through the pores. If unfilled the effect of this water on properties would be very long term. However, the presence of a filler such as wood flour in the solid region of the polyurethane causes continual absorption of moisture, swelling and eventually a physical disintegration of the whole structure. The wood flour may be incorporated in the thermosetting resin in an amount of from 10 to 60 parts by weight.

Solid polyurethanes have been shown to be susceptible to bacterial attack and the use of starch as a filler in a porous or foamed polyurethane accelerates the biodegradability of the material.

The starch acts as a potential major nutrient for some micro-organisms or is decomposed by micro-organism nutrition; these are primary requirements for biodegradation. When starch is used as a filler the starch particles are attacked by enzymes present in the soil, creating deep pits in the matrix, after digestion and removal by the enzymes. The porosity in the polyurethane then offers favourable conditions for biological and oxidated attack by the large enzyme molecules on the resin itself. The breakdown is faster as more surface area becomes available for attack until eventually the resin may be broken down to its water soluble chemical precursors.

The inclusion of both starch and wood flour accelerates the decomposition by a number of mechanisms which are partly chemical (oxidation and hydrolysis) partly physical (stress-cracking due to the wood flour) and partly biological (bacterial and fungal attack).

Furthermore, wood flour can be incorporated into the cellular thermosetting polyurethane resin, preferably in an amount of from 10 to 60 parts by weight, to produce a casket or coffin which can be burnt in a crematorium, the smoke emitted therefrom being within statutory limits.

CLAIMS

1. A casket or coffin for the burial or cremation of human remains, comprising a container and a lid made of a cellular thermosetting polyurethane resin having at least one filler so as to produce a degradable rigid or semi-rigid material and/or a rigid or semi-rigid material having controlled combustibility and thus controlled smoke emission.

2. A casket or coffin as claimed in claim 1, in which the rigid or semi-rigid material is bio-degradable and/or physio-degradable.

3. A casket or coffin as claimed in claim 1 or 2, wherein the cellular polyurethane resin is the reaction product of a di- or poly-isocyanate with a di- or poly-functional alcohol.

4. A casket or coffin as claimed in claim 3, in which the isocyanate is tolylene di-isocyanate or 4,4′ diphenylmethane di-isocyanate.

5. A casket or coffin as claimed in claim 3 or 4, in which the alcohol is a hydroxyl-ended polypropylene oxide or a hydroxyl-ended polyester, polytetramethylene oxide or a short chain alcohol.

6. A casket or coffin as claimed in claim 5, in which the short chain alcohol is butane-1, 4-diol or trimethylol propane.

7. A casket or coffin as claimed in any of claims 1 to 6, in which the filler is starch, talc, carbon black, wood flour, paper products, powdered polyurethane foam, pigments, continuous or discontinuous glass fibres and particulate fillers, continuous or discontinuous synthetic organic and inorganic fibres, or mineral fillers and fillers which are adapted to increase combustion or a combination thereof.

8. A casket or coffin as claimed in any of claims 1 to 7, in which the container and lid are each separately integrally formed.

9. A casket or coffin as claimed in any of claims 1 to 8, wherein a wood-grain finish is provided by suitably marking the surface and/or subsequently colouring and/or varnishing such.

10. A casket or coffin as claimed in any of claims 1 to 9, in which the lid of the container includes a groove in which a sealing ring can be inserted to effectively seal the casket when the lid

is in position.

11. A casket or coffin as claimed in any of claims 1 to 9, wherein a groove is provided in the top edge of the container portion for receiving a sealing ring which seals the coffin when the lid is in position.

12. A casket or coffin as claimed in any of claims 1 to 11, wherein the container and lid are so formed as to have an integral solid surface skin and a lower density cellular core.

13. A casket or coffin as claimed in any of claims 1 to 12, in which the overall densities of the container and lid are from 60 kg/cubic metre to 600 kg/cubic metre.

14. A casket or coffin as claimed in any preceding claim, substantially as hereinbefore described and exemplified.

15. A casket or coffin comprising a container and lid made of a cellular thermosetting polyurethane resin having starch as a filler so as to produce a bio-degradable rigid or semi-rigid material.

16. A casket or coffin as claimed in claim 15, in which the starch is present in an amount of from 10 to 60 parts by weight.

17. A casket or coffin as claimed in claim 15 or 16, substantially as hereinbefore described and exemplified.

18. A casket or coffin comprising a container and lid made of a cellular thermosetting polyurethane resin having wood flour as a filler so as to produce a physio-degradable rigid or semi-rigid material or a rigid or semi-rigid material having controlled combustibility and thus controlled smoke emission.

19. A casket or coffin as claimed in claim 18, in which the wood flour is present in an amount of from 10 to 60 parts by weight.

20. A casket or coffin as claimed in claim 18 or 19, substantially as hereinbefore described and exemplified.

21. A process for producing a coffin or casket comprising forming a cellular thermosetting polyurethane resin by the reaction of a di- or poly-isocyanate with a di- or poly-functional alcohol concurrently with a gas evolution process coupled with dosed introduction of one or more filler materials and utilising a reaction injection moulding machine, the mixture being fed, under pressure, into the mould cavity in the shape of a casket or coffin, and allowing the mixture to set and solidify to form the moulded article.

22. A process as claimed in claim 21, substantially as hereinbefore described.

23. A rigid or semi-rigid material comprising a cellular thermosetting polyurethane resin and at least one filler which improves the degradable nature of the resultant material or controls the combustibility and thus the smoke emission properties thereof.

24. A rigid or semi-rigid material as claimed in claim 23, comprising a cellular thermosetting polyurethane resin and starch to improve the bio-degradable nature of the resultant material.

25. A rigid or semi-rigid material as claimed in claim 23, comprising a cellular thermosetting polyurethane resin and wood flour to improve the physio-degradable nature of the resultant material or controls the combustibility and thus the smoke emission properties thereof.

26. A rigid or semi-rigid material as claimed in claims 23, 24 or 25, substantially as hereinbefore described.

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