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(54) Title: PROCESS FOR PRODUCING A REINFORCED, FOAMED POLYURETHANE PANEL

(57) Abstract

A process for producing an energy absorbing panel having at least one energy absorbing surface in a mold comprising an upper mold and a lower mold. The process comprising placing a reinforcing layer in at least one of the upper mold and the lower mold. A liquid foamable polyurethane composition is then dispensed in the lower mold. The upper mold and lower mold are closed to define an enclosure corresponding substantially to the energy absorbing panel, the liquid foamable polyurethane composition is expanded to fill substantially the enclosure to produce a resilient polyurethane foam core which adheres to the reinforcing layer thereby providing an energy absorbing surface. The reinforcing layer has a tensile strength greater than the tensile strength of the resilient polyurethane foam core. Upon compression of the panel at the energy absorbing surface to about 50 % by volume of the uncompressed panel in a direction substantially normal to the reinforcing layer, the panel recovers to at least about 90 % of volume of the uncompressed panel in less than about 30 minutes. The panel has widespread utility and is particularly useful in vehicular applications.

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PROCESS FOR PRODUCING A REINFORCED, FOAMED POLYURETHANE PANEL

TECHNICAL FIELD

The present invention relates to a process for producing an energy absorbing panel.

BACKGROUND ART

Energy absorbing devices (also known as energy management devices) are known. Such devices can take one of a variety of shapes and forms. Currently, one of the major applications for energy absorbing panels is in use in vehicles, particularly automobiles. Such panels, when used in vehicles, would be of great convenience if they could be included in or substituted for trim panel and, indeed, are commonly referred to as trim panels. Current trim panels are particularly deficient as regards their ability to combine durability with energy absorbing capability.

A common use for energy absorbing panels is in a vehicle instrument panel. An instrument panel typically includes a plastic substrate and a head impact zone. Pursuant to recent governmental guidelines for improved passenger safety, it is now a prerequisite that instrument panels and areas of the interior of the vehicle have an energy management capability.

Heretofore, known instrument panels have comprised the use of a rigid substrate over which is placed a resilient, decorative foam. The foam has an indentation force deflection characteristic of about 1 to 2 pounds per square inch at 25 percent compression of the foam. This amounts to little or no energy absorbing capability for the foam. To make up for this, the substrate must be rigid, typically with a flexural modulus of at least 8,000 MPa. The rigid substrate is usually provided at a thickness of about ⅛ of an inch and is configured to have specific defined impact zones. This is deficient since the areas which are not impact zones are insufficient to absorb the energy of an impact. Rather, in such areas, the energy of impact tends to deflect away from the rigid substrate. In the case of an instrument panel, this can lead to severe or fatal consequences for a passenger of vehicle.

The use of foam in an energy absorbing panel is known. Prior panels typically comprise the use of a friable, crushable foam (e.g. rigid polystyrene, rigid polyurethane and the like). In use, this type of foam absorbs the energy from a single impact and, concurrently, crushes. Accordingly, after a single impact, the foam must be replaced.

United States patent 4,508,774 discloses thermoforming compression of polyester-urethane foams. Specifically, this patent discloses cellular polyurethanes having a density of 15-400 kg/m^3 and based on aromatic polyisocyanates and polyester polyols. The thermoforming takes place in a forming tool at a compression factor of 1-10 and at a temperature of 140° to 200°C. This patent discloses the use of a starting polyurethane foam slab having a density of 15-40 kg/m^3 which is cut to suitable dimensions of the finished article. Thereafter, the cut slab is thermoformed using conventional techniques. The compression factor for closed molds is defined as the quotient of the density of the final polyurethane foam and the density of the initial polyurethane foam.

The process disclosed in United States patent 4,508,774 is deficient for a number of reasons. Generally, the process is complicated by having to use pre-manufactured foam. This results in extra steps associated with making and shaping the pre-manufactured foam resulting in wastage of trimmed foam. Further, the use of a pre-manufactured foam necessitates the use of a specialized mold to provide the appropriate compression factor and to withstand the conditions of rapid mold closure and specialized temperature control required in the thermoforming operation. Third, the use of a pre-manufactured foam necessitates the use of spray, laminating or hot-melt adhesives to adhere the reinforcing or decorative layer to the pre-formed foam while conducting the thermoforming operation. Fourth, when a fibrous reinforcing layer is used, the process of using an adhesive between the reinforcing layer and the polyurethane foam results in an inferior panel since the adhesive must serve the dual purpose of (i) adhering the reinforcing layer to the foam and (ii) forming a uniform matrix for inherent reinforcement of the fibrous reinforcing layer. Fifth, the requirement for a relatively high temperature during the thermoforming operation renders the overall process energy intensive.

In view of the above-mentioned deficiencies of the prior art, it would be desirable to have a relatively simple process for producing an energy absorbing panel which obviates or mitigates at one of the above-identified deficiencies of the prior art.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a novel process for producing an energy absorbing panel.

Accordingly, the present invention provides a process for producing an energy absorbing panel having at least one energy absorbing surface in a mold comprising an upper mold and a lower mold, the process comprising the steps of:

(i) placing a reinforcing layer in at least one of the upper mold and the lower mold;

(ii) dispensing a liquid foamable polyurethane composition in the lower mold;

(iii) closing the upper mold and the lower mold to define an enclosure corresponding to the shape of the energy absorbing panel; and

(iv) expanding the foamable liquid polyurethane composition to fill substantially the enclosure to produce a resilient polyurethane foam core which adheres to the reinforcing layer thereby providing an energy absorbing surface;

wherein the reinforcing layer has a tensile strength greater than the tensile strength of the resilient polyurethane foam core and upon compression of the panel at the energy absorbing surface to about 50% by volume of the uncompressed panel in a direction substantially normal to the reinforcing layer, the panel recovers to at least about 90% of volume of the uncompressed panel in less than about 30 minutes.

BEST MODE FOR CARRYING OUT THE INVENTION

It will be appreciated by those skilled in the art that the order of the process steps may be varied depending on the exact nature of the process.

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