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(54) WELDED BODIES OF THERMOPLASTICS MATERIAL

(71) We, CARNAUD TOTAL INTERPLASTIC, a Body Corporate organised under the laws of the French Republic, of Rue Paul Sabatier, 71106 Chalon-Sur-Saone, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method and apparatus for the manufacture of welded bodies of thermoplastics material, the bodies being articles obtained by extrusion of a tubular parison of thermoplastics material, followed by welding of the parison on itself.

It is common to manufacture hollow bodies for example bottles or other receptacles by extrusion of a tubular parison of synthetic plastics material, the parison then being received in a mould composed of a plurality of parts, for example two, which approach each other about the parison and flatten the parison at at least one position to form a weld of the parison on itself, said parison then generally being expanded by blowing.

The required performance of these bottles or hollow bodies is constantly increasing, notably with respect to mechanical strength and resistance to pressure, and it has been found that the part of the body at the weld forms a weak point which reduces the performance of the whole manufactured article.

This disadvantage is further increased from the fact that generally the properties of the wall of the body are improved by drawing processes applied to the wall whereas the part of the body at the weld is not subject to drawing in these processes.

The invention is intended to avoid these disadvantages and to provide a process for manufacturing of welded bodies of thermoplastics materials in which the welded zone has improved properties especially in strength, homogeneity and stability.

The invention is applicable to welded bodies obtained by extrusion of a tubular parison in which the welded zone is welded by compression of the walls of the parison to close the parison.

According to one aspect of the invention, there is provided a method of making welded bodies of thermoplastics material in which a tubular parison is extruded, wherein a gaseous atmosphere which is substantially inert with respect to the material is introduced into the interior of the parison during extrusion, wherein the parison is periodically compressed to effect welding on itself at the points of compression and wherein there is effected an expansion by blow-moulding of a part of the parison in the interior of a mold at an elevated pressure of at least 3 bars.

The gas used is preferably nitrogen. However other gases which are inert with respect to the plastics material can be used, that is to say gases which do not modify the chemical or physical chemical properties of the surface of the material.

Carbon dioxide may generally be used.

In a preferred embodiment for manufacture of hollow bodies of plastics material such as bottles and other receptacles starting from an extruded tubular parison which is welded by compression, the inert gas is introduced inside the tubular parison during extrusion in such a manner that the internal wall of said parison from leaving the die onwards is in contact with the gas, compression being carried out while the parison remains thus protected, preferably immediately after extrusion.

Advantageously after the compression has been carried out the expansion to the required shape of the tubular parison which contains the inert gas introduced during extrusion is carried out by injecting inside the parison a large quantity of inert gas under strong pressure to cause a rapid expansion bringing the parison material into close contact with the internal wall of the mould.

Whereas the internal pressure due to introduction of the inert gas during extrusion is small, for example slightly higher than one bar, the expansion pressure is at least three bars and is normally greater than 4 bars and is preferably about 10 to 12 bars.

It has been found, surprisingly, that the rate of cooling of the surface of the parison which is protected by the intert gas is increased,

probably by suppression of a surface layer which would have been formed by action of oxygen in the air and this is capable of increas- the rate of manufacture in certain cases; also with certain materials liable to crystallise, it allows an amorphous structure of plastics material to be reached while avoiding undesirable crystallisation.

Further there is obtained by contact of the material at a relatively low temperature against the walls of the mould an improved heat exchange. Efficient heat exchange is obtained inside the parison during expansion by the large quantity of inert gas under pressure introduced in order to carry out expansion; this quantity of gas may be increased if there is provided an orifice for evacuation of the inert gas in such a manner as to create during expansion a strong circulation or sweeping of the gas along the wall.

In one embodiment of the invention, the inert gas may be introduced inside the tubular parison during extrusion by passage through the central mandrel of the die, through a duct which may open for example into the centre of the mandrel.

In certain cases, especially in the case of extrusion of a hanging parison, that is to say a parison which opens to the atmosphere at its open lower end, it is advantageous to direct the gas towards the interior wall of the parison in order to improve still further the protection while reducing the quantity of gas required.

In the case of extrusion of captive parisons, that is to say of which the end is closed during extrusion, the passage of gas through the mandrel may be regulated in such a manner as to create a small excess pressure inside causing a slight inflation of the parison, the gas thus replacing the increased air pressure usually applied during extrusion of parisons in this way.

The invention may also be applied to manufacture of hollow bodies of thermoplastics material in which starting, from a section of plastics tube, there is made a preform by closing one of the open ends by deformation of this and by one or more heating devices to form a rounded bottom in which the heated and deformed material is welded on itself. This operation of deformation may be carried out with the section of the tube maintained in an atmosphere of nitrogen or other inert gas so that the gas protects from oxidation the interior wall as well as the exterior wall of the tubular section.

According to another aspect of the invention there is provided apparatus for making welded bodies of thermoplastics material, comprising an extrusion head with a central mandrel for forming a parison by extrusion, the mandrel being provided with a duct opening into the interior of the parison, a source of inert gas under pressure outside the parison connected to the duct for introducing said gas into the interior of the parison during extrusion, means for periodically compressing the parison to effect welding on itself at the points of compression, and means for effecting an expansion by blow-moulding of a part of the parison in the interior of a mould at an elevated pressure of at least 3 bars.

An embodiment of the invention will be described by way of example with reference to the accompanying drawing which is a diagrammatic cross-section of apparatus for carrying out the invention.

Referring to the drawing, there is seen an extrusion head 4 intended for manufacture of receptacles or hollow bodies of thermoplastic material. The head comprises a channel for feeding hot thermoplastics material under pressure 1 opening onto the die comprising an interior cylinder wall 2 maintained in place on the head by a screw 3.

In the head 4, inside an enlarged portion of channel 1, is mounted a mandrel 5 defining with the die 2 an annular channel through which passes the plastics material which is thus extruded in the form of a tubular parison 6 having a vertical longitudinal axis.

Below the head 4, at a certain distance from the latter in order to allow the desired degree of cooling for the parison 6, there is mounted a blow moulding device which is here simply represented by one mould composed of two parts 7 and 8 capable of approaching one another on either side of the vertical axis of the parison 6.

In known manner the parts 7 and 8 of the mould are arranged to approach and imprison a portion of the parison which is thus clamped at the two ends of the mould and forms a portion of the parison 6*a* closed on itself and imprisoned in the mould. The portion is then blown, for example by means of an injection needle which penetrates the parison until the parison wall is pressed against the internal walls of the mould to form a hollow body of the desired shape.

It will be understood that the zones such as 6*b* which are pressed together by the two parts of the mould form closed ends which are welded together. Certain of these welds, according to the desired shape of the hollow body, may then be eliminated by subsequent cutting but the bottom of the hollow body still has a welded zone forming an integral part of the hollow body.

A quantity of inert gas such as nitrogen is passed into the parison 6 which has been extruded longitudinally, the gas current passing through a duct 9 traversing the mandrel 5 and connected to another duct 10 connecting it to a source of inert gas, for example a bottle of compressed nitrogen 11. It will be understood that the interior part 6*c* of the parison 6 is filled with inert gas with at most only a negligible proportion of air.

It has been found that the quality of the

welded zones such as 6*b* is considerably improved as will be shown below.

Advantageously the rate of feed and the pressure of the inert gas conducted by the duct 9 are determined in such a manner as to create in the volume 6*c* a small pressure above that of the surrounding atmosphere, maintaining the parison 6 slightly inflated and contributing to the geometrical stability of the parison. This excess pressure may for example be of the order of 5 g/cm2.

In the case where instead of using an extrusion process with a captive parison as described above there is used an extrusion process in which the lower end of the parison is exposed to the air it will be understood that it is necessary to increase the rate of feed of inert gas inside the duct 9 in such a manner as to prevent entry of air through the lower end of the parison. Advantageously in this case the duct 9 is provided not with a single orifice to the interior of the parison, but with a plurality of orifices distributed in the proximity of the interior wall of the parison to direct the gas against said interior wall.

For example there may be made by this process bottles of polyethylene glycol terephthalate by extrusion at a temperature of 280° C with blowing causing biaxial expansion of the wall of the body of the bottle by a factor of the order of 1.5 to 3 at a temperature of the order of 270° C, the initial thickness of the parison wall being 4 mm and the final thickness being 0.5 mm.

The expansion is caused by introduction of a blowing needle through the wall of the parison at a suitable location, this needle allowing injection of inert gas such as nitrogen under a pressure of at least 3 bars, preferably about 11 bars.

There have been compared bottles made in this way with introduction of nitrogen inside the parison and other bottles made in the same way with introduction of air inside the parison.

When the bottles were tested the following result was obtained:

The welding obtained under nitrogen gave a homogeneity such that a bottle submitted to interior bursting pressure was not ruptured at the level of the welded bottom.

The welding obtained in the presence of air was such that the bottle subjected to pressure was broken consistently at the level of the welded bottom.

Instead of using blowing by needle it is possible to use a nozzle of a type known as such, for example to inject the inert gas through a part of the parison which will later form the neck or throat of the hollow body.

WHAT WE CLAIM IS:—

1. A method of making welded bodies of thermoplastics material in which a tubular parison is extruded, wherein a gaseous atmosphere which is substantially inert with respect to the material is introduced into the interior of the parison during extrusion, wherein the parison is periodically compressed to effect welding on itself at the points of compression and wherein there is effected an expansion by blow-moulding of a part of the parison in the interior of a mould at an elevated pressure of at least 3 bars.

2. A method according to Claim 1, in which the inert gas is nitrogen or carbon dioxide.

3. A method according to Claim 1 or Claim 2, in which the inert gas is fed to the parison during extrusion by a passage through the central mandrel of a die by means of which the parison is extruded.

4. A method according to Claim 3, in which parison is extruded as an open-ended tube and the inert gas is directed towards the interior wall of the parison during the introduction of the gas.

5. A method according to Claim 4, in which the amount of gas introduced into the parison is such as to create an excess pressure inside the parison.

6. A method according to any preceding Claim, in which said elevated pressure is from 10 to 12 bars.

7. A method of making welded bodies of plastics material, substantially as hereinbefore described with reference to the accompanying drawing.

8. Apparatus for making welded bodies of thermoplastics material, comprising an extrusion head with a central mandrel for forming a parison by extrusion, the mandrel being provided with a duct opening into the interior of the parison, a source of inert gas under pressure outside the parison connected to the duct for introducing said gas into the interior of the parison during extrusion, means for periodically compressing the parison to effect welding on itself at the points of compression, and means for effecting an expansion by blow-moulding of a part of the parison in the interior of a mould at an elevated pressure of at least 3 bars.

9. Apparatus according to Claim 8, in which said duct opens into the parison by a plurality of orifices directed towards the internal surface of the parison during extrusion.

10. Apparatus for making welded bodies of thermoplastics material, substantially as hereinbefore described with reference to the accompany drawing.

11. Welded bodies of plastics material, when made by a method according to any one of Claims 1 to 7 or by means of apparatus according to any one of Claims 8 to 10.

12. Hollow containers having a welded body according to Claim 11.

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