

## Description

This invention relates to a process for the preparation of isolated propellant charges for base-bleed gas generators, consisting of a propellant which is a mixture of one or more solid bodies, at least one of which is an oxidant, and a binding agent in the form of an appropriate thermoplastically deformable elastomer.

The term gas-bleed gas generators refers to gas generator charges for projectiles, and artillery projectiles in particular, which are placed in the base of the projectile and which release a gas through the combustion of a propellant which accumulates in the void formed behind the projectile in its trajectory with the objective of filling this void which is caused by aerodynamic forces and which acts as a brake on the movement of the projectile (Belgian patent no. 834.903).

The propellant charges for the above-mentioned gas generators, which are usually cylindrical in shape and have an axial combustion tube, must be equipped with an isolating jacket to ensure that combustion occurs gradually from the interior towards the exterior and to prevent the generator from being destroyed in the event of ill-timed combustion of the outer layers of charge. In conventional methods for the preparation of isolated propellant charges for base-bleed gas generators, the external surface of the preshaped charge or the parts of it where combustion must be avoided are coated with a layer of liquid hardening polymers such as polybutadienes with hydroxylized or carboxylized extremities, liquid

polyurethanes, epoxy resins or unsaturated polyesters, after which the propellant mass and the isolating coating are hardened together. The essential components of the coating which isolates known isolated propellant charges usually consist of polybutadienes, polyurethanes, epoxy resins or polyesters.

One of the disadvantages of this known system is that the adhesion between the isolating layer and the propellant mass or agent leaves much to be desired. For this reason, additives which are capable of improving this adhesion are incorporated. However, this has a detrimental effect on the cost price. The consequence of this lack of adhesion is that combustion occurs in the mass not only from the interior towards the exterior, but the flame also penetrates the external layers in which there is a lack of adhesion, thus causing the coating to be destroyed. In addition, there is the danger that the gases thus formed will cause the complete projectile generator to explode as a result of the fact that the combustion zone is expanded to an excessive degree by this irregular combustion, and the flow of gas through the axial tube is totally inadequate.

An additional disadvantage is that the application of a liquid coating layer to the preshaped propellant mass is a laborious and costly process, in that only surfaces which do not adjoin may be coated each time and the body must be turned to enable the other surfaces to be coated. A third disadvantage of the conventional system is that the substances used up to the present in the isolating coating have only a low resistance to temperature because they must be applied in liquid form with low viscosity components which thus contain only polymers of relatively low molecular weight.

This invention concerns a new process for the manufacture of isolated propellant charges and the propellant charge with isolating jacket thus produced, which does not have all the above-mentioned disadvantages of known propellant charges up to the present time. It is therefore distinctive in that there is very strong adhesion between

the isolating jacket and its surface and that the isolating layer is highly resistant to combustion. To this end, the invention specifies that the propellant body is inserted and compressed at high temperature into an isolating jacket, of which one of the essential components is a thermoplastically deformable elastomer used as a binding agent, that the propellant mass with isolating jacket is characterized by the fact that its binding agent consists of a thermoplastically deformable elastomer, that the essential component of the isolating jacket is an elastomer of the same type as above and that the binding agents of the propellant body and the isolating jacket are extremely closely bonded.

As specified in the invention, the isolating jacket is not applied as a liquid coating onto the preformed propellant mass. The isolating jacket is manufactured separately from a granular raw material either by compression moulding at high temperature using a suitable mould or by injection moulding. The isolating jacket is removed from the mould after cooling and then inserted into the mould, in which it is applied to the propellant mass under pressure.

One method by which the process may be applied as specified in the invention specifies that the propellant agent, which is preshaped using a known technique into the form of a propellant mass or charge, is inserted into the isolating jacket, which is applied in an unconventional manner under pressure and at high temperature.

According to a particularly advantageous method for application of the process as specified in the invention, the propellant agent is inserted into the isolating jacket in the form of granules. This offers the distinct advantage of eliminating the stage in which the propellant charge is preshaped and instead the propellant charge is shaped under pressure inside the isolating jacket which has been manufactured previously.

Although the propellant charge may be manufactured as a single unit, it is usually constructed by joining two

identical half cylinder shaped bodies. Indeed, the term propellant mass or charge as used in the invention applies equally to either a cylindrical body with an axial tube for the evacuation of gases or a body which is half cylindrical in shape with a groove of semicircular cross-section.

By joining the relevant parts under pressure, a very close and particularly solid bonding is obtained between the binding agent in the propellant charge and the thermoplastically deformable elastomer of the jacket which is of the same type. This very close bonding is due to the fact that the compressive stress causes an irreversible interchange of molecules between the binding agent of the propellant charge and the isolating jacket at the interface of the two substances.

The essential advantage of the invention therefore lies in particular in this close bonding between the propellant charge and the isolating jacket. Furthermore, experience has shown that the isolating jacket as specified in the invention exhibits a resistance to destruction by fusion or combustion which is appreciably better than that of known isolating layers.

In addition to the above-mentioned principal component of the isolating jacket as specified in the invention, which is a thermoplastically deformable elastomer, i.e., according to a particularly advantageous application, a triple bonded regularly structured elastomer such as in particular a butadiene and styrene or an isoprene and styrene copolymer, the isolating jacket may also contain small quantities of incombustible organic or inorganic charges, such as quartz powder, silicon dioxide, magnesium oxide, calcium carbonate or even graphite, as examples of inorganic charges. These charges are used to increase the thermal resistance of the isolating jacket during combustion. This resistance is already appreciably improved in comparison with that of the usual isolating layers because of the process used for the manufacture of the unit as specified in the invention.

Another advantage of the invention is that it enables propellant charges with isolating jackets to be manufactured with a high degree of automation. The procedure in which the propellant mass is inserted into the jacket under pressure may be easily integrated into a highly automated series manufacturing process. This is in direct contrast to the traditional manufacturing process, which is not very suitable for automation.

Other characteristics and advantages of the system as specified in the invention will become apparent from the following detailed description of an example of an application, which is given without intending to be restrictive in any way.

The isolating jacket as specified in this example of an application is produced in the form of a cylindrical jacket of total internal length of 130 mm, diameter 120 mm and wall thickness 2 mm. There is a central symmetrical aperture of 43.5 mm diameter in at least one of its bases for the evacuation of combustion gases. Since the propellant charge is usually composed of two half cylinder-shaped parts, each with a longitudinal groove of semicircular cross-section which, after the two parts have been joined together, form the axial tube which is circular in section, the isolating jacket may also be composed of two parts or shells which are half cylindrical in shape and are manufactured separately. In one particularly advantageous design, the essential component of the isolating jacket as specified in the invention is a copolymer of butadiene and isoprene or of isoprene and styrene with the addition of a small amount of silicon dioxide as a noncombustible charge intended to increase the thermal resistance of the jacket during combustion of the propellant mass.

According to one preferable application of the process for the manufacture of isolated propellant charges for base bleed gas generators, an isolating jacket as specified in the invention of the type described above, which is in the form of a half cylinder-shaped shell and at least one of its bases has a groove of semicircular

cross-section, is placed in a mould and is then filled with a granular propellant mass which contains an essential binding agent again in the form of a copolymer of butadiene and styrene or of isoprene and styrene. The whole is then heated to a temperature of approximately 120 °C and compressed at this temperature under a pressure of 20 MPa.

The isolating jacket and the binding agent of the granular propellant mass, softened under the conditions described above, join together very closely under the effect of the high pressure which acts upon them in order to produce a solidly and closely joined entity. After cooling, the half cylinder-shaped body thus formed is removed from the mould and is placed in contact with an identically shaped body as its counterpart in the base of the relevant projectile.

The results of the comparative test firings indicate that, in contrast to known isolating coatings which are entirely destroyed by combustion, the surface of the isolating jacket as specified in the invention remains practically completely intact without any interruption of continuity, except for a few isolated incidents of localized carbonization. This is in spite of the fact that the wall is appreciably thinner than known isolating coatings.

It should be stressed that the invention is not limited in any way whatsoever to the type of construction described in the preceding paragraphs but is suitable for many different applications of its characteristics, whether taken individually or combined in many different ways, with the obvious condition that the scope of the invention as indicated by the claims defined below is not exceeded.

## Claims



1. A process for the preparation of insulated propellant charges for base-bleed gas generators, which consist of a propellant which is a mixture of one or more solid bodies, at least one of which is an oxidant, and a binding agent in the form of an appropriate thermoplastically deformable elastomer, with the characteristic that the propellant mass is inserted into an isolating jacket which, as an essential component, comprises a binding agent of the same type as the above-mentioned thermoplastically deformable elastomer, and is bonded to it at a high temperature and under high pressure.
2. A process as specified in claim 1, with the characteristic that the propulsive mass with which the isolating jacket is filled is, before compression, a granular substance.
3. A process as specified in claim 1, with the characteristic that the propulsive mass is inserted into the isolating jacket which has been preformed or premoulded.
4. A process as specified in any of the preceding claims, with the characteristic that the propulsive mass and the isolating jacket together are heated to a temperature of between 100 and 140 °C while undergoing compression.
5. A process as specified in claim 4, with the characteristic that the compression takes place at a temperature of 120 °C.
6. A process as specified in any of the preceding claims, with the characteristic that the propulsive mass is compressed into the isolating jacket at a pressure of between 10 and 50 MPa.
7. A process as specified in claim 6, with the characteristic that the compression is achieved at a pressure of 20 MPa.