

Low Specific-Gravity Body Sealer Containing Resin Balloons

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ABSTRACT

A lightweight body sealer that cures at low temperatures was developed. In order to make the sealer lightweight, it is necessary to add light raw materials. In this development, the technique in which the weight reduction effect adds the resin balloon which is high and is easy to fluctuate the thickness and the particle diameter of shell was selected. Two types of resin balloons were used in combination with each other. High pressure-resistant resin balloons made of polyacrylonitrile (PAN) were one type, of which pressure resistance was increased by optimally designing heat-expandable microspheres (raw material), and the other type was high pressure-resistant polyester (PES) balloons. To enable the sealer to cure at low temperatures, it is necessary to use a resin that cures in the specified temperature zone and has the necessary physical properties. To this end, two types of resins, acrylic and polyurethane, were selected as base resin due to their good mechanical properties, when curing at low temperatures, and their versatility. These materials were used to develop a new sealer that can contribute to the reduction of vehicle body weight.

INTRODUCTION

In recent years, various international CO₂ reduction measures and policies, like those represented by the Kyoto Protocol, have been implemented⁽¹⁾. In the field of automobiles, regulations such as the US CAFÉ and European CO₂ regulations exist⁽²⁾. It is necessary to take into account CO₂ reduction in the development and manufacture of automobiles. For automobile materials, reduction of body weight is being strongly demanded as a means of reducing CO₂. In the manufacturing process,

the main countermeasures are the shortening of the drying process for curing paint or sealers, and the use of low temperature in this process⁽³⁾.

Body sealer is a sealing material that is applied to the joints between the panels inside the cabin and inside the engine compartment of an automobile, in order to prevent water and dust ingress and corrosion⁽⁴⁾. Figure 1 shows an example of the parts to which sealing material is applied and the amount of sealing material applied. Because the amount of body sealer, which has high specific gravity, used in one vehicle is large, it holds promise of realizing high weight reduction of the body, and so based on this perspective, it became the focus of this study.

At present, the most general method of reducing the weight of the body sealer is a method involving the addition of glass balloons⁽⁵⁾. However, the particles of glass balloons promote wear of the nozzle. Also, fragments of glass shattered by pressure during pressure feed cause the packing or other parts to rupture, which is an issue related to operating stability. In addition, there are other issues concerning hollow resin balloons generally used in lightweight underbody coatings. Although hollow resin balloons have the merit of realizing weight reduction, if they are added to a highly viscous material such as a body sealer, they must be fed through the pipes under high pressure during the coating process, causing the balloons to shatter under this pressure and generate air bubbles.

Accordingly, resin balloons that can address these issues were developed, aimed at the development of a body sealer that can realize low-temperature baking. Because inorganic matter such as glass is a factor

responsible for nozzle wear, the above issues were addressed by using balloons from which inorganic components had been removed, i.e., resin balloons. The pressure resistance of balloons was increased within the range where the weight reduction effect is not reduced, by optimizing the particle size of the heat-expandable microspheres, which constitute the raw material of the hollow resin balloons, and controlling the shell thickness of the hollow resin balloons.

Two kinds of resin, acrylic and polyurethane, which satisfy the required physical properties, even for low-temperature baking, were optimally blended to develop the body sealer.

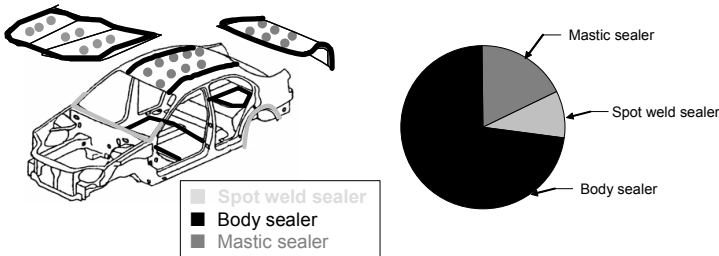


Fig.1 Example application and amount of sealing material applied

MAIN SECTION

Material Design

The selection of the resin balloons constituting the additive, and the material of the body sealer, are described below.

1-1 Selection of Balloons

There are two issues related to current body sealers that use weight reducing material: Nozzle wear and pressure resistance. The former is caused by the use of balloons made of inorganic material such as glass. Consequently, it is considered that nozzle wear can be reduced by using organic balloons, that is, resin balloons. Regarding pressure resistance, the following are the performance criteria demanded of a current body sealer.

- 1. Capable of being mixed as a sealer (cohesionless).
- 2. Have heat curing properties (heat resistance).
- 3. Performance unaffected by chemical substances used in daily activities (chemical resistance).

While satisfying the above criteria, the parameters related to the pressure resistance of resin balloons (gas-proof barrier ability, elasticity, and ease of manufacture) must be set appropriately.

Table 1 shows the basic performance of resin balloons that can realize weight reduction. Although there are no resin balloons that satisfy the performance of all of the

requirements in the table, the hollow type polyacrylonitrile (PAN) balloons, which have a high degree of design freedom and a high weight reduction effect, come closest to meeting these requirements. It was considered that the pressure resistance could be increased by raising the gas-proof barrier ability, which is deficient. Although non-hollow type polyester (PES) balloons have a lower weight reduction effect than hollow type balloons, they have satisfactory resin elasticity and gas-proof barrier ability. This is because they are not hollow types and small balloons are packed among the overall balloon particles. Consequently, it was considered that weight reduction and pressure resistance could be simultaneously achieved by using these two types of resin balloons in combination with each other.

1-2 Selection of Base Resin for Low Temperature Baking

Important physical properties of a body sealer are adhesive strength and elongation after curing. This is because the body sealer must adhere to the panel joints and prevent the ingress of water and dust without crack formation due to displacement of the panel joints as a result of stress generated when the vehicle is running.

Also, it is necessary to maintain the cost of replacing the sealing material as low as possible, and it is desirable not to allow equipment investment or the unit material cost to rise. Table 2 shows the characteristics of a general low-temperature cure type resin. Polyvinyl chloride (PVC) resin, which is currently used, is most appropriate in terms of its property and cost aspects. However, from the viewpoint of recent environmental considerations, it is desirable not to use a material containing chlorine. Polyurethane resin exhibits good physical properties at normal temperatures, but these properties worsen at low temperatures. For this reason, it is challenging to use polyurethane on its own. A water-based emulsion cures at low temperatures, but has relatively little elongation, and necessitates high equipment investment. Acrylic resin has very good low-temperature curing ability, but its physical properties are worse in the normal temperature region. From the above, it was considered that good low-temperature curing ability and physical properties could be simultaneously achieved using a combination of acrylic and polyurethane resins.

Table 1 Basic performance of resin balloons

Resin	Gas-proof barrier	Heat resistance	Chemical resistance	Ease of manufacture	Elasticity	Primary condensation
PVC (Polyvinyl chloride)	○	△	△	○	△	△
PAN (Polyacrylonitrile)	△	○	○	○	○	○
PVA (Polyvinyl alcohol)	○	△	△	○	△	△
Phenol	△	○	○	△	△	△
UF (Urea Formaldehyde)	△	○	○	△	△	△
PES (Polyester)	○	○	○	△	○	△

○ : Good
△ : Poor