Foamed seals in one-component polyurethane

The Penguin foam system with the Foamply application technology produces foamed seals in one-component elastomers directly onto the component to be sealed (FIPG sealing technology = form-in-place gaskets). Complex seal shapes can also be achieved. Foaming takes place by ventilation of the liquid plastic with conventional compressed air. Curing time amounts to only a few minutes. The applied seal is characterised by closed cells with even pore distribution, resulting in a waterproof foam.

1. Introduction

Elastomer seals are currently used in numerous applications that require sealing against dust or water. Conventional foam processes often fail in sealing against water, as open cell seals arise in the chemical foaming process. Very high water absorption can be observed particularly when the seal's skin is damaged. Single component physically foamed seals are becoming increasingly accepted for waterproof solutions. The Penguin foam process offers particular advantages in this area. The system and its associated Foamply application technology has been developed by Sunstar in Japan and has been used there successfully in the automotive and electronics industries for more than 10 years **(Fig. 1).** The company CeraCon in Weikersheim, Germany, has been supplying renowned customers in Europe with foam plants and the associated automation systems during the last 5 years. The one-component foams are based on polyurethane or silicone. Cold and hot curing versions of the material are available.

Fig. 1:
Component with foamed sealant bead

2. Physical instead of chemical foaming

Two basically different processes are possible for foaming of seals: chemical and mechanical foaming. The former produces a bubble structure by means of a chemical reaction, in which two highly reactive components have to be precisely dosed and homogenously mixed together. The high reactivity (chemical curing reaction) in the materials mixing chamber requires that the process parameters are carried out within very narrow tolerances. The technical requirements set upon the plant for this are very complex and the process management problematic. Fluctuations in the quality of the seals cannot be excluded and are generally associated with changes in ambient conditions (air humidity, temperature). Significant variations in the chemical foam seal are common.

In contrast, when foaming seals with the Penguin foam system, air and one-component polyurethane are homogenised and divided up into fine bubbles. It is through this mechanical foaming at room temperature that a closed cell foam structure arises. The way in which it works can be described as follows **(Fig. 2):** after the introduction of a defined volume of air to liquid elastomer, a twin phase flow is stream is produced on a conveyor system. This way, the gas is distributed evenly into the liquid by shear force. Once ventilated, the process makes use of the specific flow properties of highly viscous polymers to finely distribute and homogenise the material. As soon as the twin phase liquid relaxes again under atmospheric pressure, the air expands and it forms the desired foam. No curing reaction takes place in the plant, so that the system never has to be rinsed or cleaned.

3. The foam plant

The material and the plant are developed in harmony. A plant that is ready for production

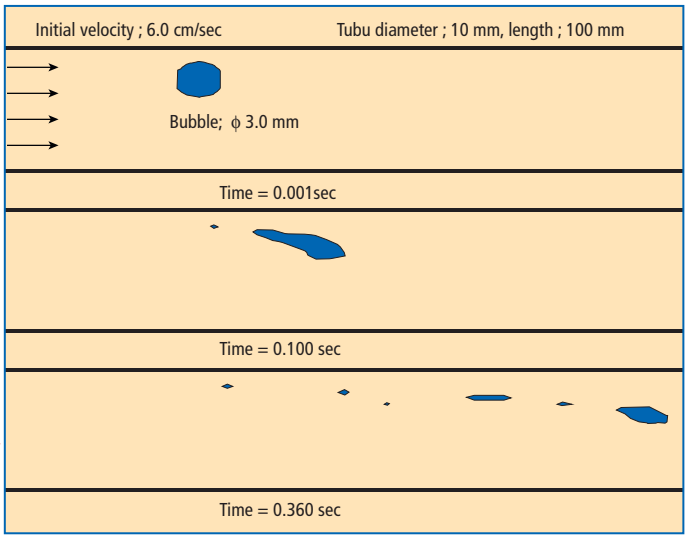

Fig. 2:
Diagram of distribution of bubbles through shear force.

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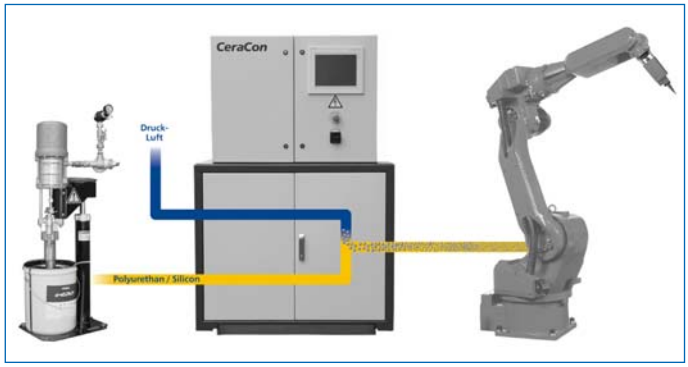
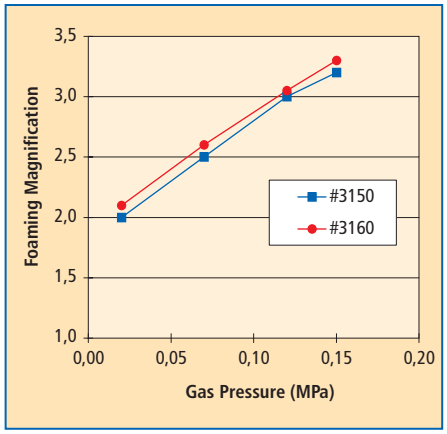


Fig. 3: *Plant arrangement*

consists of the Foamply application technology with integrated control technology and a handling robot that applies the sealant bead to the component, followed by passage through an oven for a short period if a heat curing material version has been chosen. **Figure 3** shows the arrangement of the plant without the "Thermo" oven cure system. A feeding pump and a conventional compressed air system (max. 6 bar) provide material and air to the machine. The foam volume can be varied very easily up to a factor of 3.5:1 **(Fig. 4).** The essential advantages of the process are:

- Over 95 % plant availability (no rinsing agents, no special waste)
- Stable running of the process, also under tough working conditions (wide tolerance to component temperature and ambient conditions)
- Inline capability and direct modification after only several minutes (curing within 5 min. at 80 °C)

Fig. 4: *Degree of foaming as a function of the ventilation pressure*

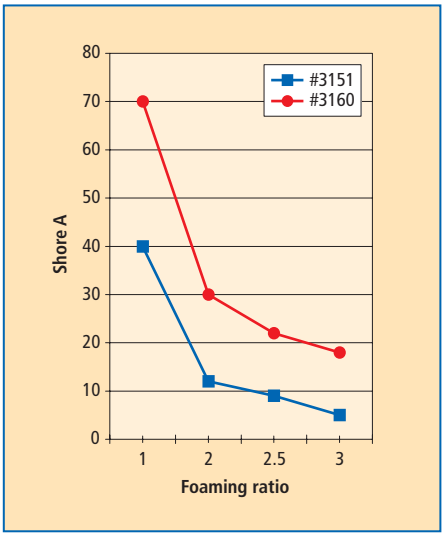


It is also interesting that this technology can operate reliably irrespective of component temperature. This enables cold metal parts to be sealed without pre-heating, or warm injection moulded parts without cooling. The Foamply plant technology has been specially developed for Penguin foam materials, but it also operates in principle with other one-component thixotropic elastomers.

4. Properties and application possibilities

The foam quality is entirely reproducible. This is a significant advantage, bearing in mind the usual certified quality assurance systems. A further important aspect is the much shorter curing times of the products. The hot curing material version cures at 80 °C in just five minutes. The foamed components can therefore be assembled already after five to ten minutes, compared with several hours with conventional two-component foams. As only one component is dosed, very small seals can also be reliably produced. The hardness values of the seals in relation to the degree of foaming are shown in **Figure 5.** The interesting applications include the automotive industry (door modules, lights, control equipment), the household appliance industry (washing and dishwashing machines, irons) and all types of housings (control cabinets, fluorescent light fittings, electrical distribution cabinets, filters).

Fig. 5: *Shore A hardness as a function of the foaming ratio*



5. Conclusion

The Foamply one-component foam technology enables the application of waterproof elastomer seals with the highest degree of reliability and plant availability, using simple operation and minimum maintenance. Further additional benefits are the very fast curing of the seals, the environmentally beneficial principle of elimination of rinsing cycles and the insensitivity to fluctuations in room temperature and air humidity. Optimum harmonisation of plant technology and materials enables cost-effective and fast production of highest quality elastomer seals that are optimally suited for the application.