VENTS MAKE SENSE

Protective vents are available with adhesive backing for applications that do not have sufficient free space to install a vent inside the electronic enclosure.

Sealed venting of enclosures improves protection and reliability.

by jason zambotti

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Consumers expect appliances and portable devices to the withstand normal wear and tear of an active household. At the same time, the electronic components used in consumer products are becoming much more sophisticated and sensitive. It is essential to protect the electronics from external contaminants such as dust, dirt, liquids, and detergents. At the same time, battery gases that build up inside appliances must be vented so as not to damage the electronics. Therefore, the design engineer must develop a product housing that allows gases to be vented, equalizes pressure, and prevents corrosion and damage to the internal electronics.

Many engineers address these issues by increasing the thickness of the appliance housing, using stronger O-rings, or gaskets at the seals, or installing additional bolts to maintain a robust seal. These alternatives prevent the damage initially, but they don't address the cause of the problem — pressure variations within the appliance itself. These pressure differences are usually caused by rapid changes in temperature and altitude, internal gas buildup, or both.

Temperature changes usually occur during normal operation of the appliance. The electronics generate heat that increases the internal temperature. As the internal temperature rises, a pressure buildup of as much as 12 PSIG can be created inside the appliance. To eliminate this pressure buildup, the housing attempts to release air, which puts significant stress on the seals.

Conversely, when appliances are exposed to cool water, the temperature decreases and a vacuum is created causing air to be drawn into the enclosure. Typical seals on a NEMA 4X enclosure can begin drawing in air, moisture, and contaminants at about 1.0 PSIG. Once inside, moisture causes damage in two ways — it begins to corrode sensitive electronics, and it creates condensation and fog on LCD and other displays.

Altitude changes also cause pressure problems within an appliance. Whether being transported

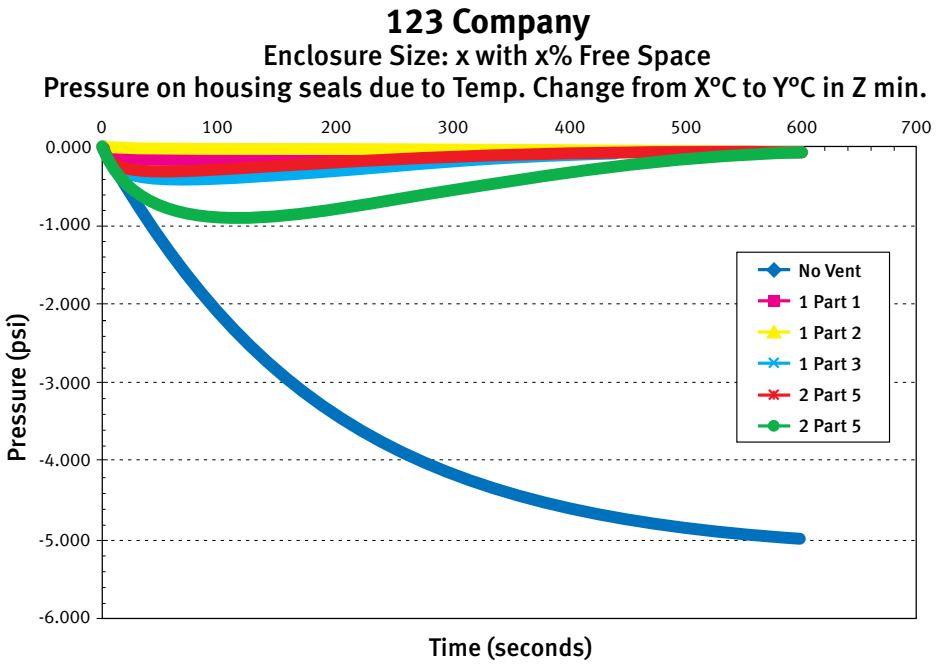

Fig. 1. Pressure on housing seals due to temperature increase from –X DegC to Y DegC in Z minutes.

from a manufacturing facility to the point of sale or being carried in a consumer's suitcase on an airplane, appliances are often transported in unpressurized containers through a wide range of altitudes, temperatures, and environmental changes. As the appliance housing attempts to equalize the pressure changes encountered during an airplane descent for landing, for example, the resulting vacuum can be tremendous.

Another issue that leads to problems for portable appliances with rechargeable batteries — such as electric toothbrushes, shavers, and flashlights — is the potential buildup of hazardous gases, such as hydrogen in the normal usage of some battery chemistries, such as NiMHd. For example, as a battery-operated toothbrush is used, the battery emits gases, which, if not released, can result in a safety-related situation.

Equalizing the internal pressure so that the stress on the appliance seals is eliminated solves the problems caused by the internal pressure difference. Drilling a hole in the enclosure is one way to equalize the pressure, but putting a hole in an airtight enclosure defeats the purpose of sealing the appliance in the first place. A hole in the housing provides free access to harmful contaminants, so the engineer's challenge is to design a housing for the appliance that allows air and gases to flow freely in and out, but prevents contaminants from entering the enclosure.

Vents made with expanded polytetrafluoroethylene (ePTFE) provide consistent airflow, but at the same time repel liquid, moisture, and contaminants. The porous microstructure of ePTFE allows air to flow freely in and out of the enclosure, but ePTFE has a low surface tension that makes it inherently hydrophobic, which means that it sheds water. Oleophobic or "oil-fearing" versions of ePTFE are also available for extremely low surface tension fluids, such as typical household cleaning agents including soap and shampoo. The result is that ePTFE prevents water and other liquids and most other environmental contaminants from entering the appliance. Although ePTFE can allow some water vapor to pass into the enclosure, the porous structure of the membrane enables the vapor to escape as well, minimizing the amount of moisture and quickly reducing condensation.

With almost 50 years of research in fluoropolymers, W. L. Gore & Associates, has engineered a versatile line of protective vents with ePTFE membranes in different sizes and shapes, including cut parts with adhesive backing or parts molded from plastic or metal that house the ePTFE membrane. While the molded components provide maximum protection in harsh environments, vents with adhesive backing are commonly used with applications with limited space for a vent inside the appliance.

Common Fluids	Typical Surface Tension @ 22°C (dynes/cm)
Mercury	484
Water	73
Glass Cleaner	38
Oil	30
Benzene	29
Detergent Wash Solution	27
Isopropyl Alcohol	22
Unleaded Gasoline	19

Fig. 3. This chart illustrates the typical surface tensions of common fluids. Different membranes are used to sufficiently vent an application that is exposed to higher or lower surface tension fluids.

Protective vents are molded from either plastic or metal to provide maximum protection in harsh environments.

GORE™ Protective Vents are easy to install in both existing and in newly designed appliances, using a variety of installation methods, such as snap-fit, threaded, bolted, adhesive bonded or heat/ultrasonic welded. If an appliance does not have sufficient space for a vent to be installed inside, the vents can be adhered to the outside of the appliance.

Gore application engineers work closely with their customers to identify the right vent to be used in each specific application, because selecting the right vent involves much more than choosing a size and shape. One variable is the amount of free space inside the appliance; this determines how much air space exists within the appliance, which in turn determines the stress of the potential vacuum when a pressure differential occurs. Another consideration is the pressure rate of any temperature change, because the more rapid the temperature change, the more pressure is put on the seals. For example, if the appliance is cleaned by running it under cold water after use, the pressure differential can be much stronger than if the appliance cools down gradually.

Once the variables that affect the durability and reliability of the appliance have been identified, the applications engineer calculates the amount of airflow that is required and the amount of pressure that will build inside the appliance. Based on these calculations, different types of vents are tested in normal operating conditions of the appliance to determine which one is the best possible solution for that specific application.

The microstructure of ePTFE membrane allows it to be used in a wide variety of venting applications in which equalizing pressure and managing condensation are crucial. Every day items such as electric toothbrushes, shavers, and rechargeable kitchen appliances need to have a watertight housing, but at the same time allow gases to escape. Outdoor speakers, irons, water coolers, and coffee makers are some other examples of applications that have benefited from using a venting solution from Gore.

One example of a rugged application is a dog collar for an electric fence. The common elements for this application are rechargeable batteries that need to be vented while keeping out dust, dirt, water and debris from adventurous dogs that have free rein within a household yard. Without jeopardizing the integrity of the product by placing a hole in the device for the batteries to breathe, the protective vent in the collar allows hazardous gases to escape while preventing the sensitive components inside the collar from being damaged.

Vents made from ePTFE are used in a wide variety of markets and applications, not just household appliances. For each application, application engineers provide solutions to extend product life and integrity. These engineers continues to study the design and manufacturing needs of the consumer appliance industry in areas such as temperature and pressure fluctuations, electronic reliability, testing methods, product standards, and performance requirements. ■

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