Protective Vents

White Paper

Condensation Reduction in Security Cameras: Comparative Performance of GORE® Protective Vents versus Desiccants

*By Boris Pak L. Su, Zhi R. Cui and Hong Y. Yu**

When condensation forms inside a security camera, it can blur lenses and compromise image quality. Condensation that remains within the enclosure can also corrode electronics, causing the camera to fail prematurely. We compared two IP66-compliant methods for reducing security camera condensation: Desiccant within a sealed camera enclosure, and a GORE® Protective Vent installed in an identical camera. Results showed the GORE® Protective Vent was significantly more effective at dissipating moisture over time. In addition, the GORE® Vent more effectively protected the enclosure from seal failure and subsequent water ingress.

Situation

To ensure optimal image clarity and reliable operation of the camera itself, manufacturers must reduce the frequency, severity and duration of condensation events within the camera enclosure.

There are several conditions that will promote the formation of condensation within a sealed security camera enclosure. These include:

- exposure to frequent or heavy rains,
- exposure to large daily temperature swings,
- sudden temperature changes due to extreme weather,
- repeated pressure differentials that stress seals to failure, allowing moisture ingress.

Historical Approaches to Reduce Condensation

1) Initially, an open diffusion port (through-hole) in the camera enclosure was viewed as a cost-effective way to dissipate interior moisture. These ports, which readily allowed ingress of contaminants such as dust, sand, water and other liquids, could not meet today's IP66 standards for ingress protection.

2) Subsequently, sealed camera enclosures were adopted to meet IP66 requirements. Since the sealed environment itself promoted the formation of condensation, desiccant packs were introduced before sealing the enclosure. However, desiccant packs have a limited effective life, and end-users must periodically replace them. This can be time-consuming and costly, due to the installation height of most outdoor security cameras.

3) Alternatively, a GORE® Protective Vent can be installed over a through-hole in the enclosure. The GORE® Vent provides IP66 protection against ingress of particulates and liquids, while rapidly equalizing pressures, and reducing condensation, within the enclosure.

Figure 1: Desiccant could not prevent severe condensation from forming and becoming trapped within this sealed enclosure.

About the GORE® Vent technology

These vents incorporate the proprietary technology of the GORE™ Membrane. Its microporous structure allows bidirectional passage of gas and vapor molecules, while blocking ingress of particulates and liquids.

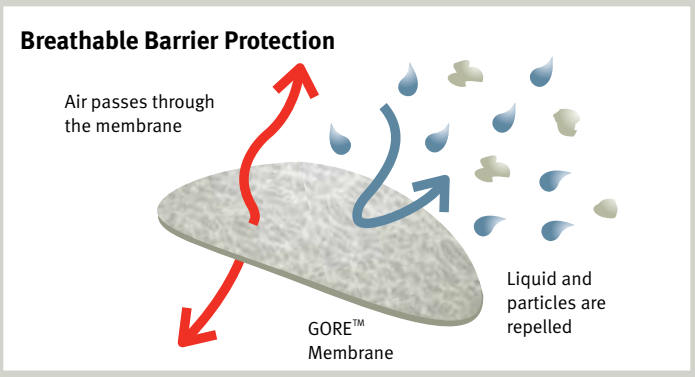

Figure 2: Vapor can escape, yet liquids cannot enter.

Made of 100% expanded polytetrafluoroethylene (ePTFE), the chemically-inert GORE™ Membrane is resistant to virtually all acids, alkalis and detergents. It is also highly resistant to UV degradation, for extended service life in outdoor applications.

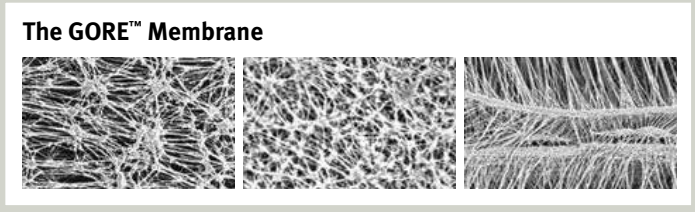

Figure 3: Using proprietary technology, the membrane's microporous structure can be tailored to varied application needs.

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About this Study

This study compared the relative condensation-reduction capabilities of the IP66-compliant sealed enclosure with desiccant, to that of the IP66-compliant vented enclosure using a GORE® Protective Vent. These findings, as well as additional data pertaining to camera performance and longevity, are presented below.

The Study Methodology

Two identical outdoor security cameras were purchased. One camera was left in its original state: sealed, with a desiccant pack inside. For the other camera, the desiccant pack was removed and a GORE® Adhesive Vent was installed over a through-hole. Both cameras were mounted within a climate chamber, with each camera powered and connected to the network under manufacturer-recommended operating conditions. Each camera was focused on, and equidistant from, its own target image.

Two separate Climate Chamber tests were performed:

- Test #1 compared image quality and humidity levels within the two camera enclosures.
- Test #2 compared the effects of harsh conditions on the two camera enclosures, and the related effects on camera function and reliability.

Climate Chamber Test #1: Comparative Image Quality and Humidity Levels

This test employed a temperature and humidity cycle extending from -15 °C / 0 % RH to 55 °C / 85 % RH. This cycle incorporated a 10-minute water shower, to simulate rain.

Climate Chamber Cycle: Test #1

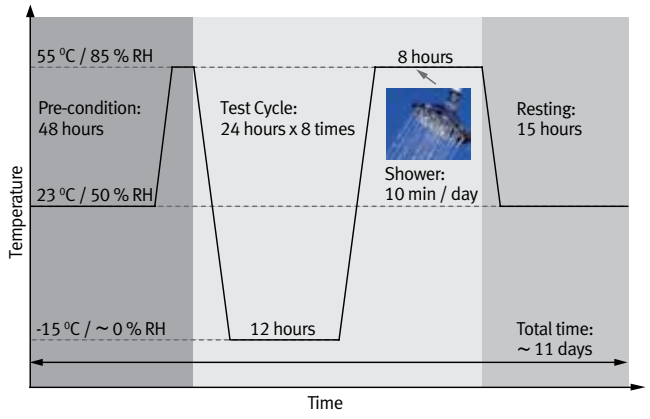


Figure 4: This climate chamber test simulated the changing weather conditions that can affect outdoor cameras.

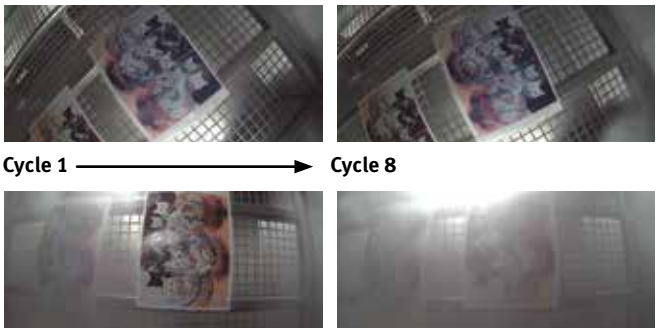
Over the course of eight such cycles, we recorded images from each camera, as well as the humidity inside each camera enclosure, in order to monitor the levels of condensation.

Image Quality Results:

As shown below, images captured during multiple subzero periods demonstrate a dramatic difference in clarity. Image quality from the camera with desiccant continued to degrade, as more condensation formed on its lens with each cycle. By Cycle 8, the image is significantly blurred. Image quality from the camera with the GORE® Vent remained much more consistent, because it did not experience a similar accumulation of condensation.

Comparison of Retained Image Clarity

Camera with GORE® Vent: Image quality remains consistent



Camera with Desiccant: Image quality degrades dramatically

Figure 5: The camera with the GORE® Vent retained superior and more consistent image quality.

Comparative Humidity Results:

The recorded humidity levels within each camera enclosure also showed important differences. While humidity within both enclosures increased in response to Climate Chamber conditions, the camera with desiccant shows a significant increase, beginning at Cycle 6. This is because the desiccant moisture-absorption process reverses itself after several cycles of high humidity. At Cycle 6, the desiccant was fully saturated and began releasing water back into the camera enclosure, creating the condensation it was intended to combat.

Comparison of Humidity Levels

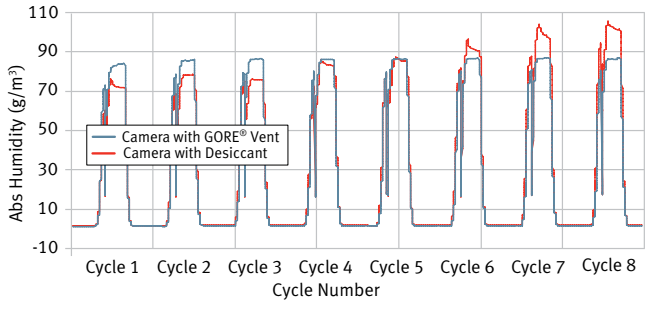


Figure 6: Beginning at Cycle 6, the fully-saturated desiccant causes a significant increase in humidity levels within the enclosure.

Climate Chamber Test #2: Camera Reliability Under Harsh Conditions

The objective of the second test was to compare the performance of the two cameras under harsh conditions. The results were examined in terms of their effect on the camera's function, as well as their implications for camera reliability over the long term.

For Test #2, the Climate Chamber was set up to reflect more challenging environmental conditions. A 10-minute water shower was applied twice daily to each camera enclosure, to simulate rain or pressure-washing. The chamber remained at a constant temperature and relative humidity of 55 °C / 85 % RH throughout this ten-day test.

Camera Reliability Results:
During the ten days, humidity levels remained consistent in the camera with the GORE® Vent. In the sealed camera with desiccant, humidity accumulated quickly over the first three days, and jumped dramatically on the fourth day. From Day 4 onward, the sealed camera with desiccant experienced serious condensation, with related degradation of image quality.

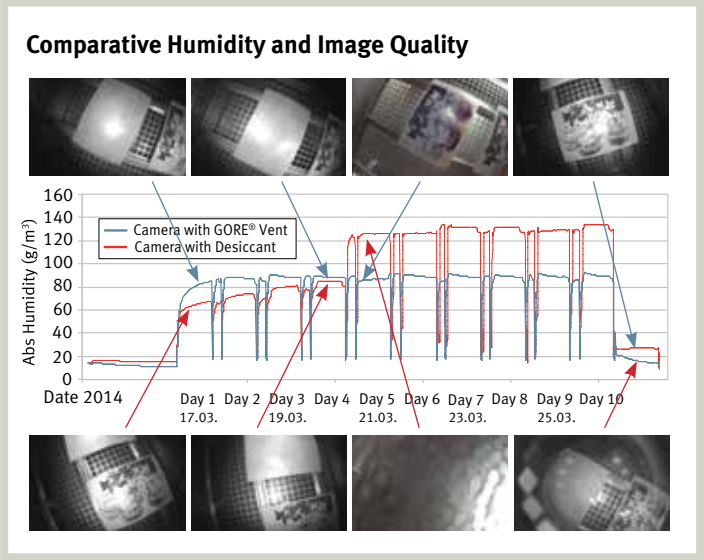


Figure 7: On Day 4, the camera with desiccant experienced a drastic increase in humidity and corresponding loss of image quality.

To understand why the sealed camera experienced the dramatic "Day 4" jump in humidity, it is useful to examine the corresponding pressure and humidity data for that camera.

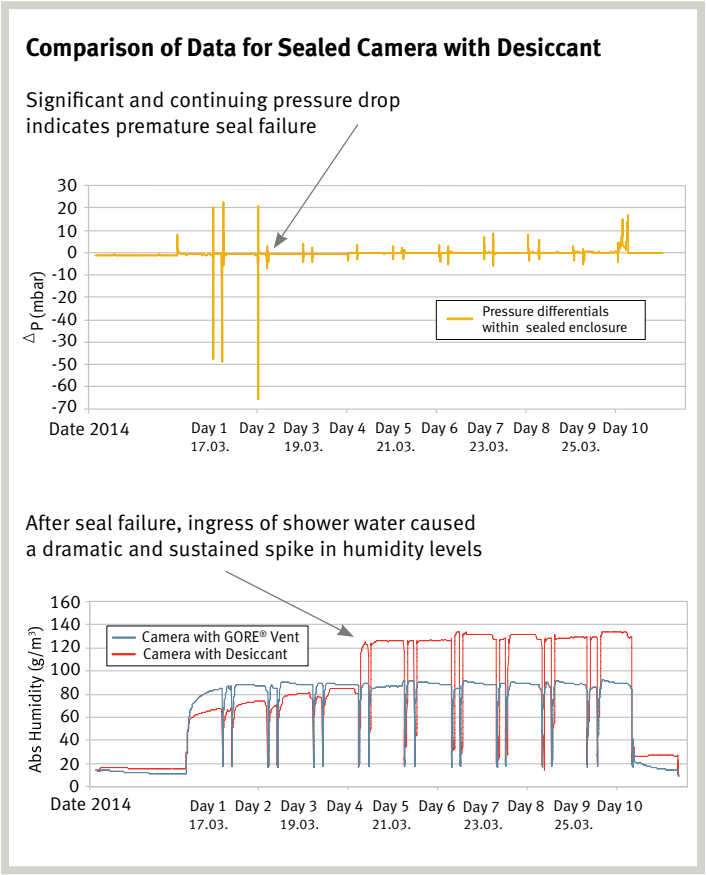


Figure 8: Because the sealed enclosure could not equalize pressure differentials, the seal was stressed to failure in just two days.

As shown above, after Day 2, pressure differentials in the sealed camera diminished dramatically. Subsequent examination showed that the strong initial pressure differentials had stressed the seal to the point of failure.

The subsequent temperature drops (induced by the water shower) created negative pressure within the enclosure, drawing ambient air and shower water in through the failed seal. The desiccant could not counteract this trapped moisture. Thus, excessive condensation formed on the lens, seriously degrading the image quality.

In the other camera, the GORE® Vent rapidly equalized pressures, so the seal for that enclosure was not stressed to the point of failure. Since the vented enclosure's seal remained intact, there was no ingress of shower water to degrade image quality. The camera with the GORE® Vent retained consistently good image quality throughout this test.

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Conclusion

These tests demonstrate that use of a desiccant pack in a sealed security camera is not an effective long-term solution to avoid condensation. The desiccant pack will become saturated, at which time it will release its moisture back into the enclosure, creating condensation that compromises image quality.

Of greater concern are the large fluctuations in internal pressures that are produced in totally sealed (i.e., non-vented) camera enclosures. Such pressure fluctuations cause severe and repeated stress on seals, leading to premature seal failure. This in turn allows ingress of external contaminants and water, and accelerates the formation of condensation. This will degrade image quality, and promote corrosion of sensitive electronic components. Either or both of these conditions will negatively impact the performance reliability of the camera, and require surveillance system down-time – or warranty claims – to remedy the situation.

Our tests demonstrate the performance advantages of incorporating a GORE® Protective Vent in security camera enclosures. Results show the GORE® Vent, which provided IP66 level protection against water and environmental contaminants, dissipated moisture much more effectively than the sealed enclosure with desiccant. By reducing the severity and duration of condensation events, the vented camera enclosure continued to deliver consistent image quality and clarity over time. The likelihood of condensation-induced corrosion damage was correspondingly reduced.

GORE® Adhesive Vents

Figure 9: These flexible, low-profile vents are easily installed.

Additionally, the GORE® Vent provided superior response to pressure differentials caused by changes in ambient conditions. Within the vented enclosure, pressure fluctuations were rapidly equalized, minimizing stress on seals and the chance of premature seal failure.

By protecting the camera's image quality and the enclosure's seal integrity over time, the installation of a GORE® Protective Vent can effectively enhance the long-term reliability of a security camera.

**** Boris Pak L. Su is an Application Engineer and Zhi R. Cui and Hong Y. Yu are Lab Technicians at W. L. Gore & Associates***

International Contacts

Australia	+61 2 9473 6800	Mexico	+52 81 8288 1281
Benelux	+49 89 4612 2211	Scandinavia	+46 31 706 7800
China	+86 21 5172 8299	Singapore	+65 6733 2882
France	+33 1 5695 6565	South America	+55 11 5502 7800
Germany	+49 89 4612 2211	Spain	+34 93 480 6900
India	+91 22 6768 7000	Taiwan	+886 2 2173 7799
Italy	+39 045 6209 240	United Kingdom	+44 1506 460123
Japan	+81 3 6746 2572	USA	+1 410 506 7812
Korea	+82 2 393 3411		

W. L. Gore & Associates, Inc.
401 Airport Road • Elkton, MD 21921 • USA
Phone: +1 410 506 7812 (USA) • Toll-free: +1 800 523 4673 (USA)
Fax: +1 410 506 8749 • Email: protectivevents@wlgore.com

gore.com/protectivevents

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