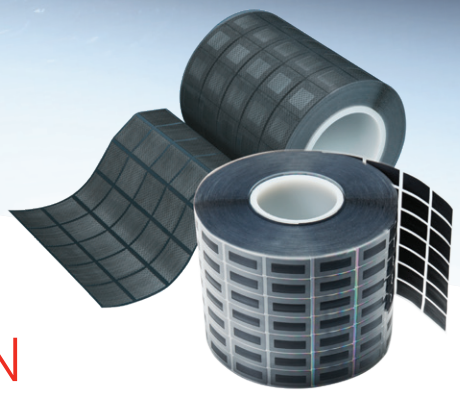
GORE® Automotive Vents
For exterior lighting



CASE STUDY

DOES YOUR HEADLAMP DESIGN DELAY CONDENSATION CLEARING?

Our study showed enclosure design greatly affects clearing times.

For automotive headlamps, a venting solution must provide three critical functions: responsive pressure equalization, reliable protection against ingress of water/fluids and particulates, and condensation management. **While lamp design has little effect on the first two functions, design factors can significantly impact a vent's ability to quickly clear condensation.**

A recent Gore laboratory study compared the condensation clearing times achieved by two identical GORE® Automotive Vents (AVS 9) in two very different headlamp enclosure designs (each from a leading OEM).

The headlamps, identified in this paper as "Lamp A" and "Lamp B," were chosen based upon OEM request. Lamp B was from a vehicle identified as having no warranty claims related to condensation. Lamp A was from a vehicle for which no warranty data was provided.

Gore engineers conducted a two-step analysis in order to:

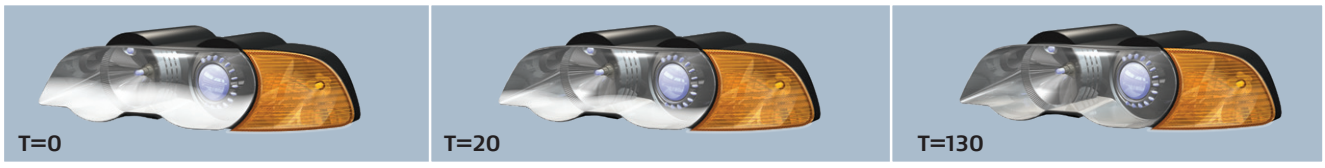
- Evaluate the relative condensation performance of the two lamp designs, and
- Identify specific design form-factors that can improve clearing times, to help reduce condensation-related complaints.

Step 1: Clearing Test to evaluate headlamp condensation performance

This proprietary Gore test protocol includes preconditioning to ensure lamp conditions at the start of the test are identical. Temperature and relative humidity are controlled during the test, to isolate the effect of lamp design on condensation clearing performance.

- Under identical test conditions, using the identical vent, Lamp A took more than six times longer to clear than Lamp B.
- This result was congruent with the warranty data, as no condensation-related warranty claims were reported for Lamp B.

Lamp A – Final clearing time: 130 minutes



Lamp B – Final clearing time: 20 minutes

Together, improving life

Step 2: Visual analysis / disassembly of each lamp

Visual analysis provides clear evidence of Lamp B's much faster condensation clearing time compared to Lamp A.

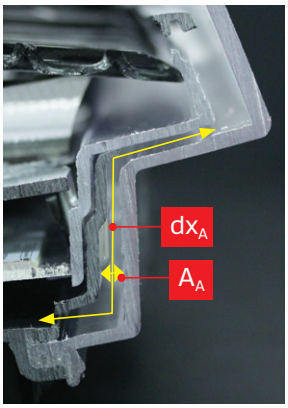
Lamp B's faster clearing time is attributed to the fact that its internal lamp design is more favorable to diffusion. The process of diffusion is governed by Fick's Law:

Fick's Law

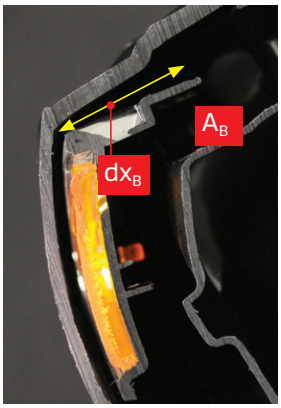
Diffusion Rate	Diffusion Constant	Exchange Surface Area	Concentration Gradient
			dc = concentration difference (between inside and outside of the housing **dx** = distance between concentrations
V_D =	$-D$ x	A x	dc / dx
	(can't be changed)	(can be changed)	(dc can't be changed with passive systems) (dx can be changed)

To facilitate diffusion, maximize the A/dx ratio between areas of high and low moisture concentration. We can more clearly illustrate this principle by examining each lamp's diffusive path, as shown below.

Diffusive paths from lens to vent



Lamp A – slower clearing time



Lamp B – faster clearing time

In comparing these headlamp designs, we see that:

- Diffusive Path Length $dx_B < dx_A$
- Exchange Surface A_A < Exchange Surface A_B

Therefore $A_B / dx_B > A_A / dx_A$ and under equal concentration gradients, we would expect Lamp B to have faster clearing performance. This expectation is consistent with OEM warranty data.

Additionally, we would also expect Lamp A to have greater potential for localized "cold spots" due to the close clearances, which can lead to condensation.

Summary

Consistent with previous data Gore has generated, this laboratory testing and visual analysis reinforce the conclusion that a lamp's internal design can significantly impact how rapidly a diffusive vent can clear condensation.

Find out more about this experiment, and ask your local Gore representative about more condensation-management solutions for your automotive lighting.

About Gore

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Gore develops products and technologies that address complex product and process challenges in a variety of markets and industries, including aerospace, automotive, pharmaceutical, mobile electronics and more. Through close collaboration with industry leaders across the globe, Gore enables customers to design their products and processes to be safer, cleaner, more productive, reliable, durable and efficient across a wide range of demanding environments. **Learn more at gore.com/autovents**

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