

Integrating Moisture Control into Structural Components

How Injection-Molded Desiccants Improve Reliability in Sealed Electronic and Optical Systems.

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Executive Summary

This whitepaper explores the challenges of moisture control in sealed systems, the design characteristics of injection-molded desiccants, and how engineers can determine when this approach is appropriate compared with traditional desiccant formats.

Moisture management is a persistent engineering challenge in sealed systems. Electronics enclosures, optical assemblies, and ruggedized transport containers frequently operate in environments where temperature swings, humidity exposure, and pressure changes can introduce condensation. Over time, even small amounts of trapped moisture can degrade performance, fog optics, corrode electronics, or shorten system life.

Traditional desiccants, such as packets or basic desiccant bags, are viable in many applications, but can present challenges in systems where space is limited, vibration is severe, or long-term reliability is required. As such, engineers designing compact or ruggedized systems often need moisture control solutions that can integrate directly into the physical structure of the device rather than simply occupying unused space.

H2OLock® IMD (Injection Molded Desiccant) from AGM Container Controls Inc. (AGM) offers an alternative to the problems associated with traditional desiccants. By combining 4A molecular sieve with a nylon binder and molding the composite into engineered shapes. Accordingly, the resulting desiccant becomes a durable mechanical component that can be precisely integrated into assemblies.

Limitations of Traditional Desiccant Formats

Traditional desiccant solutions typically rely on loose fill materials or bagged desiccants placed inside an enclosure. While effective in many circumstances, these approaches introduce several design limitations.

First, loose or bagged desiccants can be difficult to integrate into compact assemblies. In tightly packaged systems, there may be little unused space available for a desiccant packet.

Second, vibration or mechanical shock can cause traditional desiccant materials to break down or generate dust over time. This can be problematic in precision optics or electronics assemblies where contamination must be avoided.

Finally, conventional desiccants function passively as another part that must be accommodated and installed, rather than structural components.

Such limitations have led engineers in some

industries to explore alternative formats that combine moisture control with mechanical durability.

H2OLock IMD: An Injection-Molded Desiccant

H2OLock IMD is a composite desiccant material manufactured using injection molding techniques. The material combines 4A molecular sieve with a nylon binder and proprietary additives, allowing the desiccant to be molded into complex geometries while retaining moisture adsorption capability.

Unlike traditional desiccant packets, **H2OLock IMD** components can be shaped to match the geometry of the surrounding assembly. Thin walls, curved shapes, and complex mechanical features can be incorporated directly into the molded part.

Due to the nylon binder, the molded material behaves in a manner similar to glass-filled nylon. This allows the desiccant to tolerate compressive and flexural loads, and enables



engineers to incorporate it into assemblies where conventional desiccants would be neither practical nor preferred.

Key Material Characteristics

Functional moisture capacity: 2.50 g H₂O/in³

Compressive strength: 15,000 PSI (dry) & 9,500 PSI (saturated)

Flexural strength: 5,750 PSI (dry) & 2,200 PSI (saturated)

Maximum service temperature: 120°C continuous & 200°C short term

Mechanical and Environmental Performance

The composite structure of **H2OLock IMD** allows it to withstand loads that would damage traditional desiccant materials. As such, injection molded desiccant components may perform both as moisture adsorbers and as mechanical parts within an assembly.

AGM has conducted vibration testing to verify the non-dusting behavior of the molded desiccant. Accordingly, IMD was tested under a rigorous vibration profile and found that the desiccant meets the MIL-D-3464 non-dusting requirements of less than 0.5mg of dust. Such testing demonstrates that the material remains intact under vibration profiles representative of demanding applications.

As with any polymer-based material, environmental compatibility should be



evaluated for the specific application. Because the binder material is Nylon, environments that are unsuitable for Nylon—such as prolonged ultraviolet or chemical exposure — may also be unsuitable for **H2OLock IMD**.

When used within appropriate environmental conditions, the material provides a durable moisture control solution for long-term installations.

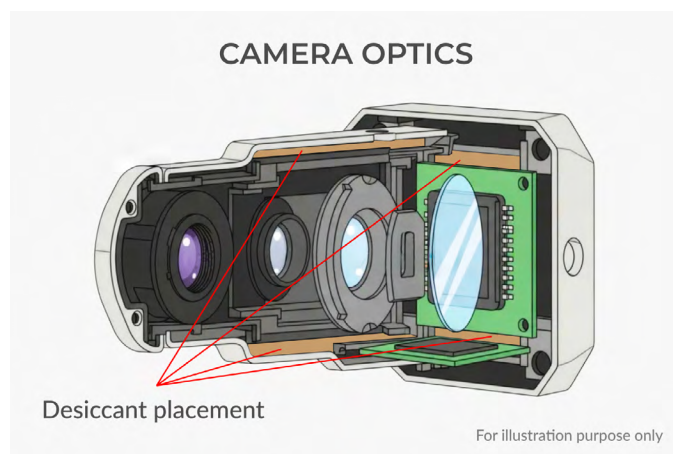
Design Integration and Customization

A primary advantage of injection molded desiccant is the ability to design a desiccant component alongside the mechanical structure of the product.

Typical installation methods include:

- Bolted mounting within an assembly
- Press-fit installation
- Adhesive bonding

Because the molded desiccant behaves similarly to a glass-filled nylon, it may also serve as a structural element in certain designs. However, engineers must consider the timing of installation to minimize unnecessary exposure to ambient humidity before the enclosure is sealed.



For this reason, a molded desiccant is typically installed just prior to sealing the given enclosure.

For development and prototyping, AGM can produce small batches of **H2OLock IMD** sample components using 3D-printed molds. This capability allows engineers to evaluate the material in their assemblies before committing to full production tooling.

Full production parts are generally produced as custom molded components. Typical tooling costs range from approximately \$10,000 to \$40,000, with tooling lead times of approximately 12–16 weeks.

AGM also offers a standard molded component (P/N 647125), a cylindrical part measuring approximately 0.344 inches in diameter by 1.62 inches long.



Desiccant Sizing Guidance

The appropriate IMD desiccant volume for a given application depends on enclosure size, sealing effectiveness, and desired service life.

As a starting point, AGM recommends a rule-of-thumb sizing guideline:

Approximately 2.88 cubic inches of **H2OLock IMD** per cubic foot of enclosure volume

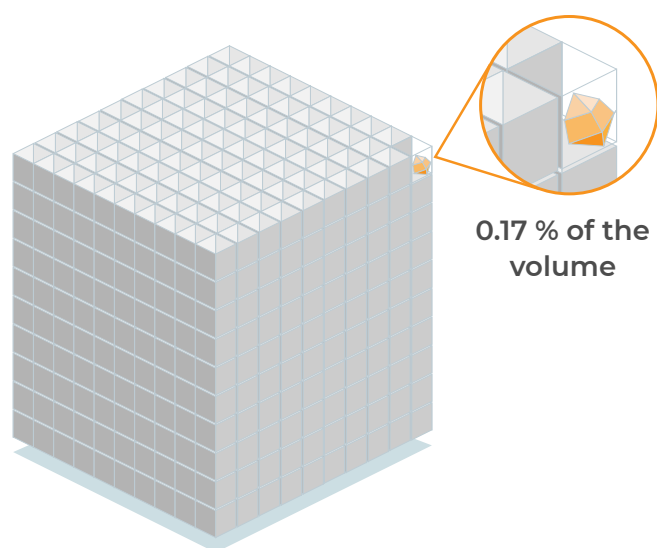
This sizing is estimated to provide approximately 12–18 months of moisture protection for a sealed enclosure under typical conditions.

Actual requirements will vary depending on the sealing quality of the enclosure and environmental exposure conditions.

The above guidelines are intended for initial considerations during design. Final desiccant quantities and dimensions will be determined

through project requirements and in cooperation with AGM engineers. For specific technical guidance, contact AGM Engineering, or explore **AGM's Hydra2O** moisture analysis service.

INJECTED MOLDED DESICCANT (IMD) SIZING DIAGRAM



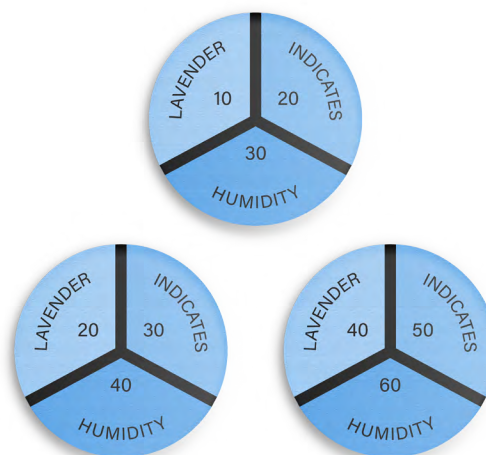
Lifecycle and Maintenance Considerations

H2OLock IMD components are not regenerable. When the desiccant reaches saturation, the part must be replaced if continued moisture control is required.

In some applications, the desiccant may be installed in a manner that allows periodic replacement. However, in others — particularly sealed aerospace or defense systems — the desiccant capacity may be sized to provide protection for the full service-life of the product.

Engineers may choose to incorporate humidity monitoring or weight tracking to determine when desiccant saturation occurs in replaceable installations.

Typical shelf life for **H2OLock IMD** components is one year from shipment when stored in unopened original packaging between 0–90°F and 0–75% relative humidity.



Example Applications

Several applications illustrate the types of environments where injection molded desiccants may be beneficial.

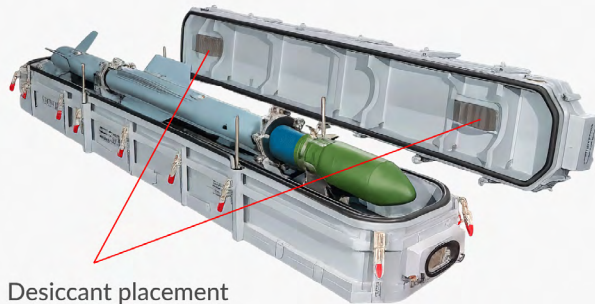
In **defense systems**, **H2OLock IMD** has been used inside missile launch and storage tubes to control moisture within sealed assemblies exposed to outdoor environments.

In **industrial instrumentation**, the material has been evaluated for use inside rugged outdoor water meters with electronic connectivity, where the electronics must remain protected from condensation over extended periods.

Other potential applications include **camera lens assemblies and optical systems** where internal condensation could degrade imaging performance.

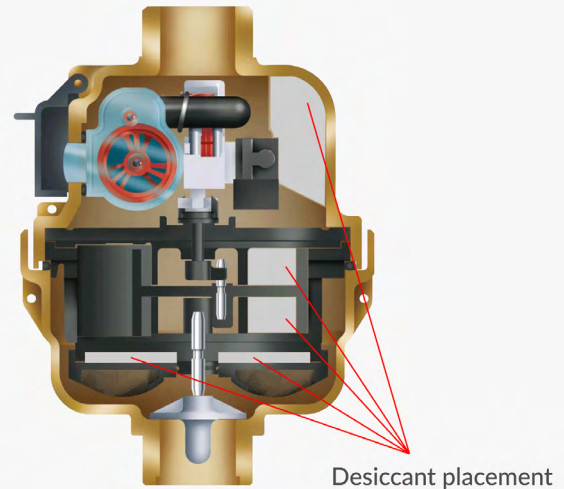
These examples highlight situations where both moisture control and mechanical durability are required within a confined space.

MISSILE CASE



For illustration purpose only

WATER METER



For illustration purpose only

Conclusion

Moisture control remains a fundamental challenge in sealed electronic and mechanical systems. As products become more compact and operate in increasingly demanding environments, engineers must often integrate moisture management directly into the structural design of the system.

Injection molded desiccants such as H2OLock IMD provide an alternative to traditional desiccant formats by combining adsorption performance with mechanical durability and geometric flexibility. By enabling custom-shaped desiccant components that can be integrated into assemblies, this approach gives engineers additional tools for designing reliable systems that resist moisture-related failure.

For applications requiring durable, precisely integrated moisture control, injection molded desiccants represent a practical option worth evaluating during the design process.

Engineering Support

Selecting the right desiccant involves balancing environment, performance and design constraints.

If your application has unique requirements—such as aerospace exposure, long-term storage or tight integration — working directly with a design engineer can help ensure the correct solution.

Need help sizing or selecting a desiccant?

AGM works with engineers to develop solutions tailored to specific applications and environments. Call AGM at (520) 881-2130, or email engineering at www.agmcontainer.com

