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Non-Metallic Enclosures Compared to Metallic Enclosures

What you want from your enclosure is long-term, productive service. Knowing your application and the environment in which it will be located will help, but understanding the materials available will complete your research so that you can make the right decision for your particular application.

Often in the design process, enclosure selection is one of the last things to consider. Alternately, the enclosure is selected up front, but based solely on what was used before or what is familiar and not what the application and environment might demand. There are many design engineers who believe that their only enclosure selections are between metal and plastic enclosures. This, of course, is only partly true.

When making the decision for purchasing the right enclosure for your application, there are a number of considerations to think about—besides environment, which includes corrosion resistance **(see Sidebar I),** temperature, size, weight, and more. Other things to examine in your research include electrical safety, conductivity, and shielding properties; security access in the event of vandalism; cooling or heating requirements; the aesthetics of the device based on whether it will be visible or not; and the overall value and cost of the system when taking into consideration time in service and initial costs.

Outside application photo of polycarbonate enclosure.

SIDEBAR 1: Recommended Materials for Corrosive Environments

Recommendation	Acids	Alkalines	Solvents
Highly Recommended	• Stainless Steel • Fiberglass	• Fiberglass • Stainless Steel	• Fiberglass • Stainless Steel • Aluminum • Powder Coated Steel
Acceptable	• Polycarbonate • PVC • Powder Coated Steel	• Polycarbonate • Galvanized Steel • Powder Coated Steel	• Galvanized Steel
Limited or Unacceptable	• Aluminum • Galvanized Steel	• PVC • Aluminum	• Polycarbonate • PVC

The Basics of Metal Enclosures

Design engineers often think about purchasing metal enclosures first, based primarily on the idea that they are stronger and more durable than most other materials. This may or may not be the case dependent on the application but, more importantly, these considerations may not be necessary in the first place. For example, you may not need an enclosure that is durable if the components being protected are housed deep inside a piece of equipment that already has its own environmental control, and is not subject to the outside environment at all—think subsystems, additional Wi-Fi circuits, or an upgraded sensor system.

When considering some of the factors mentioned above, size and weight can be a bigger issue than simply protection. This is especially the case in many automotive, medical, marine, and agricultural applications where compactness and minimal weight are key features. Further, metal enclosures often require additional sealing to keep out moisture and water. They are mechanical in nature, requiring either hinges and doors or two sections that must be bolted or screwed together.

Corrosion resistance is an important item to think about when using metal enclosure materials. Most metals corrode, under particular conditions and

at rates that depend on the type of metal used and the environmental conditions in which it is located. Consider the food and beverage industry where continual washdowns—often with detergents and chemicals—are part of the daily or weekly environment. Such regular abuses might preclude the use of company labeling and branding opportunities as well. Stainless steel and aluminum, for obvious reasons, are common choices for enclosure material, based on their high resistance to corrosion. When designing a system that will be used in harsh environments, these choices may provide you with reliable protection where other metals do not. Stainless steel enclosures are often highly expensive to purchase, making them difficult to purchase when project budget is an issue.

Strength and toughness can be a clear factor when deciding on the right enclosure. Strength is a measurement of the material's resistance to failure. Toughness, on the other hand, measures a material's ability to withstand sudden impacts. These two features work together, in that increasing toughness usually decreases strength and vice versa. When using a metal enclosure, such as stainless steel or aluminum you may get high strength, but units may dent easily, reducing the integrity of the box—and possibly breaking the sealing ability of the unit dependent on the type and material of the seal used.

For example, when an enclosure is not flush and the seal loses its properties, the enclosure is no longer water or air-tight; moisture and particulates are key reasons some electrical and electronics components fail. Plus, the internal controls and circuits can also become easier to access, reducing security of the system overall.

The Basics of Non-Metal Enclosures

Some of the most used materials for non-metal enclosures include polycarbonate, polystyrene, and ABS. It's important to note that regular advancements are being made in plastics technology. What you may have found unavailable one year may be available the next.

When it comes to polycarbonates, some are available that feature UV stabilizers used to protect the material from sun overexposure. Others may include a formulation that includes glass fibers, which can significantly

increase tensile strength, flexural strength, and flexural modulus, in addition to providing greater heat deflection for temperature sensitive applications.

Plastics are often more amenable than metals to be worked, molded, and modified to fit a specific application. This versatility allows such materials to be used in a wide variety of applications, because having flexibility in material components makes it easier to fit a specific need. Plastic enclosures have the added benefit of being lighter in weight, which makes them easier to handle and ideal for handheld devices, as well as for mounting on delicate surfaces such as sheetrock.

Some additional features that plastic enclosures make available: UV performance, broad temperature range, chemical resistance, waterproof, non-magnetic and electrical insulating, ease-of-processing, self-extinguishing flammability properties, and ease of modification. There are plastics that won't dissipate harmful gasses in the event of fire, and there are some chemicals that react negatively to metals where plastic enclosures are more suitable. Note also that most often plastic enclosures are less expensive than metal enclosures and have shorter lead times, especially when semicustom or custom elements are needed.

Shown are stainless, aluminum and painted steel enclosures.

Consider the Application

Manufacturing control systems, as well as process control systems are often direct-wired and may depend on being RFI/EMI shielded from the electrical noise present in those applications. When a metal enclosure is used, the components inside are automatically protected against such outside interference, making the overall system robust in nature. This same shielding works well with other heavy machinery, such as equipment found in the machine tool industry. Such applications often have additional needs for chemical resistance.

For these types of applications, non-metal enclosures may need to have additional shielding to maintain a safe place for sensitive electronics. Further, such enclosures may need to have special seals or use particular materials that allow them to operate in the harsh environments of the factory floor. In either case, if the enclosure houses delicate electronic circuitry there may also be a need for cooling hardware to be installed. Metal and non-metal enclosures have their value **(see Sidebar II).**

Since so much equipment and systems are being upgraded with wireless communications built into them, the enclosure market has had to keep up. When using metal enclosures, the user may need to install an external antenna in order to get optimal use from the system. If the environment dictates that a metal enclosure is necessary, be sure to also research any antenna network you plan to use with it to be sure that the antenna can also handle the harsh environment.

Consider that external antennas are often vulnerable to environmental elements, such as corrosion, ferrous oxide deterioration, and natural ambient interference from the environment itself. This may be the biggest reason why design engineers are switching to non-metal enclosures in communications applications: They allow for free transmission of electronic signals.

Because most non-metal enclosures enable electronic signals to transmit through the enclosure itself, the choice of enclosure material becomes more dependent on its ability to resist corrosion, tolerate the use of harsh chemicals, maintain a strong and tough exterior, and sustain its thermal

SIDEBAR 2: Pros and Cons for Primary Metal and Non-Metal Enclosure Types

Metal Enclosure Types	Pros	Cons
Stainless Steel	• Corrosion resistant • Impact resistant • RFI/EMI shielded	• More expensive than low carbon steel or aluminum
Low Carbon Steel	• Inexpensive metal • RFI/EMI shielded	• Requires coating to prevent rust • Will rust if coating wears off
Aluminum	• Rust resistant • Lighter than steel	• Lower impact resistance than steel
Non-Metal Enclosure Types	**Pros**	**Cons**
Polycarbonate	• Highly impact-resistant • Nice appearance • Allows for RFI/EMI transmissions	• More expensive than PVC, ABS, and Polystyrene
• **PVC** • **ABS** • **Polystyrene**	• Cheaper than polycarbonate • Allows RFI/EMI transmissions	• Lower impact resistance • Limited temperature range
Polymer-fiberglass composites	• Corrosion resistance • Weight to strength ratio • Allows RFI/EMI transmissions	• Blooming

capabilities. In addition, non-metal enclosures provide engineers with an attractive finis, and can be easily adjusted for changes added later. These include cutouts for additional access to the electronics, whether for quick security checks, to download information, or for audio/video connections.

Non-metal enclosures have, over the years, proven to be durable, never rust or corrode in harsh environments, and provide secure and lockable lids to prevent unauthorized access. They are more resilient to impact (they give rather than dent) and allow wireless systems to easily operate without an external antenna.

The one negative consequence of using metal enclosures is the compromise of the gasketed seal, which is extremely important to prevent moisture, dust, and other environmental factors from damaging internal controls. Non-metal enclosures usually have the seal inside a groove in the lid, which protects it from direct damage. All of this helps to explain why non-metal enclosures are frequently replacing metal enclosures in many applications.

In conclusion, remember that your application is the most important guide to what type of enclosure you will want to purchase. As mentioned, going with the same enclosure for every application typically isn't the right path to take. When doing your research, find companies that have multiple options available, have been doing business for a long time, and have experience and expertise in how to select and implement enclosure technology. Enclosure needs, like other vital components inside your application, should be selected carefully and confidently.