APPLICATION BRIEF

Sealing FDM Parts

Overview

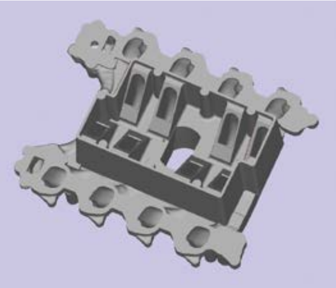
Fused Deposition Modeling (FDM) parts can provide substantial cost savings and reductions in time to market on many applications. FDM technology is an additive manufacturing process that builds plastic parts layer by layer, using data from computer-aided design (CAD) files. FDM parts also enable significant performance improvements because they eliminate virtually all geometrical restrictions. But the porosity of FDM parts has presented an obstacle to using them in functional prototyping and direct digital manufacturing applications that require sealing of gases and liquids. A number of different sealing methods have been validated for FDM parts, making it possible to take advantage of the cost savings, design freedoms and leadtime advantages provided by FDM in a wide range of new applications.

Application Outline

There are many methods to seal an FDM part and many characteristics to consider when choosing the best approach. To assist in selection, Stratasys evaluated the cost, time, difficulty, geometry limitations, maximum part size, viscosity, accuracy retention, maximum pressure, chemical resistance and temperature sensitivity of five common sealing methods.

Smoothing Station: The Finishing Touch Smoothing Station seals a part's surfaces by exposing them to a vaporized smoothing agent inside a chamber. The Smoothing Station is very easy to use and preserves dimensional integrity. Its use is limited to applications with no higher than atmospheric pressure and temperatures at or below 212 °F (100 °C). The Smoothing Station is often selected when electroplating parts, using them as patterns for investment casting or producing functional prototypes of liquid-holding geometries such as bottles or cooling lines in molds.

FDM manifold for functional testing.



CAD model of manifold showing internal features.

Production manifold.

BENEFITS OF FDM

- Extend the advantages of FDM to fluid-tight applications
  - Complex designs
  - Internal cavities and passages
- Preserve lead time advantage
- Preserve cost advantaget

FDM IS A BEST FIT

- Functional testing applications.
- Complex, intricate designs
- Low production quantities (1 to 500 pieces)
- Compatibility between preferred FDM material and sealing method
- Performance characteristics meet specs
  - Sealing pressure
  - Chemical, thermal resistance

Epoxy Coating: Hysol E-20HP is a two-part epoxy that is dispensed with a mixing gun and brushed onto the part in small sections. This method does not require an investment in equipment, and the end result is ideal for harsh operating conditions. The coating will maintain an airtight seal up to a pressure of 65 psi (448 kPa), can withstand temperatures that match or exceed those of FDM materials and is resistant to many chemical agents. It can be difficult to seal large or intricate parts with epoxy. Inaccessible features such as internal channels cannot be sealed. The thickness of the epoxy combined with the manual application reduces dimensional accuracy of the part. Hysol E-20HP may be used on any of the currently available FDM materials.

Epoxy Infiltration: BJB epoxy resin (TC-1614) penetrates the surface of porous and semi-porous parts. FDM parts are immersed in the resin and a vacuum is drawn to infiltrate the epoxy into the part. In addition to a vacuum chamber, an oven is needed to pre-heat and cure the epoxy. Epoxy infiltration offers an airtight and watertight seal up up to 65 psi (448 kPa). Parts sealed by this method also withstand high temperatures and are chemically resistant. The sealing process is straightforward and can be completed in less than three hours but is somewhat expensive due to the cost of the epoxy. When care is used in the infiltration process, there is little change in the part's dimensional accuracy. BJB TC-1614 may be used on any of the currently available FDM materials.

Dipping: Dipping FDM parts in solvent can substitute for using the Smoothing Station when it is unavailable or the part exceeds the chamber capacity. All characteristics are similar to those of the Smoothing Station except that dimensional accuracy is lower. The solvent melting action is quick and aggressive, so dimensional accuracy is difficult to control. As with the Smoothing Station, the use of this method should be limited to low-temperature, atmospheric-pressure applications. Dipping is suitable for all ABS-based FDM materials.

Painting and Filling: When FDM parts need only partially sealed surfaces, a few coats of paint and a little body putty can be an inexpensive option. Since this is a manual operation, the accuracy and quality of the end product is influenced by the skill and care of the technician. The advantages of this option include low cost, short cycle time and ease of application. Its disadvantages are lack of an airtight seal and inability to resist high temperatures or chemicals. This method can be used to reduce the porosity of FDM tooling used in thermoforming, for example.

Customer Story

The W.M. Keck Center for 3D Innovation delivers high-quality rapid prototyping and rapid production services. Recently a manufacturer of intake manifolds and other automotive aftermarket products came to the center looking to improve its product development process. The aftermarket manufacturer had performed computer simulation on fluid flow through the manifold and wanted to test prototypes of several designs that appeared promising. The conventional method of building intake manifold prototypes is machining a solid block of aluminum, which is expensive and time-consuming.

"The primary challenge in this application was that the surface of the part needed to be sealed before it could be used for functional testing." Medina said. Technicians at the Keck center evaluated the Stratasys Finishing Touch Smoothing Station and BJB TC-1614 two-part epoxy to seal the part. "The aftermarket manufacturer tested FDM parts sealed with both methods and found they provided good performance in functional testing on an automotive engine." Medina concluded. "The lower cost and shorter delivery time of FDM prototypes is enabling the aftermarket manufacturer to make rapid improvements in the performance of their product."

How Did FDM Compare to Traditional Prototyping Methods?

METHOD	COST	PRODUCTION TIME
CNC Machined Aluminum	$30,000	6 weeks
FDM	$5,740	3 weeks
Savings	$24,260 (81%)	3 weeks (50%)

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