An Introduction to Tank Sealant

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As part of the process of sealing my fuel tanks, I started researching fuel tank sealants in order to get as good an understanding of them as I could. I came up with a lot of interesting (at least to me) information and since the forums and newsgroups are always full of questions regarding tank sealants, I thought I would put together a little article describing the results of my research in hopes that it might help others when they get to this point in their projects.

Overview

Although we tend refer to all tank sealants as "proseal", Pro-Seal is actually the trade name for a line of aerospace sealants manufactured by the PRC-DeSoto division of PPG Industries (now PPG Aerospace). As there are other manufacturers's products in common use in homebuilt aircraft, I'll refer generically to tank sealant or just sealant in order to avoid any confusion.

There are a number of variations of tank sealants; however the tank sealants that are commonly used in homebuilt aircraft are 2-part, manganese dioxide cured, polysulfide sealants designed to meet the MIL-S-8802F Type II (now AMS-8802) specification. This specification describes the characteristics and properties of the sealant, such viscosity, curing time, strength and adhesion, as well as the testing methodology used to determine if the sealant meets the specification. For those who are interested, the text of the MIL-S-8802 specification can be found at: http://assist.daps.dla.mil/docimages/0000/74/12/7194.PD9 .

As homebuilders, we are not required to use Mil spec products; however it is generally a good idea to do so where practical, as these products have been thoroughly tested and the results are well known and predictable.

General Characteristics

Tank sealant is used to seal integral fuel tanks by sealing the joints and rivets, preventing fuel leaks. They adhere well to aluminum, titanium, steel and other materials. Tank sealant cures at room temperature to a flexible rubber-like state that maintains its properties within a temperature range of -65°F to 250°F. They are generally resistant to most fuels and oils used in aviation. More information regarding adhesion and fuel resistance can be found in the Mil Spec.

Basic Properties

Tank sealants are identified by 2 primary properties, viscosity and working time. There are 3 classes of tank sealant as defined by viscosity. Class B sealant is the paste consistency sealant that is most commonly used in sealing homebuilt aircraft tanks. Class B sealant is designed to be applied using an extrusion gun such as a Semco or Techcon gun or by using a spatula or similar tool, and does not sag or run on vertical surfaces. Class A sealant is a lower viscosity, pourable sealant designed to be applied by brush. Class C sealant is an intermediate viscosity sealant designed for brushing or rolling on faying surfaces. Class C sealants are not common in

homebuilt aircraft as their application and cure times are quite long compared to Class A and B sealants.

In addition to viscosity, sealants are defined by their working or application time. This is the time during which the material can be applied. Beyond this time, the material will cure sufficiently that it can no longer be worked and may not adhere properly. Working times defined in the MIL spec include ½, 1, 2, and 4 hour. 2 hour working time is the most commonly available from the normal sources. In addition to the standard sealants as defined by the current Mil spec., there are now some rapid cure sealants available that cure much more quickly than the standard sealants. They are currently available only in ½ hour working time.

The part number of the material denotes its properties. For example, an A½ part number denotes a low viscosity, ½ hour working time sealant, while a B2 part number denotes a paste consistency, 2 hour working time sealant.

There are 2 other times that are important in using sealant; these are the "tack-free" time and the "curing" time. The tack-free time defines the time by which the sealant is no longer sticky to touch and the cure time defines the time at which the sealant is completely cured to a specific hardness as defined in the MIL Spec. The following table describes the times for the most common versions of sealant.

Sealant Type	Work Time*	Tack-Free Time**	Curing Time**
A½	½ Hour	16 Hours	64 Hours
A2	2 Hours	64 Hours	112 Hours
B½	½ Hour	16 Hours	45 Hours
B2	2 Hours	64 Hours	112 Hours
B4	4 Hours	72 Hours	136 Hours
B½ (rapid cure)	½ Hour	4 Hours	7 Hours

* Minimum Time ** Maximum Time

These timings are based on a temperature of 77°F and 50% relative humidity. Variations in temperature and humidity can affect cure times. Higher temperatures and higher humidity will decrease these times, while lower temperatures and lower humidity will increase these times.

Sealant Manufacturers

There are 3 primary manufacturers of tank sealant:

1. PPG Aerospace (PRC-DeSoto Division of PPG Industries) - Manufacturers of the "Pro-Seal" line of aerospace sealants.

2. Flamemaster Corporation – Manufacturers of the "Chem Seal" line of aerospace sealants.

3. Advanced Chemistry & Technology, Inc. – Manufacturers of the AC and MC line of aerospace sealants.

The following table provides a list of product numbers of tank sealants from these manufacturers, as well as some other possibly useful products:

Product Type	PPG (Pro-Seal)	Flamemaster (Chem Seal)	AC Tech
Tank Sealant	P/S 890, PR-1440	CS 3204	AC-236
Access Panel Sealant	PR-1321, PR 1428	CS 3330	AC-215
Firewall Sealant	P/S 812, P/S 700	CS 1900	
Tank Sealant (Rapid Cure)		CS 3204R	AC-240

Most of these products are available in Class A and B viscosities, in various working times, with some available in Class C viscosity.

Packaging

Tank sealant is packaged in 3 basic forms: individual containers, pre-filled tubes, and "jar" kits. Individual containers are available in various sizes ranging from ½ pint, to 50 gallons. Common sizes used in aircraft homebuilding include ½ pint, 1 pint and 1 quart. It should be noted that MIL-S-8802 specifies that containers of 1 gallon or less be filled to 75% capacity rather than full, allowing the product to be mixed in the original container if desired. Pre-filled tubes are available in 2.5 oz. and 6 oz. sizes for use in Semco or Techcon sealant guns. MIL-S-8802 specifies that these tubes be filled to 2 oz. and 3.5 oz respectively, however some distributors provide 6 oz. tubes with up to 5.5 oz of sealant. Sealant is also available in small individual use "jar" kits with typical sizes of 1 oz, 2 oz and 4 oz. Jar kits are intended to be mixed and used all at once and are useful for small applications or repairs.

Product Sources

Tank sealants are available from the standard aircraft homebuilding sources such as Vans Aircraft, Aircraft Spruce and Wicks Aircraft; however these sources generally carry only limited varieties and packaging sizes of sealants. In addition, some of the distributors that generally cater to aircraft manufacturers and airline maintenance facilities sell small quantities of sealant and can generally supply almost any variety and packaging size. The following table shows some of the sources I am aware of and the products they carry, as of the writing of this article (presented in alphabetical order):

Company	Products	Minimum Order
Aircraft Spruce (877) 4-SPRUCE www.aircraftspruce.com	CS 3204-B2 2½ Oz. Tube CS 3204-B2 6 Oz. Tube P/S 890-B2 Pt. Kit P/S 890-B2 Qt. kit	None
National Sealants & Lubricants, Inc. (800) 527-0011 www.nationalsealants.com	Full Line of Flamemaster Products PPG Aerospace Products Empty Tubes & Nozzles	$35
PPG Aerospace (818) 240-2060 www.ppgaerospace.com	Full Line of PPG Aerospace Products	$50

Sealpak Company, Inc. (316) 942-6211 www.sealpakcoinc.com	Full Line of Flamemaster Products Empty Tubes & Nozzles	None
Van's Aircraft (503) 678-6545 www.vansaircraft.com	CS 3204-B2 Qt. Kit CS 3204-B½ 6 Oz. Tube AC-240-B½ 1 Oz. Jar Kit CS 1900 6 Oz Tube	None
Wicks Aircraft (800) 221-9425 www.wicksaircraft.com	P/S 890-B2 Pt. Kit P/S 890-B½ 2 Oz. Kit	None

Tank sealant has a useful life of approximately 9 months from date of manufacture, so you should only purchase the amount that you plan to use immediately.

Sealant Application

Sealing fuel tanks is probably the single most dreaded activity in homebuilding an aircraft. While it is time consuming and definitely messy, it is really not very difficult to do properly.

Tank sealant is incredibly tenacious and will immediately stick to anything it touches, so gloves (latex or similar) should be worn at all times during the application process. A number of extra gloves should be available as they will need to be changed often. It is also a good idea to wear old clothes as it is very difficult, if not impossible, to remove sealant from clothes. A container of solvent and a number of clean cloths and/or paper towels should be on hand to immediately clean off any sealant that gets on anything. Prior to curing, the sealant can be removed using a solvent such as MEK. Once the sealant is cured, it is very difficult to remove.

Tank sealant will adhere to almost any aluminum surface including bare metal, alodined or anodized surfaces, provided that the surface is properly cleaned. Scuffing the surface with a scotchbrite pad may improve adhesion by providing some "tooth" to the surface.

It is critical that all the surfaces to which the sealant is to be applied be properly clean and free of all contaminants such dirt, grease and oils. All surfaces should be cleaned with a solvent such as MEK. Solvent should be applied using a new, lint-free cloth that is kept saturated with solvent at all times. The surface should be dried with a second clean rag before the solvent has had time to evaporate. This will ensure that any contaminates are not redeposited on the surface. In addition, rivets should be soaked in solvent to remove any oils. After the surfaces have been cleaned with solvent, they should not be touched or body oils could contaminate the surface.

Prior to use, the sealant must be mixed in the proportion of 100 parts of Part A to 10 parts of Part B, by weight (mixing by volume is possible; however the ratio would then be 100:8.3). It is important to accurately measure the sealant in order to obtain proper curing. Prior to weighing, each part should be stirred separately. Part B is then added to Part A and mixed thoroughly until a uniform grey color is obtained. There should be no white or black streaks in the mixture. Care should be taken to ensure that no unmixed material is left on the sides or bottom of the container. If machine mixing, care should be taken not to mix so vigorously as to heat the mixture or it will

reduce the working time. When using pre-filled tubes, the proper proportions of each part are already measured and the tube should be mixed according to the instructions with the tube. No more sealant should be mixed than can be used within the working time of the sealant. As noted above, working time is affected by temperature and humidity. The specified working time is based on a temperature of 77° F. As a general rule, increasing the ambient temperature by 20°F will cut the working time by half, while decreasing the ambient temperature by 20°F will double the working time.

The mixed sealant should be applied in a thin layer to the components to be sealed. Sufficient sealant should be applied so that it oozes slightly out of the edges of the joint when pressed together. The joint can then be riveted together in the normal manner. The excess sealant that oozes out can be smoothed into a fillet around the joint. The edges and corners of all components should have a fillet of sealant applied to ensure that there are no voids that could result in a fuel leak. In addition, a small dab of sealant should be applied to the shop head of each rivet. Any excess or smeared sealant can be cleaned up with solvent.

There has been much discussion regarding thinning tank sealant in order to get it to flow into small cracks or voids. While the manufacturers do not recommend doing so, as they must maintain compliance with the Mil spec., tank sealant can be thinned using Toluene. Sealant can be thinned with up to 15% Toluene, by weight, without affecting the properties of the sealant. While other solvents, such as MEK, may thin tank sealant, they may also affect its properties with potential adverse results, so it is recommended to use Toluene if you must thin the sealant. An alternative to thinning the sealant is to use a Class A sealant whenever a lower viscosity is needed.

There is also a practice by some to over-catalyze the sealant in order to speed up curing time. This is generally not a good idea as the sealant will no longer meet the Mil spec. If a faster cure time is required, it is better to use a rapid cure sealant rather than play with the chemistry of the sealant.

After application and cleanup, the sealant should be allowed to fully cure. The curing process can be sped up somewhat by increasing the temperature of the components; however the temperature should not exceed 120°F at any time.

Other Useful Sealants

While most of the sealant discussions in aircraft homebuilding revolve around tank sealant, there are some other sealants that may be of interest:

Access Panel Sealant – This is a low adhesion sealant designed to seal access panels where periodic removal is desired. Characteristics are similar to that of standard tank sealant except that the low adhesion facilitates removal for inspection.

Firewall Sealant – These sealants are designed to withstand the higher temperatures that may be found in engine compartments and are used to seal joints and openings in firewalls.

The product numbers for these sealants are listed in the product table above.

Resources

For additional information, I suggest the following:

Sealant manufacturer websites:

http://www.ppgaerospace.com – PPG Aerospace

http://www.flamemaster.com – Flamemaster Corporation

http://www.actechaero.com – Advanced Chemistry & Technology, Inc

Sealant application systems web sites:

http://www.techconsystems.com – Techcon sealant guns and Techkit packaging

http://www.ppgaerospace.com – Semco sealant guns and Semkit packaging

Other interesting reading:

http://www.eaa1000.av.org/technicl/corrosion/faysurf.htm - An interesting article on sealing faying surfaces from EAA Chapter 1000

http://assist.daps.dla.mil/quicksearch/ - A website to search for MIL Spec documents

Disclaimer

I am not a chemical or aeronautical engineer and am not an expert in sealant technologies. This information is the result of studying the available technical information including product marketing and technical documents and MIL Spec information, as well as discussions with sealant manufacturers and distributors. While this information should be reasonably accurate, I always recommend testing any new product or process on scrap material before applying it to an airframe.

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