The Creative Adhesives Company
BEACON TECHNICAL DATA SHEET

Magna-Tac® E645

Beacon Adhesives Co. Inc.
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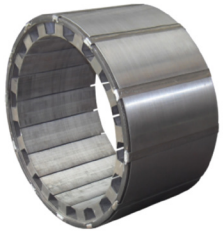
PRODUCT SUMMARY

Magna-Tac® E645 is a two-part, thermosetting, formulated epoxy adhesive for bonding stack laminations used in stators, rotors, gyros, servomechanisms, synchros, transformers and magnetic amplifiers. It can also be used as an insulating varnish for impregnated coils and small electrical equipment. Bonding is achieved by heat. Only sufficient pressure to assure complete contact is needed. Because so little adhesive is needed to accomplish a strong bond which resists shear stress, Magna-Tac® E645 has proved practical as an adhesive/dielectric in the fabrication of magnetic accelerator units such as cyclotrons and cosmotrons.

Magna-Tac® E645 is a strong metal-to-metal adhesive. Because of its excellent mechanical strength plus its resistance to many solvents, water, atmospheric conditions and temperature changes, this adhesive is adaptable to many industrial uses. It is particularly suited to the bonding of large surface areas and mass production processing.



Product Data

Epoxy Adhesive

	Viscosity	Color	Base	Wgt/Gal	Solids	Diluant	Shelf Life
Part A	6000 cps	Amber	Modified Epoxy	9.3	77%	Solvent	1 Year
Part B	80 cps	Clear		8.4	12%		

Caution!

Magna-Tac® E645 contains a volatile, combustible solvent. Provide adequate ventilation. Avoid sparks. Do not use near open flame or spark-producing equipment. Flash point is 151°F.

Methods of Stack Lamination

Most companies develop their own techniques to bond stack laminates most efficiently.
The three most common are:

1. Coil or Stack, then Vacuum Impregnate: Stack cleaned metal in flat sheets separated on a mandrel or in coils. In a pot or kettle, under vacuum, remove all entrapped air. Pressure-force adhesive between layers. Drain. Apply vacuum to remove solvent vapors. Heat cure. Cut to shape if required.

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2. Precoat, then stack: Stack parts to shape and clean. Deposit a thin film of adhesive on each surface to be bonded. Dry. Store if necessary. Assemble into stack and heat cure.

3. Coat, Stamp & Stack: Spray or roll coat adhesive onto both sides of flat sheets. Dry. Stamp to shape. Lay up adhesive-coated laminates and heat cure.

Adhesive Preparation

In order to convert the basic formulation components into a tough, hard, strong adhesive film, thoroughly mix Magna-Tac® E645 Part I with the Part II by weight in the following proportions:

By Weight Magna-Tac® E645 Part 1 – 100 parts
Magna-Tac® E645 Part 2 – 30 parts

Or...

By Volume Magna-Tac® E645 Part 1 – 100 parts
Magna-Tac® E645 Part 2 – 35 parts

The tolerance of Part II is plus or minus 10%. To assure optimum performance, mix thoroughly before using.

Reducing the Viscosity of the Mixed Adhesive

While it is not mandatory, Magna-Tac® E645 is commonly diluted with a solvent to reduce its viscosity. This allows for easier application of the adhesive.

Once part 1 and part 2 have been mixed, Magna-Tac® E645 can be diluted with Cellosolve, methyl ethyl ketone (MEK), toluene, acetone, or a 50/50 mixture of acetone and isopropyl alcohol.

Applying the Adhesive

Mixed Magna-Tac® E645 can be applied by brushing, spraying, dipping or roller coating. For very small parts, it can be dispensed easily through a hypodermic needle.

For maximum adhesive, all surfaces must be perfectly clean and thoroughly degreased. For improved strength and chemical resistance, sandblast or treat the surfaces chemically. These treatments will vary according to the material, of course.

Operators' hands must be free from grease or oil while handling coated and uncoated parts.

Cure Time

The adhesive must be thoroughly dried before curing. Drying may be accomplished at room temperature or by forced drying in circulating air ovens. If all of the solvent is not removed before curing, blisters or weakening of the adhesive film will result. Thick or highly diluted films will take longer to dry.

At normal room temperatures, air drying may take 4-8 hours. For best results, force dry at 125°F for 60 mins or at 200°F for 10 minutes. Do not dry at temperatures above 250°F (adhesive will start to cure at that temp).

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The adhesive dries to a tack free surface at room temperature. Coated parts may be stored before curing for periods of up to 6 months at room temperature. However, the adhesive film must be clean and dry.

Heat Curing

The hardening agent (Part II) of Magna-Tac® E645 is reactive above 250°F. Normal cure temperatures at the glue line range from 265°F-400°F. Curing temperature below 375°F are recommended because it is practically impossible to degrade the adhesive in that range even if the recommended curing time is exceeded.

Before curing, Magna-Tac® E645 is thermoplastic and flows freely as the temperature is raised. This allows the films to fuse to a stronger bond and assures complete "wetting" of the materials being bonded.

For certain specialized applications, however, some users prefer to retard the normal flowout. This can be done by partially curing the adhesive at contact pressure only for about 1/4 to 1/2 the "minimum gel time" shown in figure 1. Any of the normal time and temperature cycles listed may then be used for subsequent curing... but with slightly increased pressure.

Figure 1 Heating Curing Schedule

Glue Line Temperature	Minimum Gel Time	Minimum Cure Time	Maximum Cure Time
266°F or 130°C	40 min	14 hours	None
284°F or 140°C	32 min	7 hours	None
302°F or 150°C	20 min	4 hours	None
320°F or 160°C	15 min	2 hours	None
338°F or 170°C	10 min	1.5 hours	None
356°F or 180°C	8 min	1 hour	None
374°F or 190°C	6 min	45 min	None
392°F or 200°C	4 min	30 min	24 hours
428°F or 220°C	2 min	10 min	60 min

The figures refer to the temperature of the adhesive film. Allow sufficient time for the stack to attain the correct temperature. The time required for cure depends on the temperature selected, on the mass of metal and on the heat capacity of the metal in the laminate. The temperature chosen depends on the heat sensitivity of the materials being bonded and time limitations in production scheduling. If the maximum cure time is exceeded, over-curing which may cause failures - can result.

Curing Pressure

Pressure is not needed to affect the bond but is essential that the coated surfaces be in complete and intimate

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contact over the entire area of the materials being bonded. Accordingly, sufficient pressure must be applied to assure such contact. The specific amount of pressure needed will vary, depending upon the flatness of the components, porosity, resiliency, etc.

Supplemental Information

Fungus resistance: Magna-Tac® E645 after cured is fungus inert and is not conducive to fungus growth. It is, however, necessary to conduct specific tests under service conditions to determine actual compatibility with end use application.

Shelf Life

Mixed material has a shelf life of 3 months, after this time period it will begin to thicken. At this point It can be diluted with Cellosolve, methyl ethyl ketone (MEK), toluene, acetone, or a 50/50 mixture of acetone and isopropyl alcohol.

Un-Mixed material has a shelf life of 1 year from date stamp of manufacture.

Compressive Strength (approx.)	60,000 psi
Flash Point (approx.)	151°F (66°C)
Modulus (approx.)	5.0 x 105 psi
Linear Coefficient of Expansion (approx.)	65 x 10^{-6} inches/inches/°C
Thermal Conductivity (approx.)	5,000 x 10^{-7} calories/(second)(square cm)(°C)(cm)
Hardness	Shore D 75 (ASTM D 2240)
Tg	114°C
%TML	0.50 (when curled 1 hour at 100°C in air followed by 4 hours at 180°C at 10-2 Torr Vacuum) (NASA Outgassing Technical Note TND 8008

Typical dielectric properties are as follows:

Dielectric Strength	400 volts per mil
Dielectric Constant	3-4 at 106 cycles per second at 20°C
Loss Factor	0.06 at 20°C

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Typical lap shear values obtained when Magna-Tac® E645 is used to bond 0.064" etched 2024T3 aluminum alloy to itself in a 1/2 overlap are as follows:

Test Temperature	Av. Lap Shear, psi
-67°F	2800
77°F	4,000
180°F	3000
260°F	1000
300°F	800
400°F	200