NEW
REVISED
EDITION

SELECTION CHART

Dolph's®

VPI

VACUUM PRESSURE IMPREGNATION RESINS

Glossary of VPI Terms

Bond Strength: The measure of force required to break the bond of varnished helical coils of enameled magnet wire.

Bump: Briefly revert from vacuum to atmospheric pressure and again draw the vacuum. Applied in the wet vacuum cycle to help dislodge trapped air and improve penetration.

Centipoise: Unit of viscosity. Usually measured by the drag on a turning spindle immersed in the liquid, Brookfield viscosity. A force of 0.01 dyne per centimeter.

Film Build: Average build-up of cured resin on one side of a metal panel.

Copolymer: A polymer formed by the inter-polymerization of two or more chemically different monomers with each other.

cps: See Centipoise

Deaerate: Remove air and other gasses by vacuum. Note that initial deaeration after a tank fill can take from several hours to as much as 3 or 4 days depending on the amount, type and condition of the resin.

Dielectric Constant: The property of a material that determines how much charge is stored per unit volume when unit voltage is applied. The capacitance of a material compared with the capacitance of an equal volume of air or vacuum.

Dielectric Strength: The voltage a material can withstand before breakdown occurs. Usually expressed in "Volts Per Mil". Interestingly, a thicker section of material has a higher total breakdown but a lower dielectric strength, i.e. dielectric strength for one mil Mylar tape may be 3000 VPM but for 2 mils, breakdown would be only 5000 Volts (2500 VPM).

Dissipation Factor: An indication of energy loss in the circuit, as in the production of unused heat. A multiplier used to obtain useful energy compared to supplied energy.

Electrical Varnish: A resinous material used to protect and insulate electrical apparatus, which is applied as a liquid and converted by chemical action, with heat or without, to form a solid film or mass.

Flash Point: The temperature at which enough vapor is generated to flash if a spark or flame is introduced.

Foaming: An accumulation of frothy bubbles caused under vacuum by the expansion of air and other gasses trapped within the resin.

Form Wound: Describes a coil that is formed or shaped over a fixture. Often made with rectangular conductors laid precisely together, interleaved with flexible insulation. Also usually covered with one or several wraps of half lapped tape. Also a motor incorporating such coils.

Green: Describes coils or devices that have not been treated, coated or sealed.

Half Lap: Spiral tape wrap in which each turn overlaps the previous one by a half tape width. Provides a double thickness of tape.

Hertz: A term indicating the frequency of one cycle per second.

Hg: Chemical symbol for the element, mercury.

Holding Tank: A reservoir for keeping the varnish when it is not in use. Should be equipped with heavy duty mixer and vacuum capability. Refrigeration may be needed in warmer climates and/or where hot dipping or continuous use is anticipated. Also consider cooling when infrequent use (low tank turnover) is anticipated. Storage @ <75°F is suggested. Vacuum cycles can be shortened by storing the resin under vacuum to prevent build up of air and other gasses in the resin.

Hz: See Hertz.

Millibar: A unit of atmospheric pressure: 0.75 mm Hg (75 microns). One mm equals 1.33 mbar.

Penetration and Fill: The process by which the varnish is drawn or forced into and retained within the part.

Preheat: To bake the device before processing.

Preheated Oven: Oven heated until the skins (inside walls) are at temperature and temperature has stabilized. May take several hours.

psi: Abbreviation for "Pounds per Square Inch".

Random Wound: Describes a coil in which the wires do not lie in an even pattern. Not shaped before insertion in the devise. Also a motor containing such coils. Sometimes called "Mush Wound".

Continued on Back Panel

What is VPI?

Vacuum Pressure Impregnation (VPI) is a system in which vacuum and pressure are used to assist the penetration of liquids into various devices. It is often used to impregnate electrical apparatus with insulating resins (electrical varnishes), because it can provide a virtually void free insulation with only one VPI cycle (Further cycles will fill small surface openings but will not fill any areas surrounded by resin).

Advantages of VPI...

VPI produces a better insulation system than can be obtained by conventional methods, better environmental protection and superior chemical and moisture resistance (salt water immersion tests). The removal of air voids from the windings assures longer electrical life and less opportunity for corona. In addition, more solid fill means heat will be conducted to the outside more efficiently, better thermal endurance, lower hot-spot temperatures, and lower temperature rise. Further, VPI with a solventless product provides greater mechanical and structural strength and may eliminate the need for a surge ring. Blocking or tying may be replaced with Dacron felt pads that will form the necessary blocking when impregnated with resin.

DOLPH Resins for VPI...

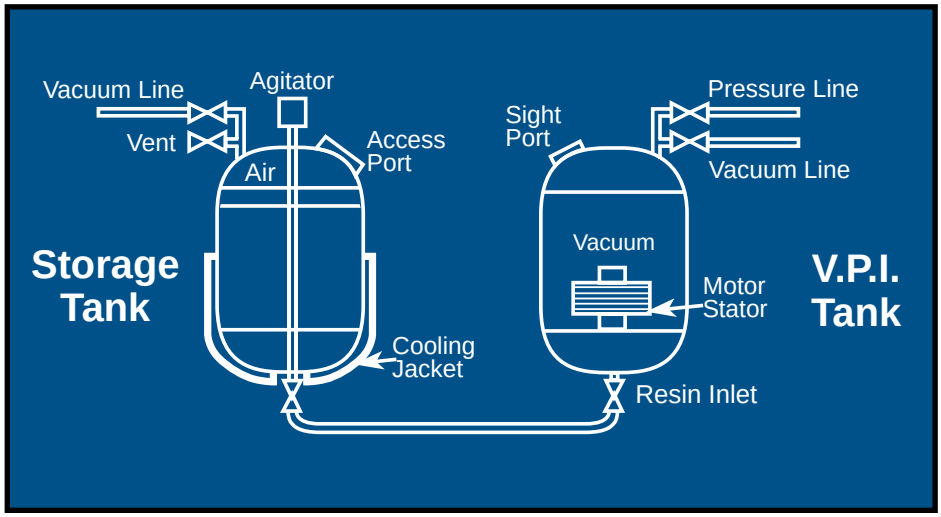
DOLPH products significantly contribute to the successful performance of the VPI process. We have continuously worked with our customers to obtain superior results. Our experience in the field and in the laboratory has allowed us to develop an array of solventless VPI products that are UL recognized and exhibit the most desirable characteristics, through exacting formulation and selection of polymers and copolymers.

Epoxy vs Polyester vs Hybrid: Epoxy is generally said to have higher build, greater moisture resistance, higher mechanical strength, and lower dielectric losses, whereas polyester is held to be easier to process, give better high temperature performance, longer thermal life, and lower cost. We have developed resins that provide varied characteristics. They include a broad choice of epoxy, polyester, and hybrid solventless varnishes. New chemistry has blended the lines between types, and each resin must be evaluated on its own merits.

Viscosity vs Thixotropy: Thixotropic resins can be used at both high and low viscosities. Immediately after mixing, they are more fluid and will penetrate better. When allowed to rest, the thicker consistency produces higher build and greater retention. In non-thixotropic compounds, viscosity along with other factors determines the thickness of the coating.

Applications for VPI...

- High Voltage Machines
- High Temperature Apparatus
- Transformers
- HID Ballasts
- Random Wound Stators
- Chemical Duty Motors
- Rugged Duty Motors
- Inverters
- Form Wound Coils
- Armatures With Coils Installed
- Precision Wound Transformers
- Ferro-Resonant Units



Typical VPI cycle...

This process should be varied according to the VPI equipment, resin and apparatus to be treated. Equipment to be processed must be green (untreated), and tapes untreated, open, or permeable so as not to block the resin. Resin filled or B-Staged tapes that cure with heat should not be used.

Preheat: The part is placed in an oven and heated to 250˚-325˚F. The preheat serves to evaporate moisture and any volatile oils, which may be present. It also improves penetration and fill by lowering resin viscosity surrounding the part, and creates suction when the part is cooled by immersion in the resin. Before proceeding to the next step, cool to 150˚F or cooler.

Dry Vacuum: After placing the part in the vacuum chamber, apply vacuum, typically 1 - 4 mm Hg, for 30 minutes. During this phase, air and any remaining moisture, oil, etc. is removed.

NOTE: During the dry vacuum, the resin in the holding tank should be deaerated and thixotropic products should be agitated (mixed) in the holding tank for at least 15 minutes. Agitation will reduce viscosity for effective penetration and fill.

Wet Vacuum: Immediately after mixing, introduce the resin into the vacuum chamber allowing it to flow up from the bottom so as not to block further penetration. The resin should cover the part by a depth of at least 1 inch. If excessive foaming occurs during the vacuum process, slow down the introduction of resin to allow time for air and gasses to escape.

Maintain recommended vacuum for 20-60 minutes. Larger units and those with more layers of tape will require a longer time under vacuum. For fine wire coils and constricted parts, bumping the vacuum may increase penetration.

Pressure Cycle: When the wet vacuum portion of the cycle is complete and the parts are still totally immersed, pressurize to 90 – 100 psi with air for an hour or longer. Note: Depending on resin characteristics, an inert gas may be required to bring vacuum up to atmospheric pressure. Form wound devices will require about 15 minutes per half lap of tape. Release pressure. Thixotropic products will have a higher build if allowed an atmospheric soak for 30-60 minutes.

Removal and Drain: Vent pressure and remove the part or drain the resin. A removal rate of 4 inches per minute or slower should be used so that the resin forms a uniform coating. Drain may take place over the tank so that runoff can be captured and returned to the reservoir. While draining, the part should hang at an angle so that flat surfaces can drain readily. This will tend to eliminate thick sections, which might promote stress cracks. Drain until major runoff stops. Follow specific recommendations on the product data sheet. If using a thixotropic product, allow a period of 1-2 hours or more after drain to promote resin retention during cure. Thixotropic products should show minimal drain in the oven.

Bake: Place the treated part in a fully preheated oven. Cure using DOLPH'S recommendations for time and temperature according to the product data sheet.

	DOLPHON PRODUCT NUMBER	DESCRIPTION	TYPICAL VISCOSITY cps 1 RPM	10 RPM	TYPICAL FILM BUILD MILS/SIDE	GEL TIME MIN. °F	SHELF LIFE @ 70°F	BOND STRENGTH ASTM-D 2519 23°C	150°C	DIELECTRIC STRENGTH VPM (I mil)	VOLUME RESISTIVITY @ 23°C	DIELECTRIC CONSTANT @10kHz 23°C	150°C	DISSIPATION FACTOR @10kHz 25°C	150°C	FLASH POINT °F	VAPOR PRESSURE, mm @ 23°C	RECOMMENDED VACUUM @ 25°C mm Hg
POLYESTER	CC-1105	High-flash, Low viscosity polyester resin: Low build, exceptional bond strength, fast cure; resists refrigerants (R123, R-134A, R22).	-	550	0.5	40 @ 230	12 mo	42	20	4000	6.2×10^{15}	4.03	5.0	0.020	0.032	>200	<0.1	1-3
	CC-1105-HTC	High-flash, slightly thixotropic polyester resin: High thermal conductivity, exceptional bond strength, outstanding noise reduction. Excellent choice for inverters.	2500	1400	2.0	10 @ 275	6 mo	45	25	3000	4.3×10^{15}	4.57	5.13	0.017	0.030	>200	<0.1	1-3
	CC-1133	Flexible, low viscosity polyester resin: Excellent penetration, nice build, outstanding sound deadening and electrical properties.	-	450	1.5	45 @ 230	12 mo	35	10	3500	2.8×10^{15}	4.15	5.03	0.014	0.027	128	1.2	1-3
	CC-1305	Semi-rigid, high-flash polyester: Higher build, good protection and excellent electricals.	-	1400	0.9	70 @ 230	12 mo	40	12	3500	8.3×10^{15}	3.35	5.36	0.010	0.108	>200	<0.1	1-3
	CC-1305-HTC	Thixotropic, semi-rigid, high-flash Polyester: Higher build and better retention; superior moisture and chemical resistance.	3200	1300	2.0	70 @ 230	12 mo	40	10	3500	9.2×10^{15}	3.94	5.31	0.019	0.034	>200	<0.1	1-3
	XL-2102	High flash, very low VOC. Polyester resin. No formaldehyde, styrene, VT, tBS or DAP. Excellent protection and electrical properties. Superior tank life.	-	380	0.65	125 @ 212	12 mo	29	9	3250	1.4×10^{14}	4.15	5.00	0.01	0.03	>200	<0.1	1-3
	XL-2103	Thixotropic version of XL resin. See characteristics of XL-2102, above.	4500	1700	1.5-2.0	9 @ 257	12 mo	26	8	3000	1.4×10^{14}	4.15	5.00	0.01	0.03	>200	<0.1	1-3
	XL-2105	Low viscosity version of XL resin. See characteristics of XL-2102, above.	-	220	0.65	10 @ 257	12 mo	29	9	3250	1.4×10^{14}	4.15	5.00	0.01	0.03	>200	<0.1	1-3
EPOXY	CC-1115	Thixotropic, semi-rigid, high build, epoxy resin: Superior electrical properties, superior moisture and chemical resistance, excellent retention and appearance.	11,500	5000	4.6	20 @ 285	12 mo	55	7	2200 (7 mil)	1.1×10^{16}	3.26	4.41	0.007	0.042	>200	<0.1	1-3
	CC-1118-LV	Thixotropic, semi-flexible, epoxy resin: Exceptional electrical properties, superior moisture and chemical resistance; approved on sealed units per Mil-M-17060E; resists refrigerants (R134A).	7500	3000	3.0	18 @ 285	12 mo	60	8	2400 (7 mil)	1.3×10^{16}	3.04	3.67	0.005	0.027	>200	<0.1	1-3
	CC-1152	Thixotropic, flexible, epoxy resin: Exceptional electrical properties, superior moisture and chemical resistance; approved on sealed units per Mil-M-17060E.	7000	3000	2.5	100 @ 285	12 mo	55	5	2500	9.8×10^{15}	3.35	5.63	0.01	0.108	>200	<0.1	1-3
HYBRID	CC-1141	Slightly thixotropic, high flash, epoxy modified polyester resin: Nice build, excellent moisture protection and electricals; low emissions; U.L. recognized; Refrigerant resistant (R22).	-	2250	1.5	50 @ 230	12 mo	35	15	3700	1.5×10^{16}	3.50	4.43	0.011	0.024	>200	<0.1	1-3

Glossary of VPI Terms Continued

Resins: A class of organic, liquid, fusible materials of synthetic or natural origin that are polymeric in structure.

Storage Life: The time during which a liquid resin can be stored @ 70°F and remain suitable for use. Also called "Shelf Life". See Tank Life.

Stress Crack: A fissure in the cured resin caused by unequal expansion and contraction of the core, flexible insulation, resin, etc.

Tank Life: The time the product remains usable in service. Tank life is affected by the frequency of use, processing temperature, turnover of material, storage temperature, and occasionally by contaminants. Also called "Pot Life".

Thermal Conductivity: The ability of a material to conduct heat. Usually expressed as: Calories/sec/cm2/°F/cm thickness.

Thixotropic (Thixotropy): Describes materials that liquefy or flow when agitated (mixed) and return to a thick consistency when allowed to rest, e.g. ketchup. A thixotropic material can therefore, be used at both high and low viscosities.

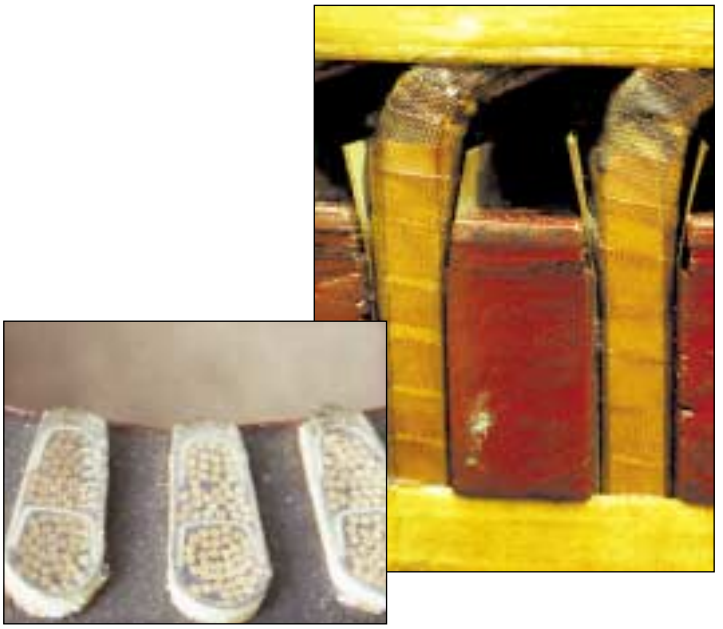
Torr: Unit of pressure (vacuum): 1 mm Hg.

Vacuum Chamber: Vessel where devices are processed. May be equipped for both vacuum and pressure. Usually also includes 2 portholes, the sight port and the light port, one for illumination, the other for viewing the process .

Vapor Pressure: An indication of the evaporation rate. The pressure in an enclosed container when the vapor and liquid are in equilibrium.

Viscosity: The resistance of a material to flow. Higher viscosity liquid flows more slowly, lower more quickly. May be measured in centipoise, or in minutes and seconds.

Volume Resistivity: The ability of a material to resist the passage of electricity through its bulk. The value is expressed in "Ohm-Cm".



The following selection charts are available:

- DOLPH Epoxies and Polybutadiene Resins
- DOLPH Rapid Reference Guide
- DOLPH Varnishes and Resins
- DOLPH-SPRAY® Aerosols
- DOLPHON® Epoxy Resins
- DOLPHON Resin Kits

AUTHORIZED DISTRIBUTOR

John C. Dolph Company

320 New Road, P.O. Box 267
Monmouth Junction, NJ 08852-0267
Tel: 732-329-2333 Fax: 732-329-1143
E-mail: info@dolphs.com
Website: www.dolphs.com
Also manufactured in:
ENGLAND • ITALY • MEXICO

Professional Memberships
ASTM EASA NEMA

5/02

JCD / 2013 / 3M / 5.02