MATRIX D -P900

Low Profile Polyester Resins

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Applications in Die Construction

Duroplastics introduces the latest innovation in unsaturated polyester resins for use in FRP (Fiberglass Reinforced Plastic); mainly, a new generation of low shrinkage resins called "Low Profile" resins.
Low or zero shrinkage constitutes their main feature; in some cases, expansion occurs during resin cure, after acceleration and catalysis.
Normally, linear shrinkage in polyester resin ranges between 1.9% and 2.9%, which results in serious inconveniences in most FRP products; this is due to tensile strain in parts, which leads to lack of dimensional stability, fiberglass print-through surfaces, parts that do not match the mold or die, etc.

Low-shrinkage resin for die construction: MATRIX D

Die costs and quality are significant means that should be considered in composite production. Usually, die and mold construction is the most expensive and longest stage in composite part production. Die quality is critical, since it defines whether a composites project will succeed or fail.Generalized use of unsaturated polyester dies started in the early '50s. From then on, shrinkage has been compensated by both manufacturers and designers. Mainly due to the characteristics of the materials used, no changes were introduced into die construction until the early '90s. Unfortunately, there were no fast methods for the production of high-quality, zero-distortion dies, guaranteeing dimensional stability throughout useful life.

Die construction based on a model takes several weeks of intensive and methodic work, including hand lay-up, fiberglass mat and woven fabric impregnation. Slow processes were necessary in order to minimize the effects of lamination exothermic reaction and, most importantly, volumetric shrinkage. Complex techniques were used in an attempt to minimize print-through in reinforcements, warping, early demolding, internal strain and surface distortion, applying thin layers and low initiator levels. Dies were cured by aging before use, alternating lamination and post-cure by high temperatures, or a combination of the two. This process was followed by intensive hand sanding and glossing to minimize die distortion.

In order to simplify the die construction process, minimize time and costs and produce fully cured dies with a permanently smooth surface, some producers, including ourselves, have developed low shrinkage unsaturated polyester resins for die construction.

MATRIX D Tooling Sequence :

- A model is prepared with mold release, and tooling gelcoat /die Gel Coat such as Duroplastic VE5001 , is applied using conventional techniques. (Request Technical Report on Gel Coat Application.)
- Once Gel Coat is adequately cured,mix MATRIX D with filler (Durocarb M10) with a 100:100 ratio. Add catalyst MEKP up to 2% of resin content.
- Laminate with Resin:CSM ratio higher than normal laminate say 4:1 ratio. Do not worry about this .
- Air is eliminated and fibers pressed by using rollers and brushes. Layers of more than 3mm are applied at a time (say 3 x 450 CSM).
- Consecutive layers may be applied immediately afterwards, even before reaching gel stage or cure of lower layers. **Ensure that the laminate gets to about 65 Deg C (Hot to touch) , should turn white on cure.**
- Depending on die specific requirements, several layers of chopped fiber or special reinforcement may be applied.
- As in conventional construction, new structural materials, such as non-woven fabrics and foams, may be applied to achieve the adequate rigidity level after first layers of CSM.

Shrinkage control has been the key element in die construction revolution. As regards low shrinkage, such systems have a linear shrinkage of 0.1 to 0.05%, as compared to 1.8% for traditional polyester.

MATRIX D Resin

Type of Material

- Modified lamination unsaturated polyester resin.
- Non-promoted.
- Non-thixotropic.
- Low shrinkage.
- Rigid.
- High reactivity.

Use and applications

- Die construction.
- Lamination at ambient temperature.
- It may be loaded with ATH or CaCO3 (Calcium Carbonate).
- Speeded up with cobalt accelerator.
- Cured with MEKp catalyst.

Main Features

- Time saving in die construction.
- Low shrinkage.
- Fast stiffening.
- Color change during cure from amber to white

Advantages

These new die construction systems present many advantages:

- About 80% time reduction; a die, construction of which usually takes from 3 to 5 days, may be finished in 3 to 6 hours.
- Dies may be put into operation within 24 to 48 hours.
- Molds may be constructed from dies and using the same process; the advantage consists in improved tolerance and more stable surfaces.

Use of zero-shrinkage dies in RTM (Resin Transfer Molding) changed die producers' views on exothermic reaction. The need for high-temperature curing of low-shrinkage resin has turned exothermic reaction into a good factor. Zero-shrinkage systems allow the production of parts with the degree of tolerance required by the large-scale automobile industry. Several plants are producing bumpers, hoods, and truck roofs with these kind of Class A high exothermic resin. Dies are producing up to 800 to 1000 parts without repairs.

Zero-shrinkage die construction systems also show good results when used for acrylic thermoforming dies. Long temperature cycles of up to 90°C and typical pressure of up to 1 kg/cm^2 are applied to these dies. Such conditions usually result in distortions in conventional polyester dies, since heat applied during thermoforming may release stress, leading to shrinkage caused during cure. This does not occur to low-shrinkage resin.

Some manufacturers have reported exceeding 1,000 thermoforming cycles using low shrinkage dies.

The efficiency of such "zero shrinkage" systems is reflected in the results obtained by a manufacturer of dies for cultured marble. In the past, dies produced by using conventional methods had to be post-cured at 120 °C for several hours. This step is now avoided and die construction terms have been cut from 3 days to 3 hours by using the low-shrinkage system.

Loaded zero-shrinkage systems have additional advantages:

- Load increases rigidity.
- Even though loads increase lamination specific gravity, die weight is reduced as a result of the increase in rigidity, thus resulting in thinner layers and support frames.
- Addition of loads improves lamination conductivity by dissipating heat produced by the exothermic reaction of molded parts, lowering the final temperature of a die's Gel Coat.

Physical-Chemical Properties

A) Appearance:	Amber liquid
B) Viscosity @ 25 C:	180/220 cps
C) Acid value:	Below 22 mgKOH/gr
D) Density:	1.10 +/- 1 gr/cm^3
E) Gel Time:	9 +/- 2 min.
F) Exothermic peak temperature:	190°C +/- 5 at 16 min. +/- 2.
G) Stability in heater at 80°C:	Over 72 hours
H) Stability at 20°C, in the dark:	Over 6 months
I) Contraction:	Below 0.2 %
J) Solid content	52.0 +/- 1
Note: E) y F)	
Cobolt 2.5 % Accelerator:	0.5 %.
Catalyst (50% active content) MEKP:	2.0 %
Temperature:	30 ºC

Mechanical Properties of Reinforced and Non-Reinforced

	Standard	Unit	Value
A) Flexural Strength:	ASTMD790	Kg/cm^2	625
B) Flexural Modulus of Elasticity:	ASTMD790	Kg/cm^2	32000
C) Tensile strength:	ASTMD638	Kg/cm^2	300
D) Tensile Modulus of Elasticity:	ASTMD638	Kg/cm^2	35000
E) Deformation at rupture:	ASTMD638	%	1.15
F) HDT (@ 18.5 Kg/ cm^2)	ASTMD648	º C	95
G) Barcol Hardness	ASTMD2583	º B	42.5
Note: Unloaded cylinder, postcured @ 80, 120 º C			

Mechanical Properties of Reinforced Resin:

	Standard	Unit	Value
A) Fiberglass Contents		%	23.6
B) Flexural Strength:	ASTMD790	Kg/cm^2	1280
C) Flexural Modulus of Elasticity:	ASTMD790	Kg/cm^2	62000
D) Tensile Strength:	ASTMD638	Kg/cm^2	730
E) Tensile Modulus of Elasticity:	ASTMD638	Kg/cm^2	70000
F) Deformation at rupture:	ASTMD638	%	1.45
G) Barcol Hardness	ASTMD2583	º B	48.4
Note: Unloaded cylinder, postcured @ 80, 120 º C			

Notes on Trouble Shooting and Tooling Construction Technology see seperate articles.