
DEVELOPMENT OF A 2 STAGE VACUUM ENCAPSULATION PROCESS

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Outline

- **History of ELNG Encapsulation**
- **Process questions we needed to answer**
- **Define the historical encapsulation process**
- **Define the new developed process**
- **Review hardware**
- **Review development and show finished product**
- **Streamlining**



Brief history of the “ELNG” process

- TTA Filled under vacuum only using 828CTBN/DEA (Diethanolamine)
- A solubility issue with the CTBN – to surface
- 826CTBN was developed - Not implemented at Pinellas-
Became the base line in 2005- needed for the impregnation of the transformer.
- Analysis showed that the unfilled resin could be a problem.
A need for a filled formulation for the tube.
- So how do we encapsulate the two formulas on top of each other?
- We showed that couldn't pour the unfilled over the filled mat'l
- Keep in mind that the Old units had the transformer on top.

Process Questions We needed to Answer

- **Filling of the resin systems**

- Under vacuum
- Ports (one or two)
- Location on the mold (top or side)

- **Unfilled material level**

- How Do we Pour the correct amount of resin for the transformer?
- Draining of material????-
Do we drain back to the correct height?
- Fixturing
Buy metering system or develop our own???



- **Preheats and Process**

- Materials
- How do we design the Molds
- What Processing parameters do we use

Historical Process

- 828CTBN – 80°C (176°F)
 - DEA - 80°C (176°F)
 - 10 MINUTE ROLL / MIX
- Molds @ 71°C for 6 hours
- Vacuum Pour
- Gradient Cure





New Process

- 826CTBN – 80°C (176°F)
 - DEA - 80°C (176°F)
 - 10 MINUTE ROLL / MIX
- 828 Resin - 71°C (160°F)
 - GMB 32 - 107°C (225°F)
 - 30 MINUTE PREHEAT
- DEA - 54°C (130°F)
- Molds @ 71°C for 6 hours



New Process Continued

- One Side port
 - Two formulas
- One valve
- Catch Tray
- Turntable
- Funnel Assemblies
- Vacuum



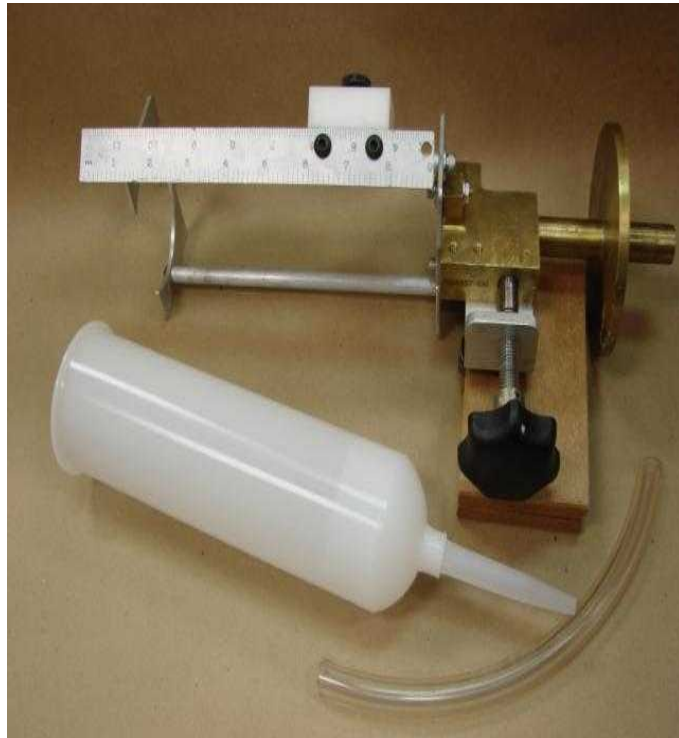
Fixturing in the Chamber

- Assembly and Turntable



Funnel Assemblies

Measurement of Resin system



Assemblies Continued





Encapsulated Units

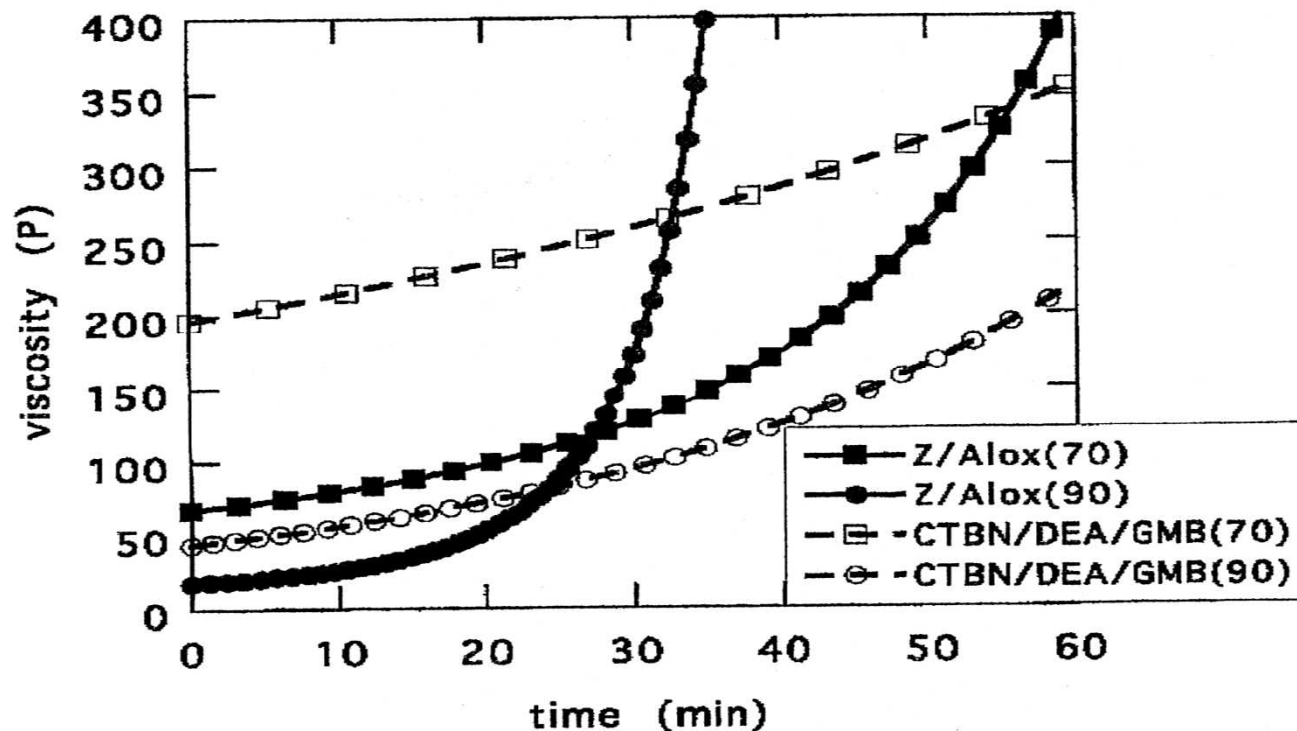
- Consistent unfilled resin height



Streamlining

What is Streamlining? What's Important?

Time/Temperature/Viscosity



Mat'l Temperatures/Streamlining

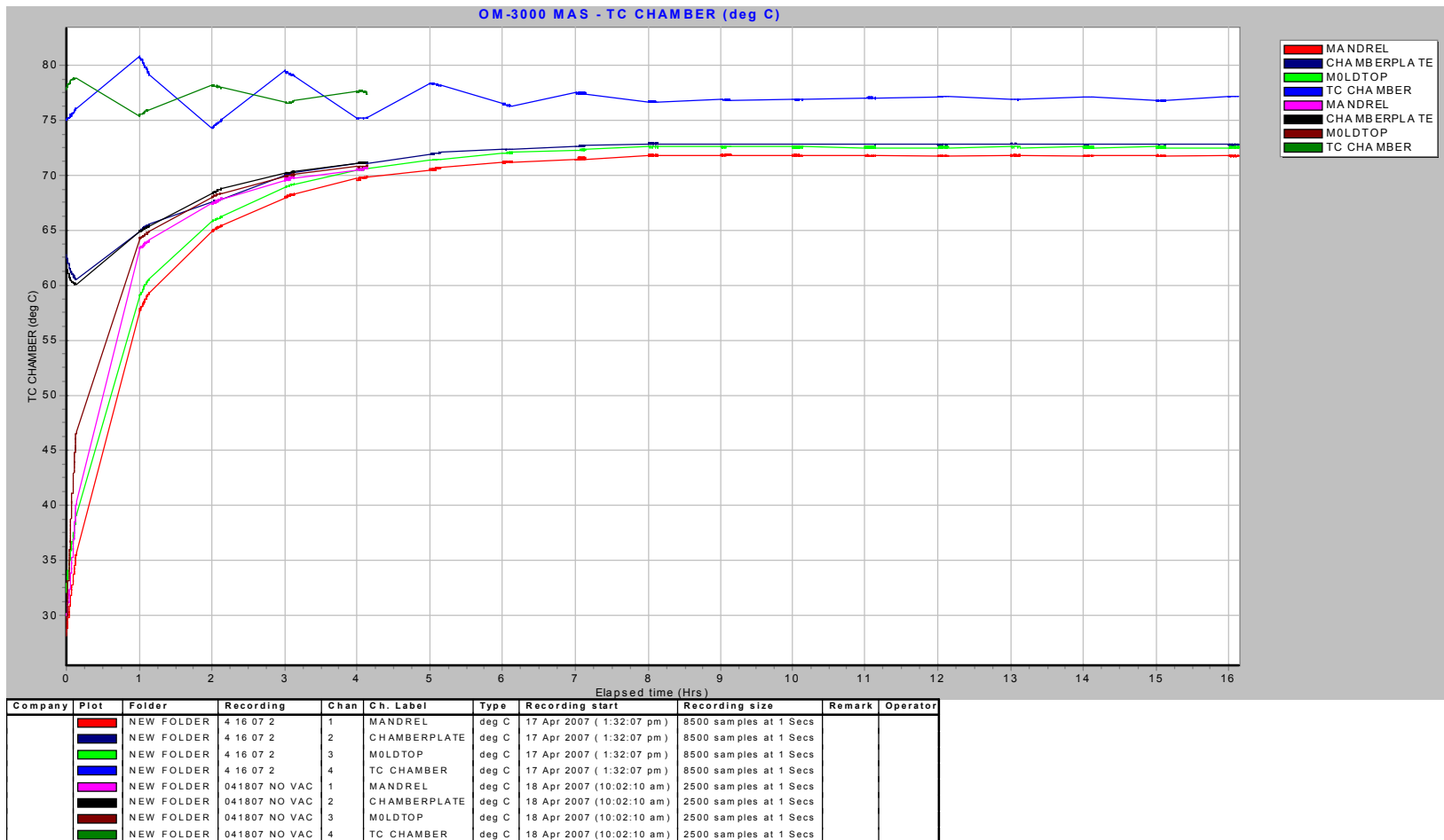
ROLLED	826 CTBN	DEA	TEMP	HOBART MIX (3min)	828	GMB32	DEA	TEMP
11/1/06 Y SS392708	80°C	80°C	171.5°F (end of process)	10/4/06 →	80°C	107°	80°C	212.0°F
11/2/06 Y	@ funnel	"	204.2°F	10/5/06 →	"	"	"	211.1°F
11/2/06 Y	80°C	80°C	213.5°F	10/6/06 →	"	"	"	211.8°F
10/31/06 N	71°C	71°C	210.3°F	10/4/06 →	71°C	107°C	71°C	206.1°F
11/3/06 N	71°C	71°C	211.6°F	10/5/06 →	"	"	"	208.3°F
11/3/06 N	71°C	71°C	219.1°F	10/6/06 →	"	"	"	204.4°F
TOTAL	600g	72gm	No pre- batching →	Evac 3min @71°C	750gm	210gm	90gm	BASIC PREHEATS

Mat'l Temps/Streamling con't

	750gms 828	210gms GMB32	90gms DEA	TEMP
30min. pre-heat-pre- batch 3min.mix/3min evac. →	*80°C 2 hrs	107°C overnight	54°C 2 hrs	208.2°F
11/9/06 → Mat'l added one after another 3min.mix/3min.evac	All mat'l overnight 80°C	80°C	80°C	213.2°F
11/14/06 → 2 hr preheat	“	“	“	211.4°F
Mat'l added one after another 3min.mix/3min.evac 11/13/06 →	71°C 2 hrs	71°C 2hrs	71°C 2 hrs	201.6°F
11/15/06 →	1 hr	“	“	204.7°F
11/15/06 →	“	“	“	203.8°F



Vacuum Chamber Temps





Investigations of Streamlining

- **Material Temperatures**
- **Time, Temperature and Viscosity of Materials**
- **Fixturing**
- **Procedures**
- **Processing**
- **Flexibility of processing**



Streamline Results

- **Processing @ one temperature (71°C)-**
 - equipment reduced from 4 ovens to 1
- **Material level consistent**
- **Fixturing is in Place**
- **Material processing time reduced**
- **Transformer Preheat/drying time- ????? Studies ongoing**
- **Process time reduced ($\approx 37\%$)**



Additional ELNG Team Members

Design: Barbara Wells –Project Lead

- **Material Properties: Doug Adolf and Mark Stavig**
- **Elec. Fab and Testing: Meliton Gonzales, Roy Lopez, Rob Hertrich**
- **Production: Therese Ordonez**
- **Mold Design: Keith Vollmer**