plenco

PLASTICS ENGINEERING COMPANY
SHEBOYGAN, WISCONSIN 53082-0758 U.S.A

3518 LAKESHORE ROAD
POST OFFICE BOX 758
PHONE 920 - 458 - 2121
F A X 920 - 458 - 1923

ISO 9001
DNV
Certificated Firm
Quality System Certified

October 4, 2002

Subject: **Postbaking Phenolic Items**

Molded phenolic parts are postbaked for several reasons:

- Dimensionally stabilize the part, especially for elevated temperature applications.
- Out-gas residual molded-in ammonia (and other volatiles), a by-product of the two stage phenolic cure reaction. This is especially important for hermetically sealed electrical applications, where ammonia in the presence of water can corrode electrical contacts.
- Improve strength.

Not all applications require the phenolic part to be postbaked. Assuming it has been determined that a postbake is needed, it is good practice to use the minimum postbake temperature and time that results in the desired properties. Too long a time is not economical. Too high a temperature can lead to embrittlement and oxidation of the organic polymer, resulting in lower strengths. The suitability and fitness for use of a postbake protocol must be determined for any given application.

There are three general rules that are recommended as guides when specifying a postbake protocol.

1. A postbake protocol is usually chosen such that the resultant glass transition temperature (Tg) is greater than the highest temperature the part is exposed to in the application. This will minimize the thermal stress induced on the part during use.

2. The temperature of the oven should be stepped or ramped (5ºC/minute, depending on the part thickness) up to about 15ºC below the initial glass transition temperature. From this temperature, the temperature of the oven should be set such that it remains below the phenolic part's instantaneous Tg. The Tg of phenolic material increases with time and temperature as additional crosslinking of the polymer occurs. The oven can be stepped or ramped (0.5ºC/min or 0.25ºC/min for thicker than 3mm parts) to the destination temperature. Again, the reason is to minimize thermal stress and give repeatable post-shrinkage.

   2.1. The initial Tg of the "as molded" phenolic part can be approximated as the molding temperature.

   2.2. If using a step postbake protocol, the following equation can be used to estimate the Tg after exposure to a set time and temperature.

   Tg, final = 9.4*ln(hours) + 0.7*(baketemp) + 0.3*(Tg, initial) + 23.4

   where:
   Tg, final = glass transition temperature after postbake, ºC
   ln = natural logarithm
   hours = time spent in the oven at bake temperature, hours
   baketemp = temperature of the postbake oven, ºC
   Tg, initial = initial glass transition temperature prior to postbake, ºC

   Example:
   If parts are molded at 165ºC and will be postbaked for 8 hours at 150ºC, the final Tg obtained will be approximately 197ºC. If they are then postbaked for an additional 4 hours at 180ºC, the final Tg would then be approximately 222ºC.

3. The postbaked parts should always be evaluated to determine if the desired result is obtained.

To reduce undesired postbaking results in large production ovens, minimize the temperature deviations caused by inadequate air-circulation in the oven and around the parts, temperature overshoot, and oven hot spots.