ASSESSING THE SENSITIVITY OF CYANATE ESTER COMPOSITES TO CARBAMATE DAMAGE

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ABSTRACT

Cyanate ester (CE) resins are desirable in the space industry as the supporting polymer for advanced composites structures. Unfortunately, the resin monomers are reactive with water in a manner that is detrimental to the desired properties of the system. This hydrolysis, which forms a carbamate, is a chain-terminating reaction that reduces the cross-link density of the final polymer. A commonly held belief in the industry is that this hydrolysis can be avoided with studious attention to processing details. However, hydrolysis cannot be avoided, merely mitigated. The idea of mitigation invokes the need to understand the relationship between the carbamate quantity and final product properties. This relationship has been determined for one common composite system, M55JB / RS-3C fabric. The method of assessment and functional relationship are presented herein.

1. INTRODUCTION

1.1 Problem history

A team at Lockheed Martin Space Systems Company (LMSSC) was working on a large composite article (AKA "Manufacturing Development Unit" or "MDU"). With the goal of obtaining space qualification, a CE matrix system was selected in order to obtain the typically described benefits of: hygrothermal dimensional stability; low outgassing; and, long shop life during layup (> 30 days). The layup tool was a graphite/epoxy monolith, ~ 1.5 cm thick. Moisture from extended shop exposure and an epoxy tool were known to trend towards problems with processing CE resin. Aware of the hydrolysis reaction which occurs during CE processing in the presence of water, documented in lessons-learned literature [1-3], the M&P and Manufacturing teams implemented the literature recommended "best practices" when designing the process steps for this MDU.

These best practices were built around the following assumptions:

- The CE resin used is stable for over 60 days at ambient conditions [4, 5].
- Drying a composite tool at 100°C "gets the moisture out".
- Carbamates do not form below ~ 140°C (280°F) [6], suggesting the use of a < 140°C dwell during the cure cycle to extract free moisture prior to hydrolysis reactions occuring.

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