Thermoplastic Composite Resin Matrices

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Abaris Training Resources in Reno, NV recently held an interesting two day conference on "Thermoplastic Composites" (see web site, www.abaris.com, for how to obtain a CD of the Proceedings) on November 6-7, 2007. The conference covered several interesting presentations on the materials, processing and applications aspects of various thermoplastic (TP) composites in the advanced composites areas.

As a result of that conference, I thought it might be timely to briefly summarize the processing and service temperature limits associated with several of the more popular thermoplastic resin matrices. At the same time, one often asks "what is the going pricing of these materials" of current interest. After doing a bit of research, with the assistance of Lou Dorworth (Abaris Training), Michael Buck (Phoenixx TPC Inc., now TenCate), Winand Kok (TenCate), Arnt Offringa (Stork Fokker) and Chris Red (Composite Market Reports), I nailed down a few of the most well known material forms.

Thermoplastic composites as a family of materials, generally exhibits excellent toughness and resistance to impact damage. They also have superior wear and abrasion resistance. Their excellent very low moisture absorption characteristics also lead to nice hot/wet mechanical properties. Most have outstanding corrosion and solvent resistance and very good FST (flame, smoke and toxicity) properties. They have certain processing advantages to thermoset materials although the process itself requires much higher temperatures and associated compaction forces.

Table 1 shows several TP resin materials, their typical processing temperature range, and, their maximum service temperature limits. To a certain degree, there are sub-families within certain resin groups that may have higher, or lower, maximum service temperature limits. Consequently, those temperatures shown are to be considered "nominal". Specific design limits would require a more detailed application requirement by the end user for the specific resin being used (*).

TP composite materials pricing depends upon a number of factors: resin type, reinforcement form and type, quantity of material ordered, current market availability, certification levels requested, etc.

Table 1. Common TP matrix processing temperature and maximum service temperature limits.

Thermoplastic Resin Matrix	*Typical Processing Temperature Range*	*Maximum Service Temperature Limits (*)*
PEKK – Polyetherketoneketone	• 327-360C • 620-680F	149C / 300F
PEI – Polyetherimide	• 329-357C • 625-675F	210C / 410F
PPS – Polyphenylene Sulfide	• 321-343C • 610-650F	140C / 285F
PEEK – Polyetheretherketone	• 385-413C • 725-775F	171C / 340F
PI – Polyimide	• 280-399C • 540-750F	316C / 600F
PAI – Polyamideimide	• 280-343C • 540-650F	260C / 500F

Consequently, the values given in Table 2 should be considered as general guidelines for current 2007 availability. However, the table should give one an idea of nominal pricing and the market segments these materials are most widely used in today.

Table 2. Current nominal prices for advanced composite and engineering composite TP materials with notation on market segment most widely used.

Thermoplastic Resin Matrix	***Pricing in USD per pound (2007 rough estimate)***	***General Market Segment of Applications (2007)***
PEKK – Polyetherketoneketone	• AS4 type ($55/lb) • IM7 type ($115-125/lb)	• Aerospace • Oil & Gas
PEI – Polyetherimide	• AS4 type ($45-50/lb) • IM7 type ($65-75/lb) • E-glass fabric ($45/lb for consolidated laminates)	• Aerospace • Munitions
PPS – Polyphenylene Sulfide	• AS4 type ($30/lb) • T300JB fabric ($90/lb)	• Aerospace • Medical • Oil & Gas • Industrial
PEEK – Polyetheretherketone	• AS4 type ($80-85/lb) • IM7 type ($130/lb)	• Aerospace • Defense • Oil & Gas • Medical
PA – Polyamide (e.g. Nylon)	• AS4 type ($25-40/lb) • IM7 type ($35-55/lb)	• Automotive • Medical • Industrial • Sports & Recreation
PP – Polypropylene & Other Commodity TPs	• E-glass type ($15-25/lb) • S-glass type ($25-40/lb)	• Automotive • Medical • Industrial • Construction