Akulon®

Choosing the right polyamide: temperature considerations

Three general situations can be distinguished

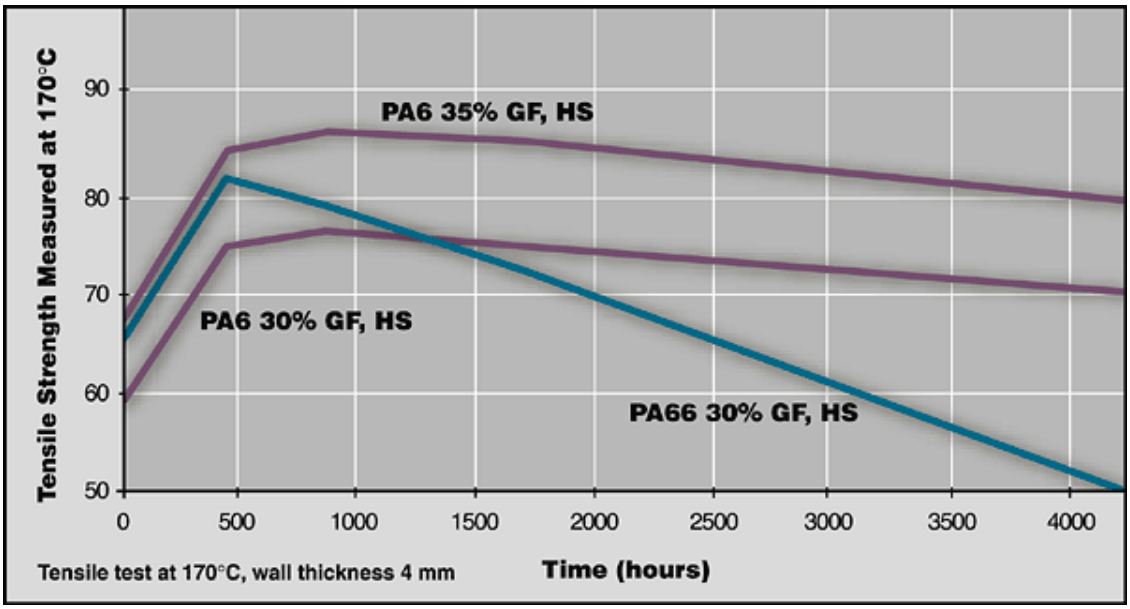
1. Continuous high temperatures, up to 185ºC
2. Very short term temperature spikes close to HDT or melting temperature
3. Hydrolysis critical environments
4. Very low temperatures

Continuous high temperature conditions

The critical design factor for the engineer is the performance value of a property at the maximum operating temperature specified for the minimum life of the part. For automotive engine components, part life requirements can be up to 5000 hrs. The temperature encountered by a component varies significantly depending on the application, its proximity to the engine, driving behavior and ambient conditions. As these can vary enormously, performance at 170ºC and for 5000 hours is taken as the reference point. For actual parts, each engineer should determine their own requirements and suitable safety standards.

The chart below shows that PA6 exhibits better long term performance at high temperatures than PA66 and should be the preferred material for any application running for extended periods above 150ºC. The better end-of-life properties of PA6 by up to 60% can be exploited in the design stage, either to reduce the amount of material needed to ensure a specific performance, or by extending durability or part life guarantees.

When operating temperatures are above 100°C, parts dry out rapidly and the effect of moisture absorption on properties can be ignored.



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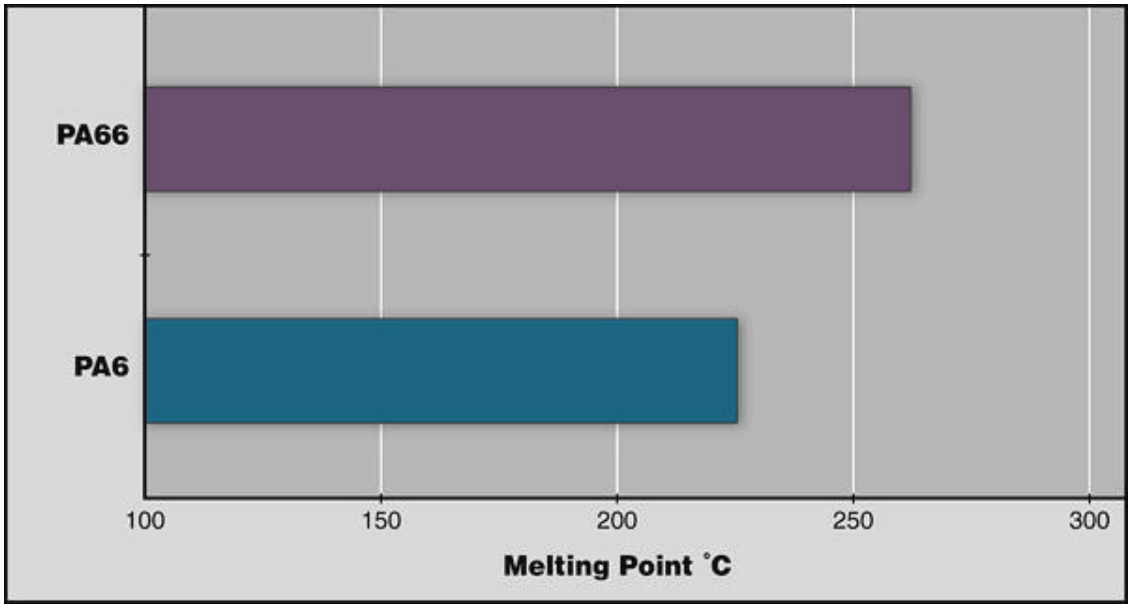
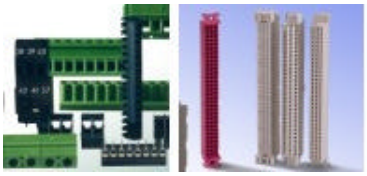
Short-term temperature spikes

Where temperatures can spike at above 215ºC (the HD T of glass reinforced PA6) but less than 250ºC, PA66 is preferred. For even higher temperatures, a high temperature material such as Stanyl may be needed.



Typical situations where this applies are in part fabrication where secondary processing under high temperatures occurs e.g. soldering in electrical applications. In practice there are very few applications, other than parts requiring soldering, that are exposed to peak temperatures above 190°C.



Hydrolysis critical environments

In hot water environments at 100ºC+, especially when glycol (as anti-freeze additive) is also present, hydrolysis can occur in polyamides, the rate being determined by the amount of water that can be absorbed. As PA66 absorbs less than PA6, it exhibits a slightly improved performance and is usually preferred. For reinforced materials, higher fill levels in PA6 can allow the use of grades that deliver the same performance as a PA66 with a lower level of reinforcement. This has benefits in terms of stiffness but with disadvantages in terms of part weight and design flexibility.

All materials used in such conditions should be heat and hydrolysis resistant stabilized types. Typical applications are radiator end caps. If hot water temperatures well above 100ºC are expected, or dimensional stability is critical, the low water absorbing high temperature polyamides would be the solution.

Low temperatures

PA6 has better ductility than PA66. At lower temperatures this makes it a tougher material; less impact sensitive, less notch sensitive and with ductile behavior that is maintained to lower temperatures. This advantage translates into safer parts (less risk of splintering at low temperatures) and lower level of breakages during processing as parts are tougher coming out of the mold. Both PA6 and PA66 can be impact modified for improved performance at very low temperatures (down to –35ºC). However, for unmodified grades where lower temperatures can be encountered, PA6 gives the better performance.

Typical applications where PA6 is preferred due to better low temperature performance are power tools, ski and snowboard bindings, automotive exterior parts etc.