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How Honeywell Aerospace use CES Selector to support material substitution and reduce costs

A WEB SEMINAR REPORT

Honeywell Aerospace, Tempe, is a well-established designer and manufacturer of a wide range of mechanical systems and accessories for the aerospace and marine industries. During a live webinar hosted by NASA Tech Briefs in May, 2014, John Perek, Principal Materials Engineer, described how they have been using CES Selector™ in their material selection and substitution process for over 15 years, describing two specific case studies. Both demonstrate the benefits Honeywell have seen in terms of reduced selection time and cost avoidance. As Perek explained, these benefits come from applying a rational material selection process that is exhaustive, auditable, and repeatable: ***"that is the process we should all strive for and CES Selector is the tool that helps us achieve that."***

The full webinar (also featuring Lockheed Martin and NASA) is available to watch on demand on the Granta website: www.grantadesign.com/products/ces/casestudies.htm#honeywell

Two Case Studies: How Honeywell Aerospace use CES Selector

Case Study 1: Using CES Selector for a metal to polymer material substitution

Honeywell Aerospace wanted to substitute a polymer for the aluminum alloy used in the manufacture of a pressure regulator housing. The initial approach was to convert the original aluminum alloy hog-out to a moldable Valox polyester, while the geometry and size were maintained. However, it is not unusual for problems to arise with fixed-geometry metal-polymer substitutions. In this case, the thick central section led to issues with very low yield rates and delayed cracking after molding. To overcome this, CES Selector was used to investigate alternative injection molding materials that were more forgiving to this challenging situation. Honeywell began the rational selection process by defining the design requirements of the housing, material, and production method. These included:

- **Environmental performance constraints**—maximum service temperature and solvent resistance.
- **Production methods**—a material capable of injection molding was required.
- **End user requirement**—compatibility with self-cutting thread screws for installation purposes.

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Design Requirements:

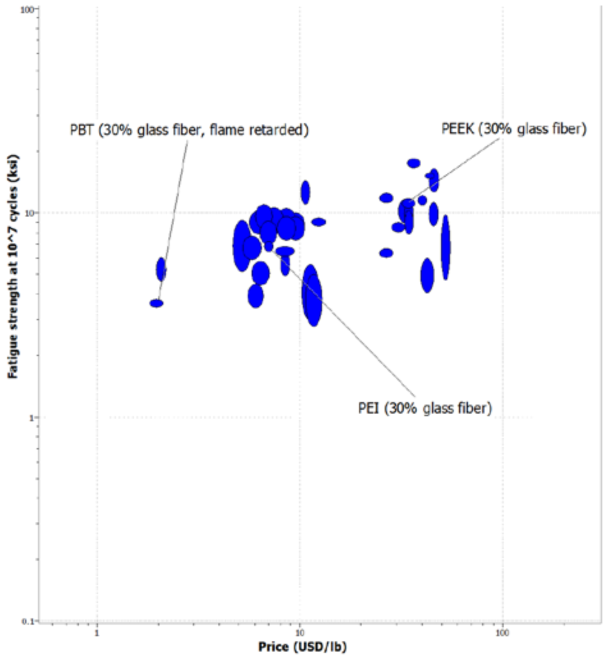
- ✓ Service Temperature = 350 ^{o}F max
- ✓ Injection Moldable
- ✓ Good Solvent Resistance
- ✓ Tough/Ductile
- ✓ Can use self-cutting thread screws

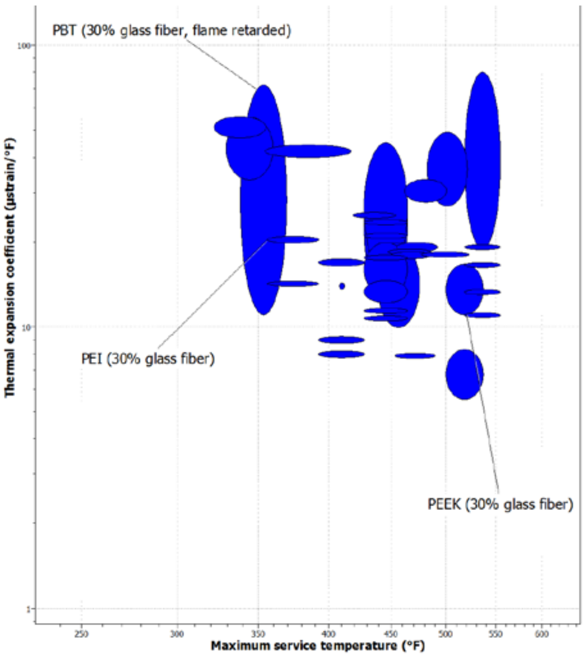
CES Selector makes use of Granta's MaterialUniverse™ data resources, providing complete property data for virtually every class of purchasable engineering material—around 3000 potential candidates. As property values are either populated with known, referenced data or with values estimated using Granta technology, Honeywell Aerospace can be confident that they have considered the complete 'universe' of potential candidate materials: no suitable materials will be excluded simply because their properties aren't known.

The range of possible materials was quickly reduced (using a 'Tree stage' selection) by restricting the choices to those materials that met the processability criteria. The pool was further reduced by adding two 'Limit stages', taking account of maximum temperature and durability. Based on the design specifications, two materials (PEEK and PEI) were identified as possible alternatives to the polyester (PBT): these are highlighted below in the material property charts (Ashby Diagrams) generated using CES Selector.

The chart on the left shows that there is relatively little difference in fatigue strength between the candidate materials. However, from considering the thermal expansion coefficient and maximum service temperature (right), PEEK was chosen as the preferred material for component testing to ensure that it performed as well as, or better than, the baseline material.

By using CES Selector the M&P team were able to the identify a successful material substitute which addressed many of the issues associated with delayed cracking and low production yield.





Case Study 2: Replacing a metal by a lower cost polymer composite

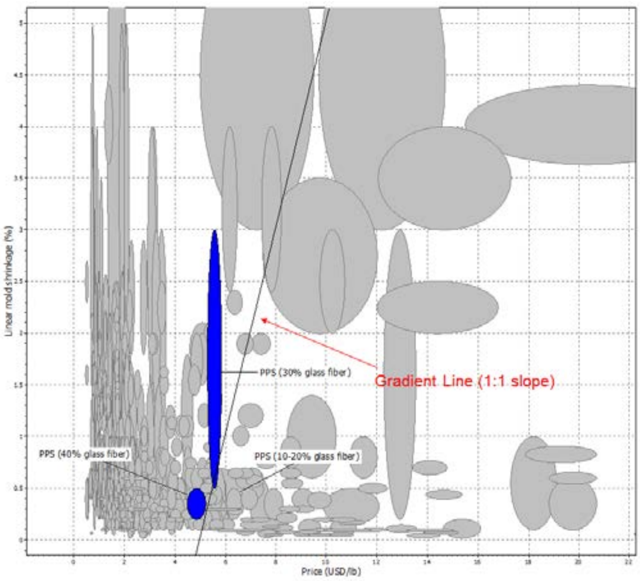
The second case study was an example of work conducted over ten years ago, showing the longevity of the CES Selector project at Honeywell, and its value in making long-lasting design decisions. The right material decisions on parts that remain in production over long time periods can have substantial financial implications. The case study considered a project which aimed to replace aluminum with a polymer composite in an Air Turbine Starter (ATS) oil cover in order to reduce cost. As in the previous example, Honeywell defined the key design requirements of the material substitute and the component's performance criteria:

- **Cost**—preferred cost/weight limit.
- **Environmental performance constraints**—maximum service temperature, inherent flame resistance, and good solvent resistance.
- **Production methods**—injection moldable with as little post mold machining as possible (limits for linear mold shrinkage were defined).
- **Preferred material type**—a thermoplastic resin, either filled or unfilled, would be considered as suitable.

Design Requirements:

- ✓ Service Temperature = 300 °F max
- ✓ Thermoplastic resin, filled/unfilled
- ✓ Injection Moldable
- ✓ Linear Mold Shrinkage: 0 - 1 %
- ✓ Inherent Flame Resistance
- ✓ Good Solvent Resistance
- ✓ Price < 10 US$/lb

Honeywell used Granta's MaterialUniverse to ensure their selection drew on the full range of engineering materials. By applying limits based on the design specifications (a 'Tree stage' to limit the materials to those with appropriate processability, and a series of 'Limit stages') two possible materials were identified: PPS (40% Glass Fibre) and PPS (30% Glass Fibre). They are shown as blue ellipses on the chart below: the greyed out materials are those that failed one or more of the limit stages.



To minimize post production machining, linear mold shrinkage had been identified as an important characteristic to consider for material selection. The material property charts identified that the PPS (40% Glass Fibre) would meet the mold shrinkage design needs in addition to the wider requirements.

The substitute material successfully underwent further testing. Following verification in a test program, the new product was approved by the client and has now been in-service, successfully, for 10 years.

Conclusions

Perek's presentation clearly demonstrated the importance of taking a rational and systematic approach to material selection. The case studies provide just two examples of how they have used CES Selector over the last 15 years, as well as highlighting the benefits of Granta's MaterialUniverse as "***an 'Encyclopedia' of generic materials data"***. Perek also touched on the role of CES Selector within Honeywell's broader materials data management strategy, which includes the use of GRANTA MI™.

Across their different use-cases, Honeywell see the main value of using CES Selector as centering around two key themes:

- Reduced selection time—by accelerating the search for material property data and material process selection via digitization.
- Cost avoidance—by eliminating unnecessary testing or drawing changes resulting from improper material selection

Having worked with many versions of CES Selector over the years, Perek was able to conclude that "***CES Selector has proven to be a valuable part of the Material and Process Engineering's (M&P) Integrated Computational Materials Engineering (ICME) toolset. CES Selector is an essential tool for preliminary design, component re-design, material obsolescence issues, and proposals***."

View this report online: http://www.grantadesign.com/news/news/reports/honeywell-ces.shtml