Polymer Services Group
Innovation, Application, Evaluation

How Long Will This Part Last?

There is no test that can answer the question, "How long will this part last?", because there are too many factors that can affect the service life of a product. However, there are tests that can yield important long-term information which can help ensure satisfactory long-term service of a product.

As an example, the primary concern in plastic pipe is failure due to long-term sustained pressure. So, plastic pipe materials are evaluated for long-term creep rupture under pressure. At high pressures (high hoop stress), samples of the pipe will rupture in short time periods. As the pressure, and therefore the hoop stress, is reduced, failure will still occur, but at somewhat longer times. By plotting the data of log hoop stress versus log time-to-failure, generally a straight line will develop, from which one can extrapolate to longer times. The generally accepted limit of extrapolation is one log decade beyond the longest data point. So if you have data out to one year, you can reasonably extrapolate to 10 years and, so on.

Actual failures exhibit a spread in the data, meaning that some specimens at a particular stress will exceed the average predicted life, while some will fall short. So a service factor must be applied to the data to ensure that failure will not occur in the expected time frame. The design factor should also take into consideration normally expected variations in processing, service conditions, and even foreseeable misuse or abuse of the product.

Not all materials behave linearly, however. Some materials --- maybe all materials under the right circumstances --- exhibit a significant break or downward slope in the failure line. In such cases linear extrapolation is inadequate. The data may be better analyzed with a non-linear model. Oftentimes in these situations, long-term elevated-temperature testing is used to accelerate the effect of time. The rule-of-thumb is that evaluating a pipe material for 1 year at the service temperature plus 40°C is generally equivalent to 50 years at the service temperature.

Now so far all of my comments have been related to plastic pipe materials. That's because there is such a large data base of knowledge on these materials. However, the same data can be generated on tensile specimens of any plastic material in much the same way as the pipe materials have been evaluated. Remember, however, that **the data generated is compound specific**. That is, the data developed on one compound may be significantly different for another compound, even with the same base resin. The effects of molecular weight, MW distribution, additives, and reinforcements, all can have a significant effect on the long-term behavior of the part.

So, there is no easy answer to the question, “How long will this part last?”, but there are ways to make reasonable estimations as to the projected service life, which can help ensure satisfactory long-term service of a product.

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