

## Evaluation of Long-Term Hydrostatic Strength for Sulfone Polymers

Plastic piping systems for both residential and commercial plumbing are becoming much more prevalent because of their outstanding corrosion resistance and ability to eliminate potential contamination from heavy metals. These important benefits combined with simpler installation techniques and a lower overall system cost make plastic piping systems an attractive and economical alternative to metal piping systems.

When selecting a material, you must consider how the material will perform when exposed to the expected end-use environment. For pressurized systems, it is important to understand how the material will perform when exposed to constant stress in the presence of water at various temperatures. A study of the long-term hydrostatic strength (LTHS) of several unfilled sulfone-based polymers has been conducted and is reported in this bulletin.

The following materials were evaluated:

- 1) Radel® R-5000 polyphenylsulfone (PPSU)
- 2) Acudel® 22000 PPSU blend
- 3) Udel® P-1700 polysulfone (PSU)

The life of a component can be affected by many factors in addition to internal pressure. These factors include cyclic pressure load, water chemistry, part design, assembly methods and external environment. Other testing requirements are often specified, usually in national standards or codes, to help determine a component's suitability for use under these varying conditions. Discussion of these test methods is outside the scope of this document.

### Test Procedure

The accepted methods<sup>1,2</sup> for determining design stresses for plastics used in pressurized plumbing systems involves the determination of time-to-failure of an extruded or molded tubular specimen under constant internal pressure. Testing is performed at different temperatures to reflect potential operating environments and to allow extrapolation beyond the test period.

To determine time-to-failure, cylindrical parts made from the material are exposed to a constant internal pressure while being maintained at a specific operating temperature. The stress level resulting from the internal pressure is determined from the equation:  $\sigma = p(d-t)/2t$

$\sigma$  = maximum tensile stress

$p$  = internal pressure load

$d$  = outside diameter

$t$  = minimum wall thickness

Multiple samples are tested at varying internal pressures for each temperature condition selected. The time to failure for each test specimen is recorded. Data (failure time, temperature and stress) from these tests are analyzed according to widely accepted standards<sup>3,4</sup> to determine the mean stress that causes failure at various time/temperature combinations.

### Results

Testing was performed by independent test laboratories according to European Norm EN 921. Details of test specimens and temperatures are provided in Table 1. Results extrapolated from data following ISO 9080 Method 4 are shown in Table 2.

Table 1

**Injection Molded Test Specimen Dimensions and Test Temperatures**

	Test Specimen Dimensions (mm)			Test Temperatures (°C)
	Length	Diameter	Thickness	
Radel R-5000	270	40	3.3	20, 60, 95, 135
Acudel 22000	270	40	3.3	20, 110, 135
Udel P-1700	288	50	4.0	20, 95, 110

Table 2

**50-Year Prediction Values and LPL Values Calculated by ISO 9080 Method 4**

Temp (°C)	Time (hours)	Radel R-5000		Acudel 22000		Udel P-1700	
		Mean (MPa)	LPL (MPa)	Mean (MPa)	LPL (MPa)	Mean (MPa)	LPL (MPa)
20	438,000	41.5	36.6	39.4	33.4	13.4	–
70	438,000	25.4	21,3	18.9	15.2	5.7	–
95	438,000	18.1	14.6	12.3	9.6	–	–
23	100,000	43.2	38,2	40.9	34.8	15.7	–
93	100,000	20,8	17,0	14.0	11.3	4.7	–

The Lower Prediction Limit (LPL) is the stress level at a given time that will not produce failures in 97.5% of the test samples at 50 years.

Complete test reports for each material are available upon request.

**North America**

Solvay Advanced Polymers, L.L.C.  
4500 McGinnis Ferry Road  
Alpharetta, GA 30005-3914  
USA  
Phone 800.621.4557 (USA only)  
+1.770.772.8200  
Fax +1.770.772.8454

**Austria / Germany / Switzerland**

Solvay Advanced Polymers GmbH  
Rosstrasse 96  
D-40476 Düsseldorf  
Germany  
Phone +49.211.5135.9000  
Fax +49.211.5135.9010

Solvay Advanced Polymers and its affiliates have other locations around the world. Please visit our website at **[www.solvayadvancedpolymers.com](http://www.solvayadvancedpolymers.com)** for the office nearest to you.

**Benelux and Rest of Europe**

Solvay Advanced Polymers Belgium  
Industriepark De Bruwaan 9  
B-9700 Oudenaarde  
Belgium  
Phone +32.55.33.9505  
Fax +32.55.31.5129

**Japan**

Solvay Advanced Polymers, K.K.  
3rd Floor, Nihon Seimai  
Ichibancho Building  
Ichiban-cho-23-3, Chiyoda-ku  
Tokyo 102-0082  
Japan  
Phone +81.3.5210.5570  
Fax +81.3.5210.5580

**Health and Safety Information**

Material Safety Data Sheets (MSDS) for our products are available upon request from your Solvay Advanced Polymers sales representative or by writing to the addresses shown above. Always consult the MSDS for the product you consider using.

Radel, Acudel and Udel are registered trademarks of Solvay Advanced Polymers, L.L.C.

To our actual knowledge, the information contained herein is accurate as of the date of this document. However, neither Solvay Advanced Polymers, L.L.C. nor any of its affiliates makes any warranty, express or implied, or accepts any liability in connection with this information or its use. This information is for use by technically skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other substance or any other process. This is not a license under any patent or other proprietary right. The user alone must finally determine suitability of any information or material for any contemplated use, the manner of use and whether any patents are infringed.