



# Technical Service Memorandum

January 2003

## Defining and Comparing PPS Types

Phillips Petroleum Company was the first commercial producer of polyphenylene sulfide (PPS), and Chevron Phillips Chemical Company continues to manufacture the full line of cured, linear, and branched PPS polymers under the Ryton® PPS trade name. Our plant in Borger, Texas has been producing Regular PPS polymer since 1972. We began commercial production of high molecular weight (HMW) PPS polymers in 1977. We are the industry leader in PPS technology, holding over 200 patents in this area.

Each PPS polymer type (cured, linear, or branched) has unique properties that affect compound performance. This allows us to tailor-make compounds to meet the needs of specific customer applications. Regardless of the polymer type utilized, Ryton® PPS will satisfy a broad range of physical, electrical, thermal, and chemical requirements. The following definitions and graphs will demonstrate the performance characteristics inherent to a few of our polymer systems.

### Regular PPS

Regular PPS is an off-white, linear polymeric material of modest molecular weight and mechanical strength. The polymer exhibits a glass transition temperature ( $T_g$ ) of approximately 85°C and an approximate melting temperature ( $T_m$ ) of 285°C. When heated above  $T_g$ , the material crystallizes rapidly. Regular PPS is primarily used in coatings.

### Cured PPS

Cured PPS results from heating of PPS in the presence of oxygen (curing). Generally, the property changes that occur are a result of molecular chain extension and formation of some molecular chain branches that increase the molecular weight and result in some thermoset-like properties. Examples of these thermoset-like characteristics include good thermal stability, dimensional stability, and resistance to harsh chemical environments. However, PPS is a thermoplastic and does not suffer from many of the shortcomings of thermosets. Cured PPS performs well in coatings and injection molding compounds.

### HMW Linear PPS

HMW Linear PPS has a higher molecular weight than Regular PPS. The molecular weight of this polymer is nearly double that of Regular PPS. This characteristic is achieved directly by polymerization. Curing is not necessary. The increased molecular chain length results in higher tenacity, elongation, and impact strength. These characteristics make HMW Linear PPS ideal for fibers and tougher injection molding compounds.

### HMW Branched PPS

HMW Branched PPS also has higher molecular weight than Regular PPS. However, the "backbone" of the extended molecule has additional polymer chains branched from it. This attribute improves some mechanical properties, as well as tenacity and ductility. HMW Branched PPS is suitable for films and injection molding compounds.

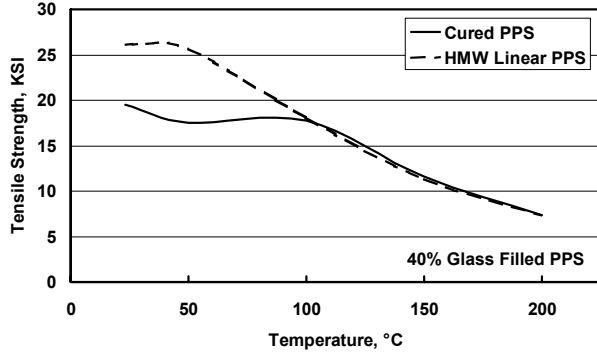
### Glass Reinforced PPS Compounds

On the accompanying page is data comparing the mechanical and thermal properties of 40% glass reinforced injection molding compounds made from Cured PPS and HMW Linear PPS. The data given in Table 1 shows that compounds utilizing cured PPS, such as Ryton® R-4-200NA, can provide mechanical properties comparable to any compounds utilizing exclusively uncured HMW Linear PPS. Figure 1 and Figure 2 show that even when HMW Linear PPS may provide greater tensile or flexural strength than Cured PPS at room temperature, there is little difference in mechanical strength at elevated temperatures. Figure 3 illustrates that there is little difference in flexural modulus (stiffness) between Cured PPS and HMW Linear PPS, even at elevated temperatures. Figure 4 and Figure 5 exemplify the superior elevated temperature creep resistance of Cured PPS compared to HMW Linear PPS.

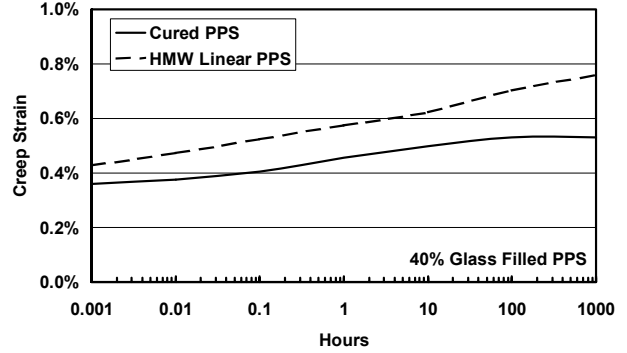
### Bibliography

1. J. F. Geibel and J. E. Leland, Encyclopedia of Chemical Technology, Vol. 19, p. 904 (1996).

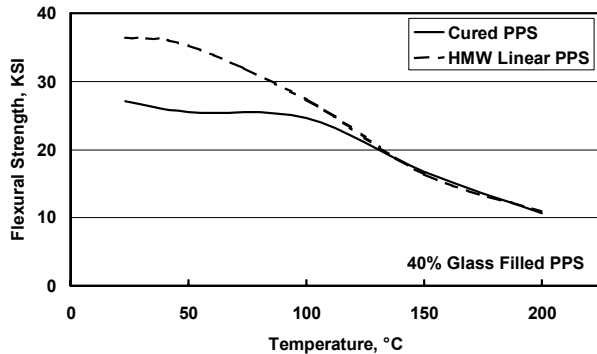
**Figure 1. Tensile Strength vs Temperature**



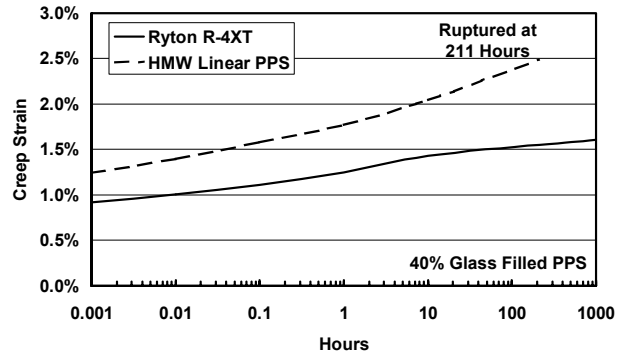
**Figure 4. Tensile Creep at 250°F and 5000 psi**



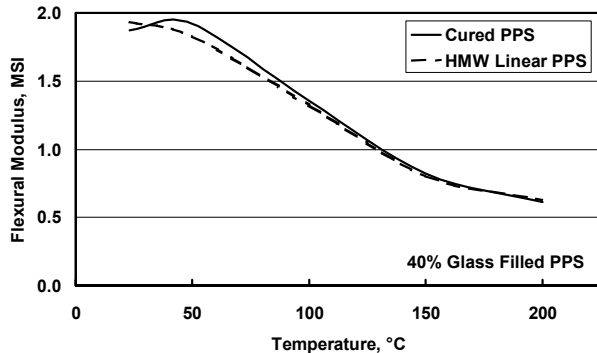
**Figure 2. Flexural Strength vs Temperature**



**Figure 5. Tensile Creep at 250°F and 10,000 psi**



**Figure 3. Flexural Modulus vs Temperature**



**Table 1. Properties of 40% Glass Filled PPS**

Property	Method	HMW Linear PPS	Ryton® R-4-200NA
Tensile Strength, MPa	ISO 527	195	195
Elongation, %	ISO 527	1.9	1.7
Flexural Strength, MPa	ISO 178	285	280
Flexural Modulus, GPa	ISO 178	14	14
Notched Izod, kJ/m <sup>2</sup>	ISO 180	10.0	9.0
Unnotched Izod, kJ/m <sup>2</sup>	ISO 180	35	35

Before using this product, the user is advised and cautioned to make its own determination and assessment of the safety and suitability of the product for the specific use in question and is further advised against relying on the information contained herein as it may relate to any specific use or application. It is the ultimate responsibility of the user to ensure that the product is suited and the information is applicable to the user's specific application. Chevron Phillips Chemical Company LP does not make, and expressly disclaims, all warranties, including warranties of merchantability or fitness for a particular purpose, regardless of whether oral or written, express or implied, or allegedly arising from any usage of any trade or from any course of dealing in connection with the use of the information contained herein or the product itself. The user expressly assumes all risk and liability, whether based in contract, tort or otherwise, in connection with the use of the information contained herein or the product itself. Further, information contained herein is given without reference to any intellectual property issues, as well as federal, state or local laws which may be encountered in the use thereof. Such questions should be investigated by the user.

For more information and technical assistance contact:

CHEVRON PHILLIPS  
 CHEMICAL COMPANY LP  
 Ryton® Business Unit  
 P. O. BOX 4910  
 The Woodlands, TX 77387-4910  
 Phone Toll Free: 1-877-798-6666  
 Website: www.RytonPPS.com

Another quality product from



The Woodlands, Texas