PV Fluid Products

The PROGRESSIVE
rotor and stator company

Product
Service
Quality
Manufacturing

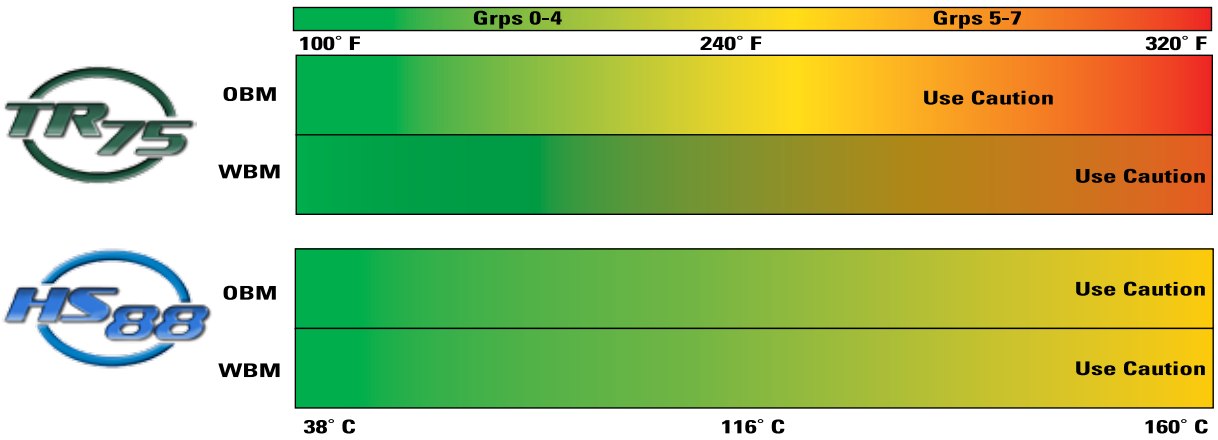
STATOR ELASTOMERS

PV Fluid Products is dedicated to providing customers with the latest in elastomer technology.

As a progressive rotor and stator company, one of our goals is continuous improvement in stator elastomer compounds. Our ongoing research and development program has already resulted in elastomers that expand the range of practical applications in the drilling industry in both water based and oil based drilling fluids. Current elastomers are:

- HS88 - a high strength, 'hard rubber' nitrile elastomer capable of taking 50% higher differential pressure which generates 50% more torque and power. Engineered for high aromatic / low aniline point drilling fluids, this elastomer is resistant to chunking and chemical swell and is designed for excellent performance in demanding and challenging applications
- TR75 - a "tough rubber",standard nitrile (NBR) elastomer that has good hydrocarbon resistance and is stonger than most conventional NBR elastomers. It produces more power and delivers improved service

Fluid Temperature Compatibility Chart



This chart is meant as a guide in selecting an appropriate elastomer for the application and is not intended as an indicator of elastomer life downhole. Fluid compatibility is a function of the chemical make up of the mud, including the aniline point in hydrocarbon based drilling fluids. Solids, viscosity, and other mud properties will also play a role in elastomer life downhole.
This chart is based on historical data collected and evaluated by PV Fluid Products and is not indicative of all applications.
The end users' field experience with the drilling fluids being used and the fit should always be taken into account.

Stator Selection

When selecting an elastomer for a specific application, consideration should be given to the temperature at which the power section is expected to run downhole, the type of drilling fluid to be used and the operating fit between the rotor and stator.

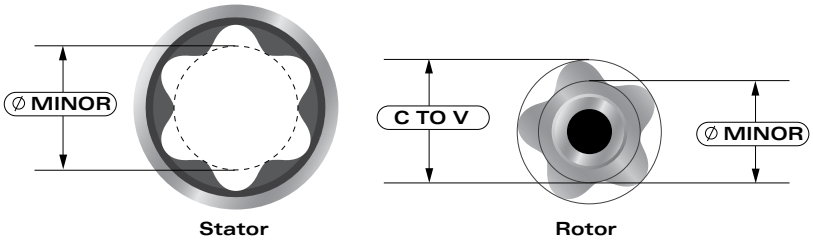
The operating temperature is usually determined by the expected circulating temperature. This will usually be a little lower than the bottom hole temperature (BHT). The power section has to be selected so that the fit between the rotor and stator is within an acceptable level when the circulating temperature is reached so that optimum performance is achieved.

- If the fit is too tight, the power section will have high power but low service life
- If the fit is correct, the power section will have optimum power and good service life
- If the fit is too loose, the power section will have low power and low service life

The formulas below can be used as a guideline to size rotors and stators for optimum setup at the suggested temperatures.

Odd Lobe Rotor
Rotor C to V – Stator Minor = fit *
(*) negative = clearance; positive = compression

Even Lobe Rotor
Rotor Minor + 2ecc – Stator Minor = fit *
(*) negative = clearance; positive = compression



• All measurements are in inches to one thousandth of an inch *• C to V is the "crest to valley" measurement on an odd lobe rotor.*

Thermal Expansion

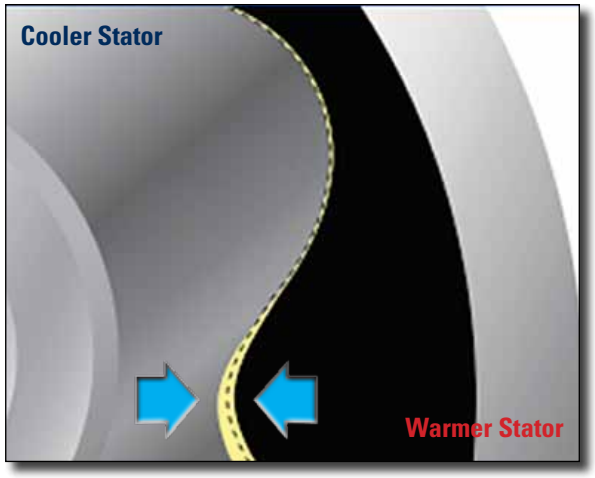
As the rotor and stator heat up downhole, thermal expansion takes place which changes the fit. The elastomer has a higher rate of thermal expansion than the rotor and the rate of thermal expansion is also determined by the elastomer and the model. When the heat reduces, the thermal expansion also reduces.

The main sources of heat are

- Internal – the heat generated by the rotor turning in the stator
- External – heat from the formation

Internal heat is accommodated within the design of the power section, external heat is accommodated by stator fit selection. Looser fit stators are available for higher downhole temperature applications.

The fit at surface and in the workshop will be looser than the fit downhole.



Formula For Thermal Expansion

$$\frac{\Delta L}{L} = \propto[\Delta T]$$

ΔL = Change in Length
ΔT = Change in Temperature
$\propto$ = Coefficient of Thermal Expansion (CTE)

Chemical Swell

Chemical swell occurs when the drilling fluid reacts with the elastomer and a chemical change takes place and it varies by elastomer type and by drilling fluid.

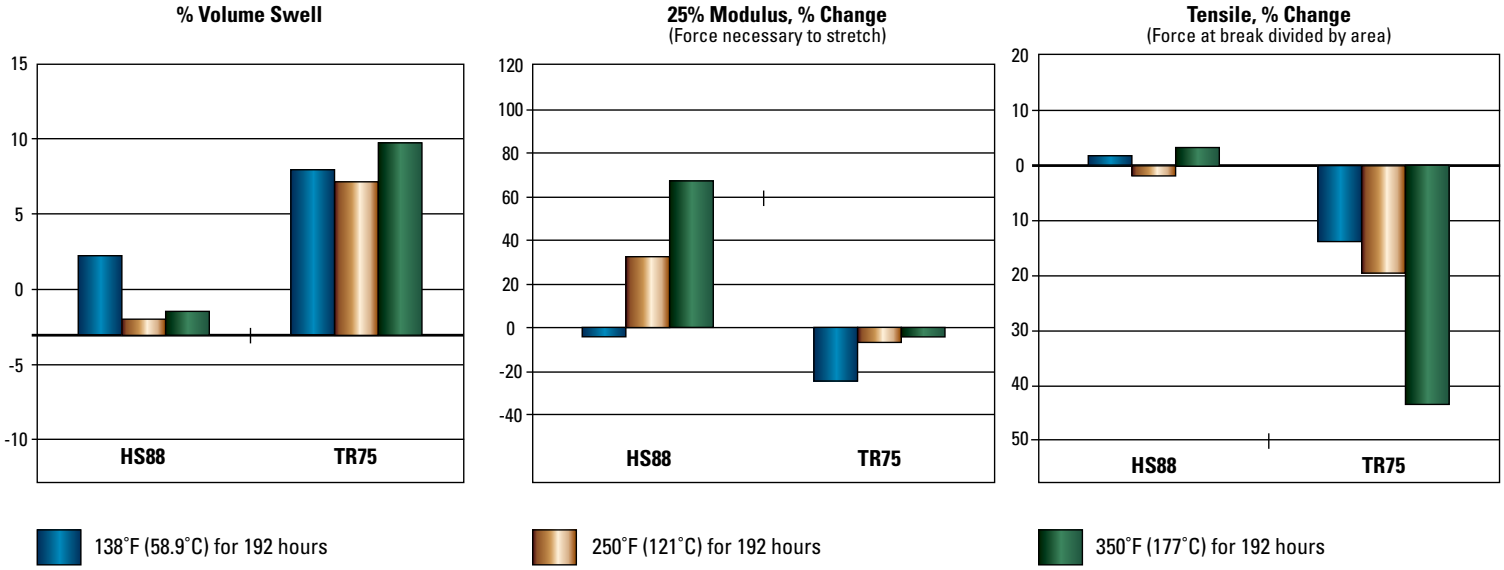
If the aniline point of the drilling fluid is lower than the circulating temperature, there is more chance of chemical swell occurring.

The effects of chemical swell tend to have a permanent effect on the elastomer and result in changes to the mechanical and physical properties, to the fit and to the service life e.g.

- The elastomer can swell and become softer
- The elastomer can shrink and become harder

Immersion tests on elastomers in drilling fluid can be undertaken to help identify changes to the key mechanical properties of the elastomers. This helps determine what elastomer and fit should be used for a specific application. Typical results are:

Diesel Baseline Test



Observations and conclusions reached in this report are based on lab results obtained using PV stator elastomer and mud samples supplied to PV Fluid Products and are based on ASTM testing standards. Fluid Products does not guarantee that the results of this test will be duplicated in actual drilling conditions. This report is provided for general guideline purposes only.

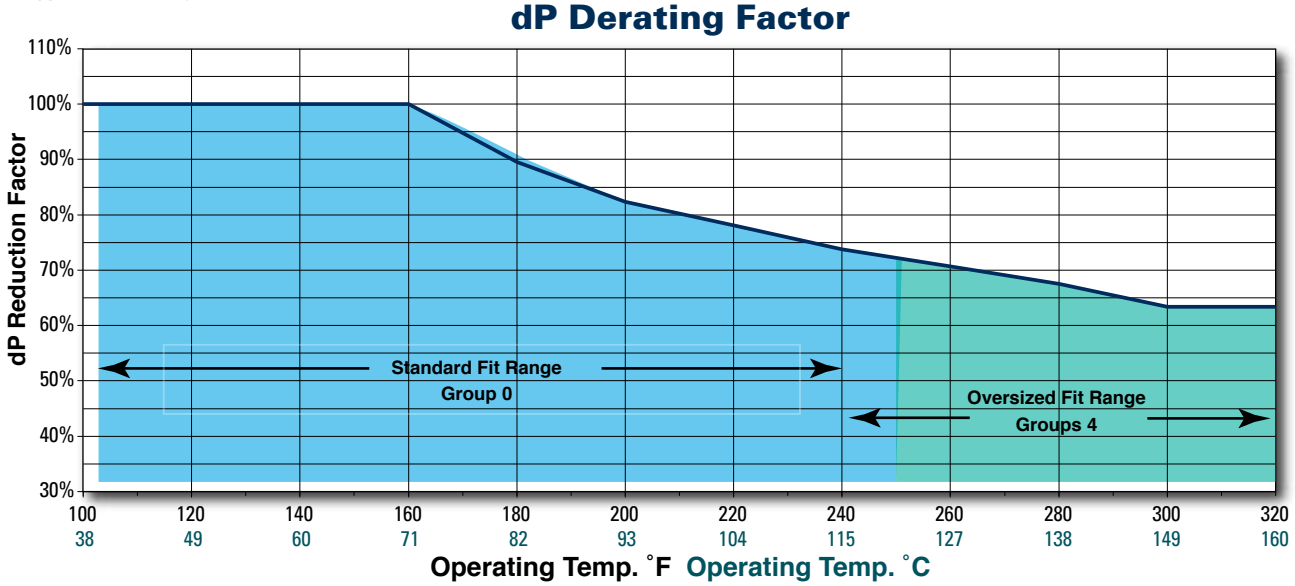
Temperature Derating

Elastomers lose some of their mechanical strength when they get hotter. For optimum service life, the maximum Operating Pressure across the power section should be reduced (derated) as the temperature increases. The derating factor increases with the temperature so to calculate the derated Operating Pressure at given application temperature, multiply the Maximum Operating Pressure by the derating factor.

Each stator's performance specification sheet shows the maximum Working Pressure, the maximum Off-Bottom Pressure and the maximum Operating Pressure (for the power section only).

Maximum Working Pressure = the maximum pressure that can be put across the power section before slip starts to occur.
Maximum Off-Bottom (OFF-BTM) = the pressure, at maximum flow rate, needed to overcome the internal mechanical and hydraulic friction in the power section.
Maximum Operating Pressure = maximum Working Pressure – maximum OFF-BTM (i.e. the remaining pressure available for the drilling operation).

A typical derating chart is shown below.



Stator Shelf Life

In general, elastomers age when exposed to heat, light, ozone, oxygen and radiation. Aging causes the elastomer to harden and crack and changes the mechanical properties. A borescope can be used to view the internal condition of a stator and a durometer gauge can be used to measure the hardness of the elastomer.

The recommended shelf life for a NEW stator stored with the ends covered is:

- 3 years – if the stator is stored in a climate controlled environment
- 2 Years – If the stator is stored inside or outside, in moderate conditions (up to 100°F / 38°C)
- 1 Year – if the stator is stored outside in high heat conditions

It is recommended that stators stored outside are painted a light colour and are located out of direct sunlight. It is also recommended that stators are relined after each run, particularly when used with invert or oil base mud and in high temperature applications.

If used stators are to be re-run, local knowledge and experience should be used to determine shelf life. Used stators should be flushed out with clean water before being laid down. The rotors should not be stored inside the stator.

For more information on PV elastomers, fit charts, derating curves, etc., please contact your local PV sales office.

PV Fluid Products Ltd.
Nisku, AB. Canada
Phone: +1 780-955-8800

PV Fluid Products, Inc.
Houston, TX. USA
Phone: +1 281-550-1500

PV Fluid Products GmbH
Wolfenbüttel, Germany
Phone: +44 (0) 1625-505912

PV Fluid Products UK Ltd.
Macclesfield, Cheshire UK
Phone: +44 (0) 1625-505912

PV Fluid Products Ltd.
Calgary, AB. Canada
Phone: +1 403-640-0331

PV International
Bridgetown, Barbados
Phone:+1 246-427-8617

PV Dubai
UAE
Phone: +44 (0) 1625-505912

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www.pvfluid.com

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