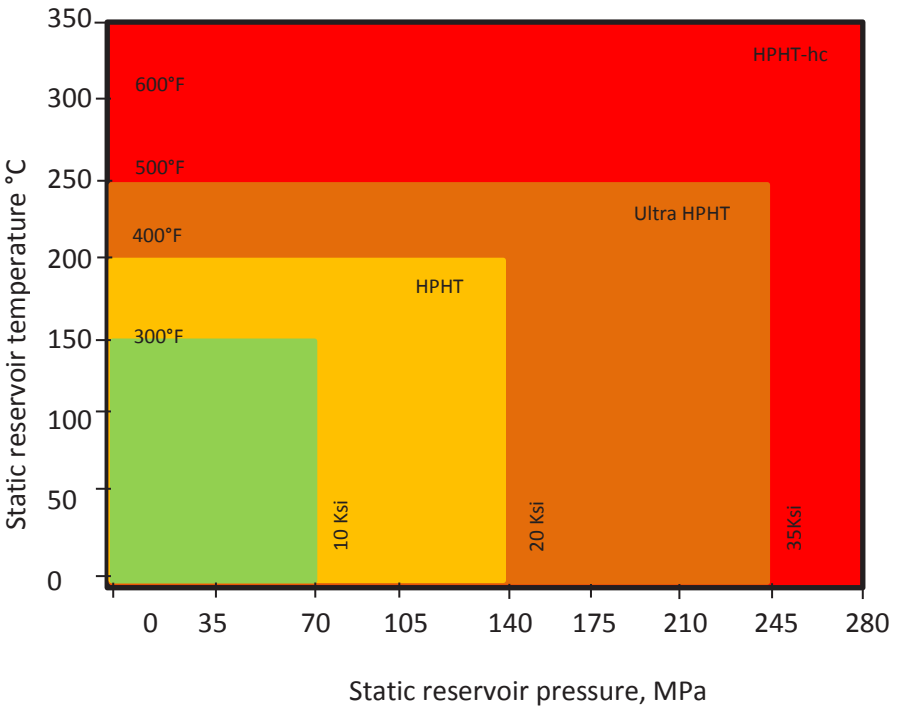
Fluorocarbon Goes HPHT

Despite the growth in renewable energy, the world's reliance on fossil fuels will continue for the coming decades and as such, even the recent variability in the price of oil cannot curb the need for exploration and production of fossil fuels to meet these demands. The market frequently suggests "The easy oil has gone" so exploration and production must develop fields in hostile locations and conditions.

Fluorocarbon has many years of experience in engineered seal design and material development to meet the demands of fluid handling in Oil & Gas applications. However, in recent years our designers and engineers have become even more innovative in addressing the challenges posed by HPHT (High Pressure, High Temperature) applications.

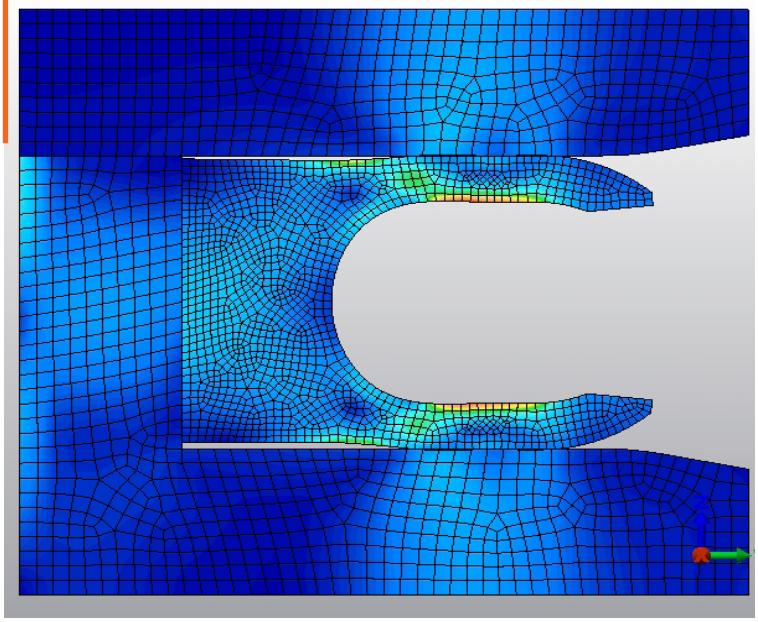
HPHT is defined as those wells with a bottom hole temperature greater than 150°C (300F) and requiring pressure control equipment with a rated working pressure of above 69 MPa (10,000 psi) (S.P.E. E&P Glossary, HPHT, 2013). However, further advances in exploration, extraction and production mean some wells are reaching higher pressures and temperatures, termed as Ultra HPHT (205°C, 138MPa) and even Extreme HPHT (260°C, 241MPa).

These temperatures and pressures are pushing the workable limits of traditional elastomeric and polymeric materials and our material and seal engineers are working with downhole and fluid control component manufacturers to ensure our products continue to meet these challenges along with the typical requirements of resistance to Hydrogen Sulphide (H_2S), age degradation, and the hazard of particulates in the media promoting erosion in the seals.



Fluorocarbon has a wide range of polymers within its portfolio and continues to develop new grades of high performance polymers, in partnership with raw material suppliers, to create high strength and high temperature grades of material that retain flexibility and energy when combined with springs in the engineered seal design. These materials allow our engineers to be innovative with solutions that include multi-piece assemblies with sealing and support rings, engineered to use system pressures to enhance seal effect yet prevent material flow through clearances.

To instill confidence in our contract partners, our solution proposals are verified using sophisticated finite element codes. Our vast experience in material development and engineered seal design, allows us to select and use material models which accurately represent the materials non-linear viscoplastic behaviour under different conditions. As the changing applications and operating environments demand, the profile of the materials, whether microscopic or macroscopic, will require re-configuration and innovation. As an integral part of the final sealing solution design, Fluorocarbon's ability to develop specific

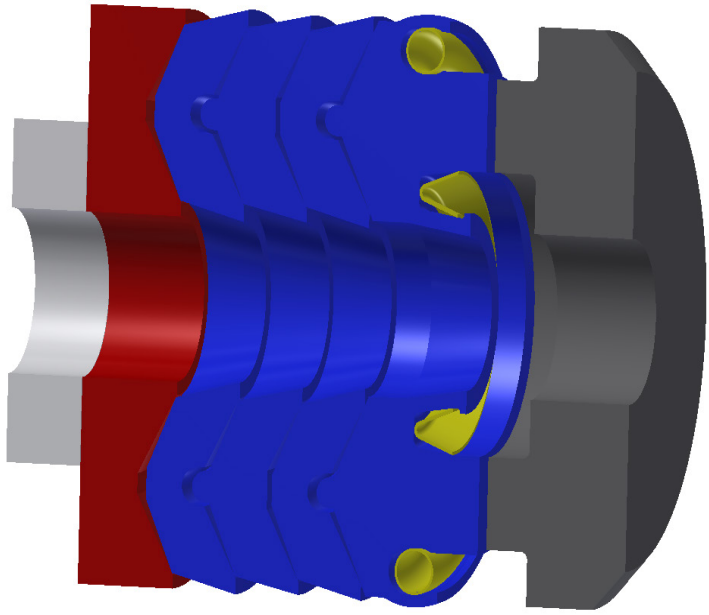


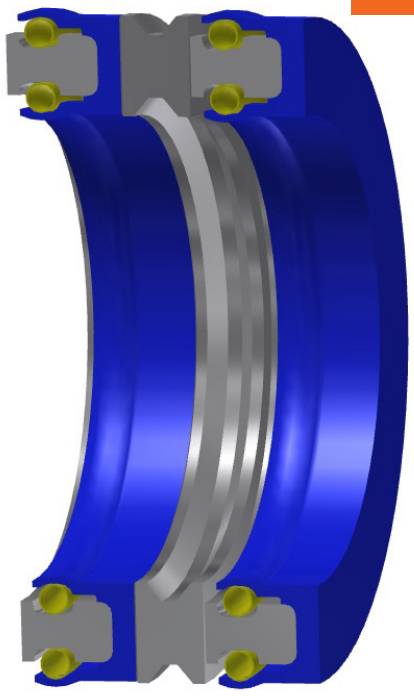
materials, and conduct tensile, compression and other tests, creates a platform for collaborative engagement at all stages of product life cycle from concept to product optimisation. This capability gives Fluorocarbon the flexibility to simulate and experiment with key variables and develop innovative sealing solutions to address the challenges posed in HPHT applications.

The API 6A Appendix F PR2 test is undoubtedly the most widespread qualification, combining both the effects of pressure (P), and temperature (T). It is a qualification that has been specifically designed for components which will be commissioned in remote and hostile environments and gives engineers absolute confidence that their components can withstand the most arduous environments throughout their working life. Fluorocarbon has worked extensively with these engineers, and in many cases is required to consider additional functions, providing the optimum package of performance.

An example of this is a sealing solution design for a gate valve seat seal which was required to meet the PR2 qualification of 15,000psi (1035 Bar) and 350F (177°C), but to also meet the design function of seat load energy which required upstream seals to provide controlled venting in reverse, without detriment to downstream sealing performance. Furthermore the materials of construction needed to be NORSOK M-710 and NACE M-0175 approved.

This required an innovative approach to design allowing reverse pressure to flow around the seal and careful material consideration to reduce creep, all within a small space envelope. Our in depth engagement and understanding of the increasing demands from our customers and from within the industry ensures Fluorocarbon expertise provides multi-faceted solutions to demanding problems





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Whilst HPHT conditions only represent a small proportion of the total number of wells in operation, this number is growing. The developments and innovations in product design and material research, driven by the high temperature and high pressure conditions, have relevance in many of the conventional and alternative production technologies. Moreover, unique demands of each region, field and application, whether in HPHT, Shale gas fracking or use of Liquefied Natural Gas demand unique solutions throughout the oil and gas sector in down-hole, subsea and surface technologies.

As technologies advance, international and national standards are reviewed to keep abreast of the changes. Fluorocarbon works with and influences many of the regulatory bodies, standards agencies and associations. This ensures continuity in meeting the innovation demands whilst compliance and acceptance criteria are considered and met accordingly. •

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