High Performance Elastomers & Polymers for Oil & Gas Applications
17-18 April 2012
Copthorne Hotel Aberdeen, UK

DAY ONE: Tuesday 17 April 2012

08.15 NETWORKING BREAKFAST AND REGISTRATION

09.15 Welcome and Introduction to High Performance Elastomers & Polymers for Oil & Gas Applications 2012

Session 1: Testing

09.30 **Extrusion resistance of elastomers: a study of factors that affect performance**

The importance of extrusion resistance for elastomers designed for high pressure high temperature (HPHT) applications is well known in this market sector. Whilst elastomer mouldings can be given enhanced pressure capabilities through the use of metal parts, elastomers with increased levels of extrusion resistance at high temperatures will benefit the industry. This paper describes a simple method for evaluating extrusion resistance, and studies FKM and HNBR compounds at different temperatures and extrusion gaps. It also examines any correlation between standard laboratory test data and failure conditions.

Having benchmarked these elastomers which use conventional compounding technology, modifications will be made to improve their performance using a number of techniques. Finally, an assessment of the maximum extrusion resistance that may be expected from an elastomer at elevated temperatures whilst maintaining a balance of elastomeric properties will conclude the paper.

Peter Warren, Andrew Douglas & Stephen Winterbottom, James Walker & Co Ltd, UK

10.00 **Kinetic and mechanical properties of swellable polymers under geometrical constraints**

Swellable packers is widely used in oil-field. The packer is made of an elastomer crosslinked on the exterior surface of a metallic tubing. When the packer is deployed in a borehole, the elastomer imbibes a solvent (water or oil) and swells. After the swollen elastomer touches the wall of the borehole, a significant amount of time is needed for the solvent in the elastomer to

redistribute, building up the sealing pressure to the state of equilibrium. The sealing pressure and the sealing time depends on the geometric parameters (i.e., the thickness of the elastomer and the radii of the tubing and borehole), the modulus of elastomer, and the affinity between the elastomer and the solvent. In this work, I will present a model that includes all these component. This model can be used to provide quantitative analysis on the kinetic and mechanical properties of swellable packers under downhole conditions.

Yucun Lou, Agathe Robisson & Sudeep Maheshwari, Schlumberger-Doll Research Center

10.30 **Observing rapid gas decompression damage: a novel technique**

Elastomeric materials employed in sealing applications can be sensitive to physical damage arising from rapid gas depressurisation (RGD) events. This phenomenon has been causing problems in the oil & gas sector for decades, as it can ultimately lead to leakage in critical sealing applications. Its avoidance in service situations is often not possible since long periods for depressurisation are not viable. In addition, uncontrolled gas decompression may accidently occur and compromise seal integrity.

Development work in elastomer formulation and processing by seals and materials suppliers has resulted in a range of commercial sealing compounds with good resistance to RGD events. However, service conditions are becoming more severe and this, along with increased qualification and accountability requirements, means that the task of developing such materials is never complete, making it more difficult for even the best elastomer compounds to survive RGD events.

A technique has been developed which allows direct observation of elastomer seals as they react to the application and removal of pressurised gas. Thermal expansion, swelling, contraction, deformation, blistering and splitting have all been observed and characterised with reference to the prevailing test conditions.

This paper will highlight several relevant topics:

- the underlying causes of RGD damage;
- a novel technique for observing it in-situ; the mechanism of rapid gas decompression will be explained using this optical technique;
- geometrical effects of seal and groove dimensions;
- the impact of hydrocarbon liquid on RGD resistance.

Dr Sabine Munch, MERL Ltd, UK

11.00 COFFEE AND NETWORKING

11.30 **Elastomers in CO_2**

Carbon dioxide is a naturally occurring organic gas that is frequently encountered in hydrocarbon environments. The CO_2 molecule has some unique properties causing it to be problematic when in contact with popular oilfield elastomers. Relatively small concentrations of CO_2 in hydrocarbon assays frequently prove to be problematic if consideration is not given to the choice of polymer, cure, and reinforcement.

This paper examines the response, in both quantitative and qualitative terms, of several popular oilfield polymers to CO_2.

Daniel L Hertz III, Seals Eastern Inc, USA

12.00 **Fluid ageing and rapid gas decompression of HNBR elastomers**

Dr Victor Nasreddine, Dr Kevin Kulbaba, Dr Andreas Bischoff & Christian Müller, LANXESS AG, Germany; Larry Chen, Dr David Gerrard & Jim Goodson, Baker Hughes, USA

12.30 Q & A SESSION

12.45 NETWORKING LUNCH

Session 2: Materials and Polymers

14.00 ***In situ* crosslinked synthetic cement for use in cementing and zonal isolation of unconventional wells**

As the Oil & Gas industry continues to push the limits by drilling unconventional and challenged reservoirs, the need for sealant materials with enhanced properties for cementing difficult to drill wells becomes increasingly critical. Traditional cement materials are limited for these applications due to high viscosities, narrow operating temperature windows, rigorous hole clean-out requirements, long set times, incompatibility with crude oil and oil-based drilling fluids, and a limited range of mechanical properties. Herein we present a system for forming a crosslinked synthetic polymer cement *in situ* for use in cementing and zonal isolation under unconventional or extreme conditions. This system has been shown to have a low ECD rheological profile, enhanced mechanical properties, and desirable thickening times as compared to traditional offshore cement slurries. In addition, its synthetic nature allows for custom tailoring of set times for individual BHST as well as tailoring of mechanical properties to meet the requirements of unique specialized applications, such as squeeze cementing, lost circulation remediation, *in situ* packer formation, or cementing of unconsolidated formations.

Dr Erin B Murphy & Marc Hein, Kraton Polymers, USA

14.30 **Low temperature perfluroelastomer development**

As oil and gas exploration and processing moves to colder, sub-zero climates, perfluoroelastomer sealing performance is becoming critical – just how low can perfluoroelastomers go? This paper reports the development of a new perfluoroelastomer (FFKM) capable of withstanding temperatures as low as 40^0C, and as high as $+250^0$C – the widest range or any current FFKM and ideal for managing the thermal shock of surface to downhole deployment.

In addition to exhibiting consistently lower compression sets across a range of temperatures compared with other FFKMs, the new perfluoroelastomer has high levels of resistance to methanol, amines, acids and other aggressive chemicals. The paper will report the testing of the new FFKM in some detail covering pressure testing, compression set, methanol immersion, mechanical properties, nitrogen leak testing and low/high temperature testing.

John Kerwin, Precision Polymer Engineering Ltd, UK

15.00 **All-aromatic liquid crystal polymers for cryogenic and high temperature composite applications (tbc)**

Prof Theo J Dingemans, Delft University of Technology, The Netherlands (invited)

15.30 COFFEE AND NETWORKING

16.00 **Novel high performance elastomers for mining, downsteam and pipeline construction applications**

Polyurethane (PUR) elastomers are widely used in the oil and gas industry. From pipe conveyors to external and field joint coating and repair all the way to cups and discs for in-line inspection and cleaning tools. In offshore and subsea applications, PUR elastomers are used for bend restrictors, bend stiffeners, and buoyancy devices.

In the past, attempts to introduce PURs into further applications, e.g., interior pipe coatings, to utilize the extremely high abrasion resistance of polyurethanes were only successful in certain niche applications. Often, the material were not able to withstand the entire temperature range or chemical environment required in oil & gas applications. For pipe coating, the relatively weak adhesion of conventional PURs to metal surfaces prevented widespread use.

ROSEN, a technology leader in pipeline inspection developed new High Performance PUR Elastomers for the cups and discs of their in-line tools that would be resistant enough for the strongly developing subsea pipeline market (distances between pig launchers and receivers up to over 1200 km and more. Standard PURs will wear out to quickly for such applications.

Meanwhile, this development has led to Pigging discs allowing operating temperatures – 50 to + 135°C as well as highly acidic and alkaline media, e.g., pure ammonia.

- A pipe abrasion protection coating with extremely high adhesion to steel.
- Systems where the excellent material properties of High Performance PUR Elastomers are combined with electronic systems to simultaneously protect valuable assets from harsh environments and from third-party damage.
- Exactly adjustable visco-elastic damping (rebound resilience) allowing new vibration damping solutions for pipelines and for reciprocating machinery.

This presentation will describe details of the material properties and show examples of the success of High Performance PUR Materials in the oil & gas industry.

Michael Magerstädt & Gunther Blitz,ROSEN Swiss AG; Holger Schmidt, ROSEN Technology and Research Center GmbH, Germany; Ralf Dopieralla, ROPLAST GmbH, Germany

16.30 **Perfluoroelastomer parts for demanding oil and gas applications**

Jean-Luc Matoux, DuPont International Operations SARL, Switzerland

17.00 Q & A SESSION

17.15 END OF DAY ONE

18.30 EVENING SOCIAL EVENT

DAY TWO: Wednesday 18 April 2012

08.30 NETWORKING BREAKFAST

Session 3: Sealing

09.30 **Extreme oil field seal applications**

Seal system service limits are often based on conservative physical property test data that may not accurately represent the down hole oilfield environment. This paper focusing on the application of rubber and plastic seals in situations that far exceed the standard industry accepted performance limits. These extreme applications can be limited by many factors such as time and temperature but still exist none the less.

Buc Slay & Steve Streich, Halliburton, USA; Winston Webber, Halliburton, UK

10.00 **CVD tungsten carbide coating extends life of elastomeric seals and enables high temperature seal design**

Elastomeric seals in rotating or reciprocating equipment suffer from premature wear in abrasive applications and in some cases limit the maximum operating temperatures of down-hole tools.

In both applications, the newly-developed CVD Tungsten Carbide coating can prolong seal life and increase the maximum operating temperature.

The coating protects the metal shafts or plungers from scratching and scoring which can accelerate the elastomeric seal wear rate greatly. Unlike traditional thermal spray WC/Co coatings, the CVD coating is free from Cobalt binder. As a result, the coated metal counter-surface retains a good finish for longer in operation and thus is less abrasive for the seal. Leaching of Cobalt from traditional thermal spray coatings exposes hard grains of Tungsten Carbide sometimes described as “cheese-graters”, and which increase the wear of elastomeric seals.

The Hardide coating has been tested on metal/metal seals suitable for operating at high temperatures which could damage elastomeric materials. Thanks to the coating abrasion-resistance and anti-galling properties the seal remained operational even under significant mechanical loads.

Such coatings are resistant to H2S and can protect metal components from aggressive sour oil and gas attack.

Dr Yuri N Zhuk, Hardide Plc , UK

10.30 COFFEE AND NETWORKING

11.00 **High performance polyurethanes in the oil & gas industry**

Seals made of polyurethane elastomers are widely used in large number of industries such as off-highway, mining, heavy industries, machine tools and others since many years for both, static and dynamic applications. Polyurethane seals show excellent leakage performance and pressure resistance, outstanding tribological properties and reasonable fluid compatibility for hydraulic applications. However, in the oil and gas industry much higher requirements in terms of chemical compatibility and pressure resistance as well as others are put on seals respectively sealing materials.

This works describes the performance of high performance polyurethanes providing increased chemical compatibility against oil and gas media, combined with excellent sealing properties and pressure resistance. Special modifications offer additionally improved friction and wear performance and therefore increased service life of these elements.

Thomas Schwarz, SKF Economos GmbH, Germany

11.30 **Elastomers for high temperature/high pressure applications (title tbc)**

Representative of Trelleborg Sealing Solutions

Session 4: Materials

12.00 **Lessons learnt from failure analyses and success stories**

At Swerea KIMAB and our subsidiary Institute de la Corrosion in France there is a long tradition of research in the area of predicting the performance and understanding the reasons for premature failures and in helping with materials selection for both polymeric and metallic materials in corrosive environments. Much of our knowledge has been built from analysing components that have been in service. In the oil & gas industry there is a lot of testing required for the materials to be qualified for service but different standards can rate a set of materials differently. How will this set of material rate in real service? How relevant is the testing? Some of these questions can be answered from analysing components that have been in service.

Dr Karin Jacobson, Swerea KIMAB AB, Sweden

12.30 Q & A SESSION

12.45 NETWORKING LUNCH

14.00 **Life prediction of polymers for the oil and gas industry**

As the service conditions in the oil and gas industry become increasingly more demanding, there is a greater need to demonstrate that the materials selected are fit for service. This is particularly important for polymeric materials as their properties are time and temperature dependent and can be significantly affected by the fluids they come into contact with. To predict life, accelerated laboratory tests can be carried out based on the service conditions the component will experience. These short-term ageing tests are most suited to rank different polymers for their susceptibility to chemical attack or change in properties.

Unstrained tests, however, do not give any real information relating to long term design data or predictions of expected lifetime when subjected to static or dynamic loads in an extreme environment. Hence the performance of the polymer is often over estimated, resulting in unexpected failure. Therefore, it is important for engineers to understand the behaviour of a polymer in its operating environment to ensure that the accelerated test programme is applicable.

This paper discusses the different effects of the operating environment on polymers when subjected to both static and dynamic loads. It also discusses what ageing mechanisms occur during service (oxidation, thermal degradation, chemical attack, plasticising etc.) and the test methods available to characterise performance. By understanding how the polymer behaves during service, engineers will have greater confidence in the durability of components used in high performance oil and gas applications.

Andrew Hulme & Jenny Cooper, Smithers Rapra Technology Ltd, UK

14.30 **High performance elastomers from naturally occurring modified oils**

Polyols being the determinative factor to decide mechanical as well as physical properties also the cost. Over a period of time processable Isocynates have not been invented too many, but large amount of polyols are researched ,with addition of fuctional groups, orientations, mixture of more than one polyols, polyols with metallic chealets, and many more are under research. For countries having no oil field or gas reserve areas, always cost of import of these crude oil offshoot products is a matter of real concern. This paper intends to focus on development of Polyol/s from naturally occouring oils and is practical, cost-effective conversion, effectively consumed and being used .Trial quantity was 12,000 kgs(26,500 Lbs.)We would like to share this first exploration and subsequent additions further. It is studided that edible/vegetable/flower extracts are successfully modified to get polyols but the usage was limited to foam making. Whereas this invention wants to highlight mechanical values of elastomeric product developed from these polyols, may be useful for high performance applications. Raw material availibility and processability could be locally controlled ,which may make product cost at least 20/25 % lower than that of existing prices.

Jayant Khadilkar & Aditya Khadilkar, Jay Elastomers Pvt Ltd, India

15.00 Q & A SESSION

15.15 COFFEE AND NETWORKING

15.30 CLOSE OF PROCEEDINGS

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