MacDermid Offshore Solutions

Oceanic HW 443

443 443 ND & 443 R
Subsea Production Control Fluid

General Description

Oceanic HW443 has been specifically developed for use in higher temperature wells and is also highly recommended for closed loop blow out preventors (BOP). Its temperature range is from -25°C (-13°F) up to 135°C (275°F). It was designed to help improve safety when producing hydrocarbons from hot wells. Fluids in the past (water based and hydrocarbon) showed degradation when subjected to temperatures over 100°C (212°F). In a hot well the sub-surface safety valve could operate at temperatures exceeding this. This subsea control fluid has been the result of two and a half years of research and development. It is stable up to 135°C (275F) with no physical or chemical change, improving performance and reducing the chance of blockage, corrosion and wear.

Oceanic HW443 contains a leak tracing fluorescent dye, it has vapor phase corrosion inhibitor to prevent corrosion of metals above the fluid surface and it is approximately 90 to 100 times less toxic than fluids developed before its formulation. Being water-based control fluid, Oceanic HW443 is suitable for use in open or closed loop subsea control systems. It has been developed to give good lubrication combined with wear resistance and an excellent anti-corrosion package. It is resistant to seawater ingression providing seawater stability and protection against microorganisms. Oceanic HW 443R is a rhodamine dye option to enhance the environmental acceptability even further. Available only from the UK manufacturing facility for the North Sea and Norwegian sector.

Physical Properties

This following section describes the typical properties of Oceanic HW443, if any variations of these limits are required, these can be supplied. By changing the glycol content, we can reduce or increase the viscosity, freezing point or specific gravity.

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Oceanic HW	HW443	HW443R	HW443ND
Appearance	Fluorescent Green Liquid	Fluorescent Pink Liquid	Amber Liquid
Viscosity (cS) @ -20°C = -4°F 0°C = 32°F 20°C = 68°F 40°C = 104°F	25.0 9.2 4.4 2.5	25.0 9.2 4.4 2.5	25.0 9.2 4.4 2.5
Pour Point °C (°F)	-25 (-13)	-25 (-13)	-25 (-13)
Specific Gravity @ 15.6°C (60°F)	1.071	1.071	1.071
pH	9.7	9.7	9.7
Specific Heat Capacity $J.kg^{-1}.K^{-1}$	3445	3445	3445
Thermal Conductivity $W.m^{-1}.K^{-1}$	0.470	0.470	0.470

Oceanic HW443
Bulk Modulus @ 4°C (39°F)

Pressure, psig	Isothermal Secant Bulk Modulus, psi	Isothermal Tangent Bulk Modulus, psi
1000	408633	412443
2000	413398	421108
3000	418164	429861
4000	422930	438704
5000	427696	447636
6000	432462	456656
7000	437227	465765
8000	441993	474963
9000	446759	484250
10000	451525	493626
11000	456290	503091
12000	461056	512645
13000	465822	522287
14000	470588	532019
15000	475354	541839

An independent laboratory has determined bulk Modulus results for MacDermid Offshore Solutions LLC.

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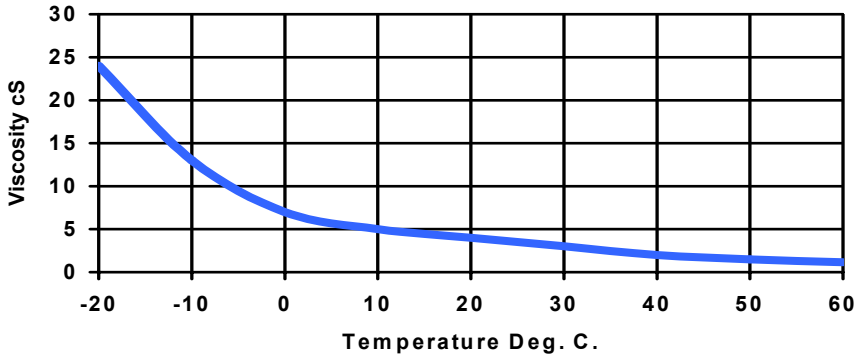
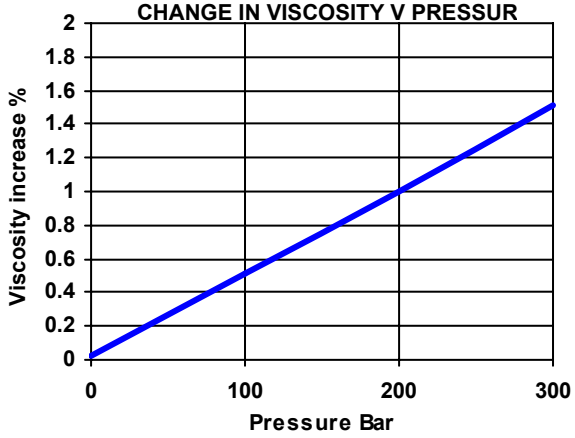
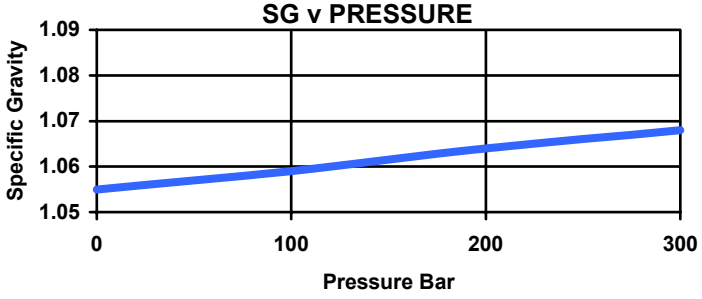
OCEANIC HW 443
TEMPERATURE V VISCOSITY



OCEANIC HW 443
CHANGE IN VISCOSITY V PRESSUR



OCEANIC HW 443
SG v PRESSURE



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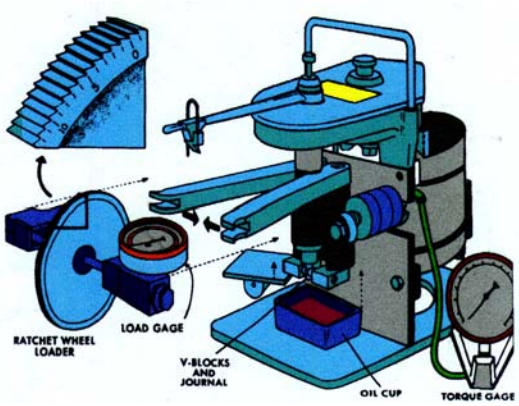
Material Compatibility

Elastomers Oceanic HW443 is suitable for use with common O-ring materials such as Nitrile, Buna N, Silicone, Neoprene and P.T.F.E., and AFLAS. Composite materials such as common Fluoroelastomers impregnated cotton should be avoided, as they may absorb moisture and swell over extended periods. Some grades of common Fluoroelastomers have proven to be incompatible at high temperatures, due to the alkaline nature of water-based fluids. Some polyurethane and all porous gasket materials should be avoided. Testing on compatibility done by R.A.P.R.A. for FSSL Ltd. Show this control fluid has no detrimental effect to any seal material used on their control systems. (Copies of this report are available on request.) Thermoplastics used as umbilical hose linings are generally acceptable. The Institute of Offshore Engineering (IOE Group), and MacDermid show no problem with current hose materials used with Oceanic HW443 (again these reports are available on request).

Metals All ferrous and yellow metal alloys are compatible. Poor quality Zinc and Cadmium plating should be avoided as porosity can cause lifting of the plate. Aluminum rubbing contacts should be avoided; non-rubbing hard-anodized aluminum is acceptable. Many tests have been used to evaluate Oceanic HW443 using pumps, valves and actuators, there has been no evidence of any corrosion in these components since the fluid formulation was finalized early in 1992. Testing done for FSSL on three materials used in their valves showed there is no corrosion with Ferralium SD40, 316 S11 Stainless Steel and Monel K500. Call MacDermid Technical Staff for compatibility of metals used in an application.



Filter Element Some impregnated paper types lose strength in contact with aqueous fluids. Recommended filter types are woven polypropylene or glass fiber. Long term testing has been done with the Pall Ultipor III medium and this is now recommended for use with all Oceanic HW fluids

Paints Most paints used in the offshore industry are compatible with Oceanic fluids. The most satisfactory being Nylon, Phenolic and Epoxy based coatings.

Lubrication and Anti-Wear Properties

Falex Lubricant Test The Falex Lubricant Tester is a well-established method for evaluating the lubricating performance of fluids. It is generally used specifically for metal-to-metal lubricating situations. The most commonly used test procedure is to gradually increase contact load until failure of the lubricant results in welding of the test

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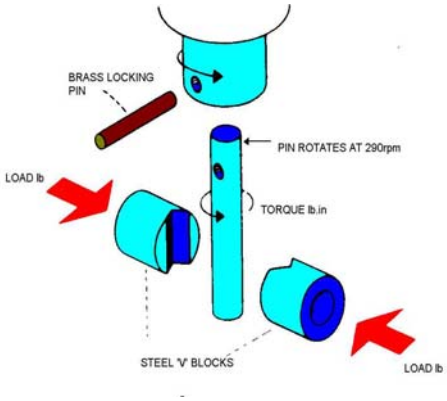
piece contact points, the relative performance of lubricant being quantified by the load achieved before failure occurs. This procedure is, however, inappropriate to the testing of low viscosity water based fluids such as subsea production control fluids. The main reason for this is that in conventional lubricants, high loads are often encountered in plain bearings, rotary pumps, and some gear tooth contacts. High contact loads in such applications generate local high temperatures, which in turn cause chemical reactions with additives within the fluids to generate surface films that provide "extreme pressure" lubricating characteristics. In most subsea fluid lubricating situations, such loads and contact temperatures are not achieved, and hence fluids containing additives of this type alone would not be effective. For lubrication of the mating surfaces of critical components such as shear seal valves, it is necessary for the fluid to possess good "boundary" lubricating ability. This is relatively difficult to achieve with a very low viscosity water based fluid.

To establish performances in this area, MacDermid uses the Falex Lubricant Tester with a modified test sequence. This involves primarily an extended test running for 30 minutes at a load of 500 lbs. The wear that takes place during this period is measured, as is the torque on the test pin. The condition of the surface of the test components is also reviewed.



To ensure consistency of testing, each 30-minute test run is preceded by a "run in" sequence consisting of the test load being increased in 100 lbs. Increments from 0 up to the final test load of 500 lbs. Each incremental load is maintained for a period of 1 minute.

Correlation with Field Performance When this test method was adopted in 1984, a considerable amount of work was carried out in conjunction with the manufacturers of components such as shear seal valves to establish that the relative performance of fluids could be evaluated using the described procedure. It was established that fluids ranked in performance using the 500 lbs. Falex test procedure would behave in similar fashion when tested on valves, and subsequent field experience has been found to support this.

This is particularly true in the case of some blowout prevention systems in which valves, which are known to stick with some fluids, have performed reliably when operated with Erifon HD856 BOP Control Fluids. This result was predicted by the performance characteristics exhibited by Erifon HD856 on the 500 lbs Falex test procedure when compared with other fluids used in the same application.

Evaluation Results When evaluating results it is important to note the torque produced (the lower torque means a better lubricant) and the

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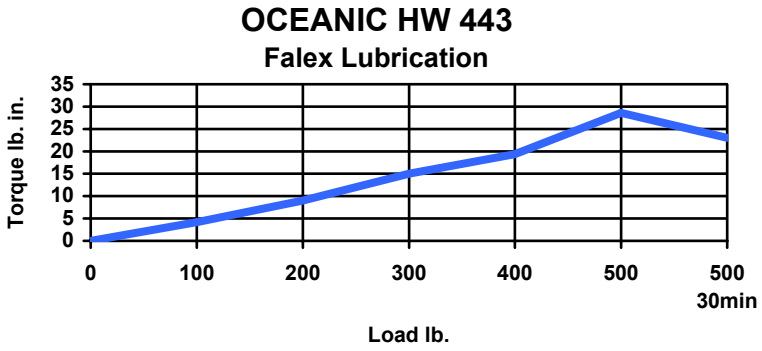
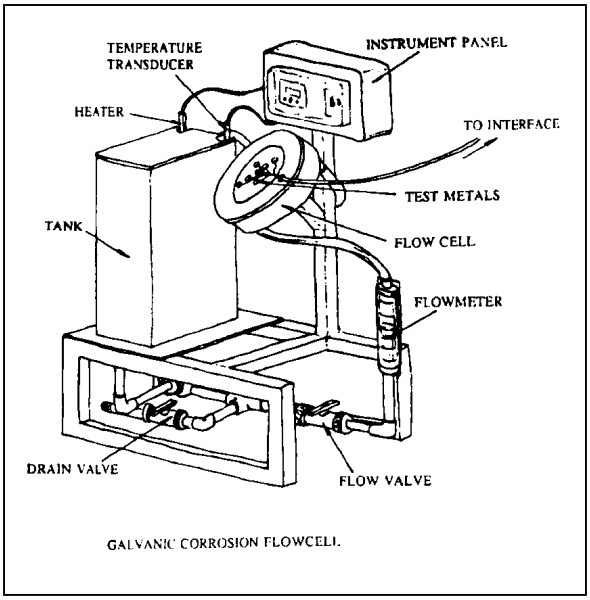
wear teeth or metal removal (low metal removal shows a good anti-wear package).

Results For Oceanic HW443 The Oceanic HW443 gave good lubrication results with little metal removal. There were only 12 wear teeth (some fluids give 100's).



Corrosion Resistance

Oceanic HW443 has been fully tested with all common metals used in the offshore industry for crevice and galvanic protection. All ferrous and yellow metal alloys are compatible. Poor quality Zinc and Cadmium plating should be avoided as porosity can cause lifting of the plate. Aluminum rubbing contacts should be avoided; non-rubbing hard-anodized aluminum is acceptable.



GALVANIC CORROSION FLOWCELL

MacDermid uses the most up to date corrosion monitoring equipment. This equipment is currently going through evaluation to be included as a standard IP test method. Many tests have been used to evaluate Oceanic HW443 using pumps, valves and actuators. There has been no evidence of any corrosion in these components since the fluid formulation was finalized early in 1992.

Testing done for FSSL on three materials used in their valves showed there to be no corrosion with Ferralium SD40, 316, S11 Stainless Steel and Monel K500. It would be

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normal to have a graph of corrosion rates at this point in the document, but as no corrosion was found this would be a pointless exercise.

Stability

Oceanic HW443 is completely stable and has been designed for an indefinite operating life. This control fluid can also withstand a large amount of seawater contamination before the operating properties of the fluid are affected. We would not be concerned about the fluid stability even with 20% seawater contamination.

Discharge Into Marine Environments

Discharge in U.K. Sector of North Sea Oceanic HW443 production control fluid is included in the U.K. Notifications Scheme for the Selection of Chemicals for Use Offshore. Under this scheme, the U.K. Department of Energy has studied the chemical composition and toxicological effects on marine organisms of the Oceanic fluid. The fluids have been attributed Class E status; hence notification is not required, provided that the usage rate does not exceed 1000 tonnes per annum per installation.

Discharge in Other Waters Oceanic HW 443 has been used widely in waters around the world with no observed environmental effect. To assist the relevant authorities in setting permissible discharge rates for Oceanic HW fluids, MacDermid have subjected HW443R to a variety of tests to establish their effects on marine organisms. The tests carried out cover acute toxicity of Oceanic HW fluids to a crustacean, sedimentary re-worker, fish and to a marine alga, and a study of the biodegradability and bioaccumulation of all the chemical components. This testing follows the PARCOM guidelines and is available in the form of the HOCNF. Oceanic HW443R meets all the requirements for use in the strict Norwegian sector of the North Sea.

Thermal Stability

MacDermid Offshore Solutions was the first company to realize there was a need for high temperature fluids in the subsea industry. Because no methods had been written to evaluate such fluids, a method had to be developed. Fluid was analyzed before being filled into a High Temperature High Pressure Pod and exerted to 140°C (284°F) and 10 000 psi.

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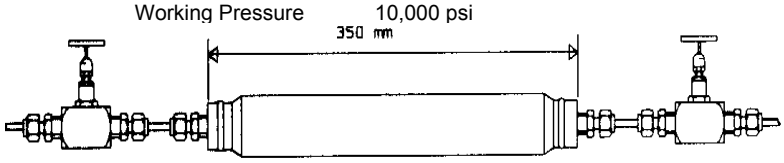
Capacity	170 ml
Max Pressure	15,000 psi
Working Pressure	10,000 psi



High Pressure, High Temperature Subsea Test Leg – MacDermid Offshore Solutions, Drawn by: S. McManus 15/8/89

After test it was re-examined for changes in viscosity, pH, solids content and chemical structure. There was no change in any of these properties with Oceanic HW443. Fluid removed from the pod after 6 months was the same as when it was filled. Testing on a number of high temperature water-based fluids by Sintef in Norway has shown that Oceanic HW443 ranks top after a 12 month test program, more results (24 month) will be available soon.

Should the reader require more in-depth information about our Oceanic HW range of fluids, please consult our Oceanic HW Fluids User Guide, copies of which are available upon request from our Technical Services Department. This booklet gives information on flushing, installation and maintenance procedures for our fluid range.

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