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## **Transocean Leads the Way with Another First** **Deepwater Nautilus Uses Terresolve Readily Biodegradable Hydraulic Fluid**

### **Background**

As with most offshore services companies, Transocean, Inc. was experiencing the increasing pressure from customers, the Coast Guard and the Materials Management Service (MMS) regarding hydraulic fluid leaks and spills. Even small spills can result in significant costs in terms of downtime, cleanup and fines. As a result, there is growing interest in biodegradable fluids. The Nautilus has recently finished a 6000-hour field demonstration using Terresolve Technologies' readily biodegradable EnviroLogic 146H hydraulic fluid. The fluid not only protected the Nautilus from the exposure due to leaks and spills but also actually improved the performance of their hydraulic system.

When Transocean first began to explore available environmentally safe lubricants, they learned not all environmentally safe fluids or the companies that promote them are the same.

Since there is no standard for environmentally preferable fluids, many different types of products claim to be environmentally safe. For the most part they fall into three major classes of products:

1. Inherently Biodegradable products are those that will break down "some day" and the time to do so is usually measured in years. The environmentally safe aspect is that they are made from either food grade oil or highly refined petroleum base fluids and contain no heavy metals in the additives. While not truly biodegradable, they do have reduced toxicity.
2. Readily biodegradable products such as vegetable based oil break down into safe, environmentally compatible components (CO<sub>2</sub> and H<sub>2</sub>O) by over 90% in 28 days or less. They are also non-toxic, so they don't kill marine life. They typically are designed for low operating temperatures (less than 220°F).
3. Synthetic products usually offer enhanced performance as compared to vegetable or petroleum products. Some can be readily biodegradable and non-toxic and can withstand operating temperatures over 400°F.

Then Transocean found Terresolve Technologies, Ltd is a company that is entirely focused on biodegradable products. Since Terresolve is so focused, they understand the benefits and limitations of readily biodegradable products. They had been marketing readily biodegradable products to a wide range of industries throughout the world for over nine years.

Terresolve explained the various types of “environmentally safe products” and how some companies were attempting to mislead the industry. They offered to work with Transocean to modify their product to meet the stringent demands of offshore applications. Terresolve and Transocean would evaluate oil samples once a week.

### Field Demonstration

With these performance characteristics in mind, Terresolve and Transocean proceeded with their field demonstration in November 2002. The Central Hydraulic System (CHS) of the Deepwater Nautilus was chosen for its wide range of applications. It powers over 40 different pieces of equipment from most major manufacturers including Varco, Weatherford, Schlumberger, National Oil Well, Ingersol Rand and others. It is a 3000-psi system, powered by 5 Hannon hydraulic power units and Rexroth axial piston variable stroke pumps.

Interestingly, when this project began, most U.S. based equipment manufacturers had little or no experience with readily biodegradable fluids, while most European manufacturers were well aware of them. The US manufacturers had evaluated white oil “inherently” biodegradable fluids and found, for the most part, white oils did not offer sufficient performance. They have since evaluated the Terresolve biodegradable products and either approved them for use or are in the process of evaluating them.

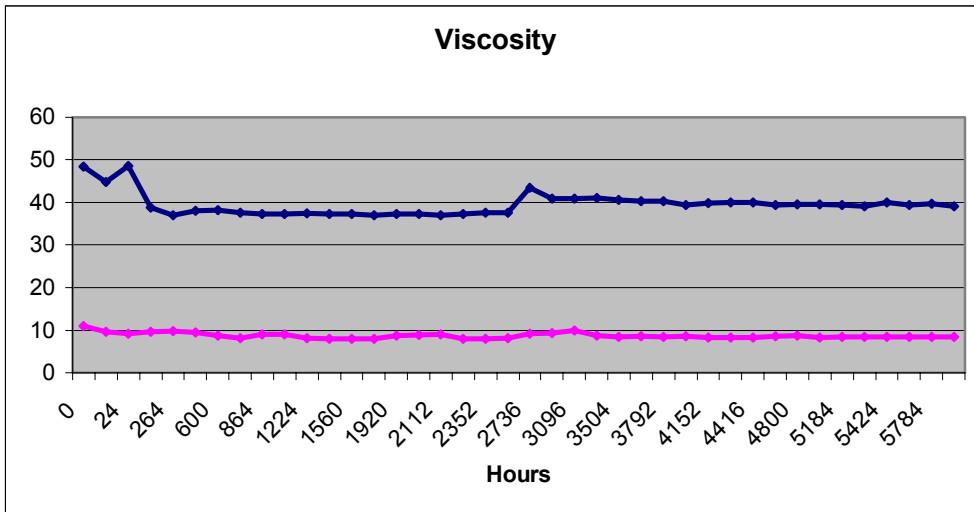
To maintain proper cleanliness, a 40-liter per minute (12 gallon per minute) bypass kidney filter was installed. A 3-micron absolute, 200 beta ratio, water-absorbing cartridge was used. This system maintained fluid cleanliness to an ISO 16/15 level and maintained water content below 0.03%.

While Terresolve EnviroLogic 146H is compatible with petroleum fluids, to ensure proper results, a thorough drain and flush was performed. Over a 36-hour period, the Nautilus’ petroleum based hydraulic fluid was drained and the system was flushed 3 times with Terresolve’s EnviroLogic 146H oil. Typically, an environmentally compatible flushing fluid would be utilized, however, in this case, utilizing the EnviroLogic 146H was logistically simpler. After each flush, each component of the system was operated briefly to ensure complete flushing. Despite this effort, there was a fairly high residual petroleum level as measured by elemental analysis (137 ppm Zn). The system was then refilled with fresh EL 146H and put back in service. Almost immediately after the changeover was complete it was noticed that the system operating temperature dropped. That was expected because the lubricating qualities of a vegetable oil are better than those of petroleum.

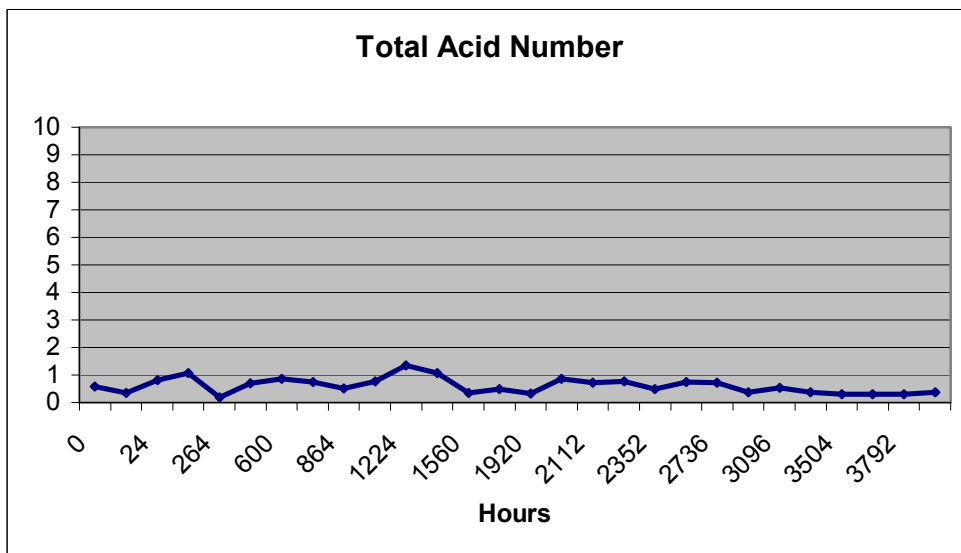
In-service oil samples were taken on a weekly basis and analyzed at independent labs by both Terresolve and Transocean. Due to some repeatability issues for the independent lab, a third lab was utilized for “round-robin” testing.

### Results

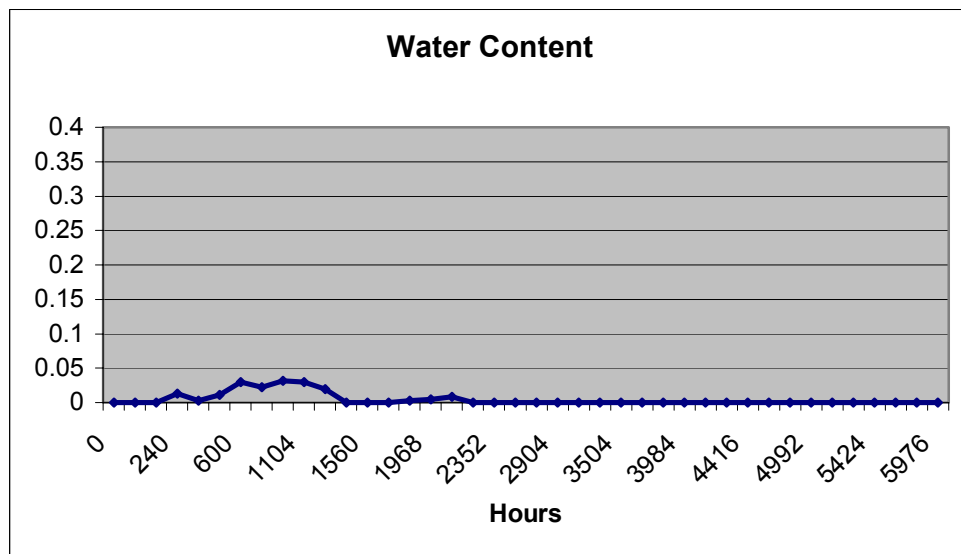
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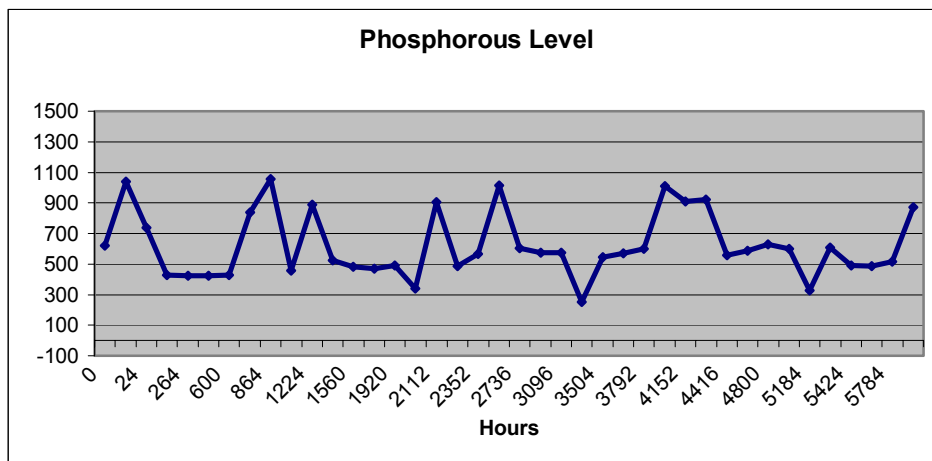
**Chart 1 Viscosity**



**Chart 2 Total Acid Number (TAN)**



**Chart 3 Water Content**



**Chart 4 Phosphorous Level**

Observations

Throughout the entire demonstration and to this date, the performance of Terresolve’s EnviroLogic 146H has been excellent. The biofluid actually improved overall performance, decreasing operating temperatures and increasing overall system responsiveness. This is typical because the lubricating qualities of a vegetable oil are better than those of petroleum thereby reducing friction and wear. It should also be noted that the biofluids, which have a much higher Viscosity Index than petroleum, maintained a superior high temperature profile.

Over time, the harsh working environment actually sheered the fluid viscosity at 40°C down about 10 viscosity units, dropping an ISO 46 hydraulic fluid “out of grade”. While the viscosity loss did not to have any adverse effect on performance, a change of 10% or more can be a negative indicator. Since all the other major characteristics maintained their appropriate levels and the high degree of viscometric flexibility of the hydraulic system, there was no concern about the performance of the fluid. In addition, this viscosity at 100°C, which is closer to the operating temperature of the system, stayed constant. The formulation, however, was modified to improve the shear stability and the fluid stayed in specification for the remainder of the trial. All the other parameters remained in specification and the fluid continues to perform well.

Even taking the higher cost of using EnviroLogic 146H, the Nautilus has saved money. The maintenance staff has reported a reduction in the servo-valve sticking, which saved in man-hours, equipment and downtime. Maintenance and repair savings as high as \$80,000 per month were reported.

While every effort is made to prevent hydraulic fluid from escaping, there was an incident where there was a release. The Nautilus took appropriate action, preventing further spillage, attempting to reclaim as much oil as possible and reporting the spill to the MMS and the Coast Guard. When the authorities learned it was a readily biodegradable product, they required no further action and no fines were levied.

Additionally, using a readily biodegradable hydraulic fluid allows the Nautilus to work in environmentally protected areas and potentially gain jobs that they could not with petroleum based fluids on board.

### Conclusions

The true proof of performance is the field. Any fluid supplier should support their customers with routine oil monitoring and interpretation of the results. Since biodegradable products behave differently than conventional petroleum products, one should not count exclusively on the conventional oil analyst's interpretation test lab results.

It is important to partner with a biofluid supplier that has enough field and technical experience to support an oil-monitoring program willingness to support product changes.

Many factors should be considered when choosing a biodegradable fluid. The key considerations to be evaluated prior to selecting any fluid include; temperature, pressure, seals, elastomers, water intervention, fluid life, spill potential and client choice

Readily biodegradable lubricants can save time, money and protect the environment, however, they must be properly maintained. Since the key to long fluid life and top tier performance is keeping the fluid clean and dry, proper filtration is essential.

Transocean had to do their homework to determine that using a readily biodegradable hydraulic fluid was the "right thing to do". It's the right thing for their clients, the right thing for the environment and right thing for Transocean.

### About the Authors

Fred Sullivan is the Mechanical Superintendent for Gulf of Mexico/North American Region for Transocean. He has over 20 years of field marine engineering experience both in Military and commercial equipment. Mr. Sullivan is considered an expert in deep-sea drill rig maintenance and the application of on-board biolubes.

Transocean excels at constructing oil and natural gas wells in the deep waters and harsh environments. They provide rigs for all types of petroleum companies in offshore drilling markets that include the U.S. Gulf of Mexico and eastern Canada, Brazil, the U.K. and Norwegian sectors of the North Sea, West Africa, Asia, including Australia, the Middle East, India and the Mediterranean.

Mark Miller is the Head of Sales and Chief Executive Officer of Terresolve Technologies. Mr. Miller has a B.S. in Chemical Engineering from Tufts University and an M.B.A. from Manhattan College. He has engineered, sold and marketed lubricants and lubricant additives for over 20 years.

Terresolve Technologies, a Cleveland-based company, is dedicated to providing non-toxic, biodegradable lubricating products that deliver exceptional performance. For more information about Terresolve, field test results and all of its environmentally friendly products, visit their web site at [www.terresolve.com](http://www.terresolve.com) or call (800) 661-3558.

