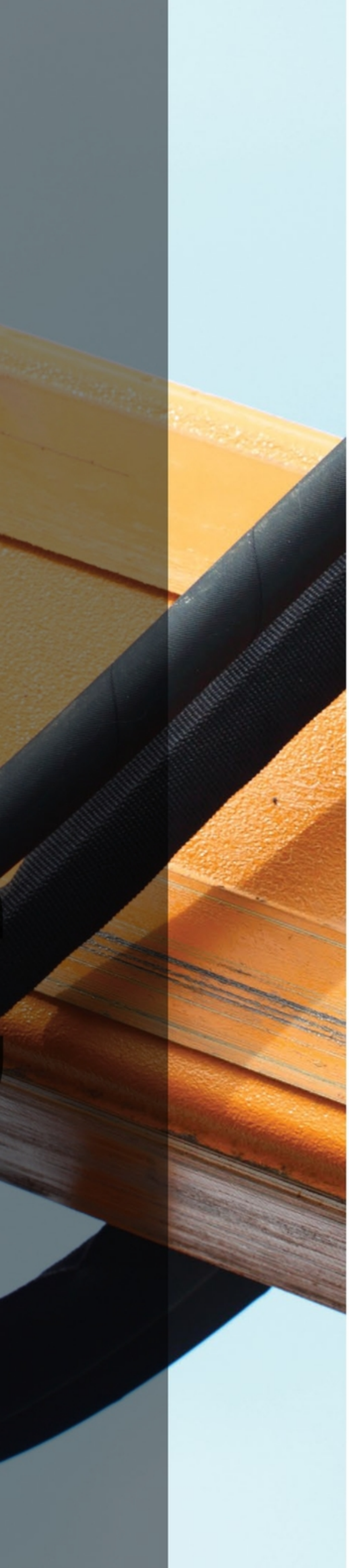
EVOLVING DEMANDS FOR HYDRAULIC FLUIDS

By Boris Kamchev



The development of more efficient machinery led to the creation of more compact hydraulic systems. According to an industry insider, these smaller systems operate at higher temperatures, pressures and pumping speeds, and they need more sophisticated fluids. In some Western European countries and Scandinavia, modern hydraulic fluids should also exhibit reduced environmental impact with its recycling possibilities and biodegradability.

Modern hydraulic fluids should protect the application, minimize unexpected downtime and avoid unplanned maintenance, according to Shell's Mark Draper. "The fluids have to have extremely good antiwear properties and very good oxidation and thermal stability," he told the ACI's European Base Oils and Lubricants conference held in September in Warsaw.

"In addition, hydraulic fluids have to show excellent surface properties such as air release, demulsibility, foaming and filterability." Draper is the Anglo-Ditch oil major's hydraulic fluids product developer, Shell Global Solution branch, based in Thornton, United Kingdom.

Base Fluids

Typically, 90 to 99 percent of hydraulic fluid is base oil, Draper said. "Viscosity index improver can comprise 1 to 10 percent of the fluid, while chemical performance additives should amount to 0.5 to 2 percent. Each of these components plays an important role in determining the final fluid properties," he observed.

Shell found that API Group I hydraulic fluid formulations are largely leftovers from the past and that few of today's premium fluids are based on Group I base oil. Rather, Group II formulations are used increasingly in modern hydraulic fluids. "They have natural improvements in oxidation stability and surface properties. These formulations require an optimized approach to ensure effective control of wear and cleanliness," Draper said.

Premium Group III and polyalphaolefin or Group IV base oils are used in higher tier products, and they cost more, he said. "They require a good understanding of the interactions between base oil and additive chemistry. They are not just drop in 'me too' solutions."

Evolution in Specs

ISO 11158, the core hydraulic fluid standard, has remained largely unchanged for several years, but this specification provides the essential foundation for a basic hydraulic fluid, according to Shell. "The base oil

provides the basic viscometrics while the additives provide antirust, copper protection, wear protection and filterability properties. Besides demulsibility, foam control and air separation, the base oil and additive mix should also provide elastomer compatibility and oxidation stability," Draper added.

He explained said that industry specifications have evolved significantly over the years. For example, Eaton's M-2950 S and I-286 S specifications were combined into Brochure 694, then subsequently into the current E-FDGN-TB002-E with its additional bench performance tests.

A common component of the Eaton specifications is the 35VQ25 pump test (ATS 373 and ASTM D6973). The specification now requires higher FZG (FLS 11) performance and additional seal compatibility testing.

"Denison's HF-0 specification adds more varied bench requirements and a more demanding hybrid pump test (T6H20C) with both vane and piston pumps," he said. A new Denison specification is evolving slowly but is not expected before around 2018.

"In 2013, Bosch Rexroth introduced a two-tier system that was later simplified to a single level approval system, following very limited industry adoption of the two-tier approach," Draper said. Bosch Rexroth's RDE 90245 Fluid Rating List approval process now provides simplified bench testing requirements, but the RFT-APU-CL fluid bench test is now mandatory for all listings.

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Getting the Additives Right

More demanding operation requires improved and more complex products from additive suppliers, according to Shell. "Simple antiwear and antirust systems are now confined to basic entry quality fluids. In contrast, multiple component systems use various antiwear chemistries based on zinc and high and low phosphorus formulations," Draper said.

In addition, the additive formulation must match the primary and secondary antioxidants to the base oil characteristics to optimize performance. Other important additives include detergents, lubricity agents, demulsifiers and antifoaming agents.

Modern hydraulic fluids are faced with satisfying increasingly competing demands, including improved energy efficiency, increased wear protection, longer oxidation resistance and better friction control. Optimizing a fluid for just one property rarely provides the optimal solution and can lead to reduced shear stability, excessive friction, greater hydrolytic instability, sludge deposits and poor filterability, according to Draper.

More Rigorous Testing

Over the years, the pump tests have become more rigorous, demanding increased running times, pressures, speeds and inspection criteria. "For example, vane pump tests typically run for 250 hours, while vane/piston pump combinations or piston pump tests run for up to 600 hours. Pressures increased too, from 138 bar to 450 to 500 bar, while temperature can be as high as 100 degrees C," Draper said.

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Pump Test Evolution

Parameter	V104C (ISO	35VQ25	T6H20C	RFT-APU-CL
Pump Type	Vane	Vane	Vane/Piston	Piston
Operation	Steady State	Steady State	Rapid Cycling	Cycling & Steady State
Speed (rpm)	1,400	2,400	1,700	4,000
Pressure (bar)	138	204	280	450-500
Temperature (°C)	65	95	110/80	100
Time (h)	250	3 x 50	600	500
Inspection Criteria				
Weight Loss	√	√	√	√
Component Condition		√	√	√
OEM Inspection			√	√

Source: Shell International

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He added: "Where we really need to start paying attention is how the fluid performs under stress. Can it still provide the same level of protection under variable conditions? Examples include outdoor operation, where temperatures can change with the season or throughout the day, or when mobile equipment is transported from one site to another. At higher temperatures, many hydraulic fluids can lose some of their wear protection because of excessive thinning."

One of the most useful performance tests for the equipment and hydraulic fluid under lab conditions is the Bosch Rexroth RFT-APU-CL rig test, according to Shell. The closed loop test combines a hydraulic pump and a hydraulic motor, and it puts both the equipment and the fluid under high stress.

This test consists of three phases: a 10-hour break-in, 300-h swivel cycle and a 200-h corner power cycle. The test's rating criteria include component weight/dimensional change, oil analysis, material compatibility and efficiency. "These are tough conditions for any fluid, particularly for ISO VG 32," Draper acknowledged.

Users and original equipment manufacturers demand globally consistent products, he added. "Just passing the specification tests is not enough. The fluid needs to work in real equipment, in real time with real customers – all over the world," Draper said.

He concluded by outlining the technology profile for hydraulic fluids going forward. "Modern hydraulic fluids must provide longer equipment life, longer oil life and improved system efficiency."

To ensure long equipment life, the fluid should carry a Bosch Rexroth RDE90245 rating; meet Denison, Eaton and Fives-Cincinnati specifications; and be registered with Japan's Construction Mechanization Association," Draper said. To provide long oil life, the fluid should survive at least 5,000 hours in the Turbine Oil Oxidation Stability Test and more than 400 minutes in the Rotating Pressure Vessel Oxidation Test to demonstrate it antioxidancy reserve.

Finally, to meet system efficiency requirements, the fluid should control foaming, air release and water separation. And it should provide excellent lubricity and control of slip stick effects.

In a separate presentation, William Downey, senior vice president at Novvi LLC added that another important factor for top tier hydraulic fluids is environmental performance. In this regard, he noted, it should be nontoxic, recyclable and biodegradable. And it should carry the European Union's Ecolabel. □

Long-life hydraulic fluids should survive at least 5,000 hours in the Turbine Oil Oxidation Stability Test and more than 400 minutes in the Rotating Pressure Vessel Oxidation Test.