

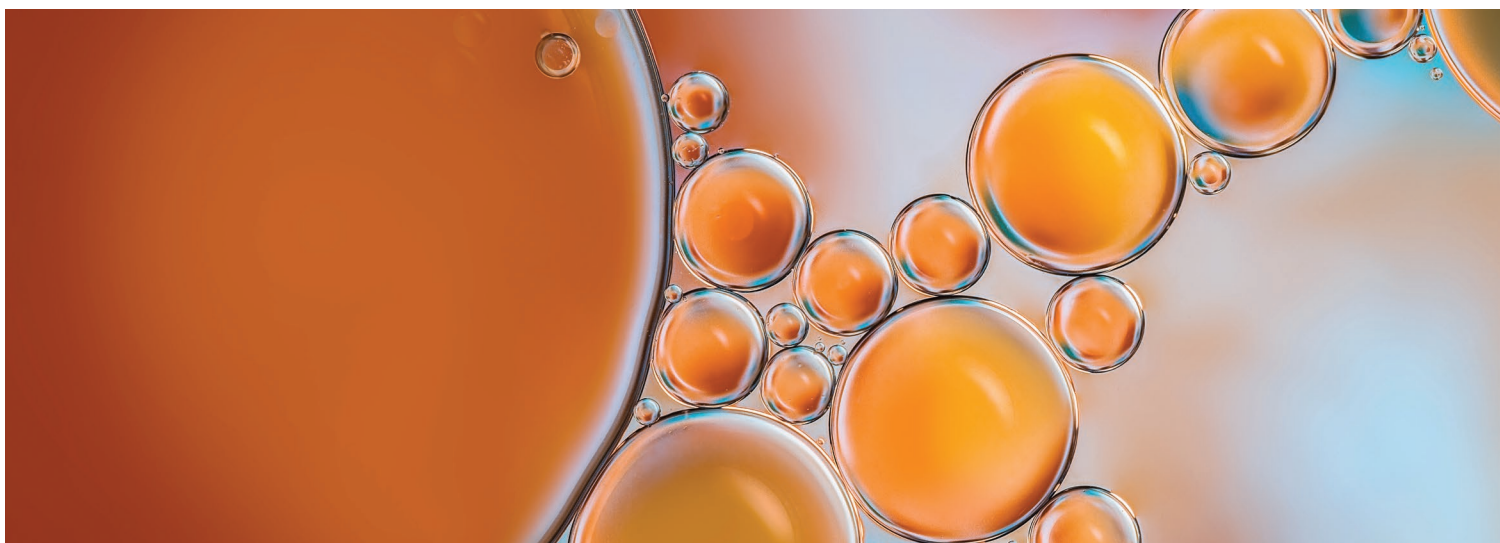


GAS-TO-LIQUIDS (GTL) HYDRAULIC OILS, PROTECTING YOUR LUBRICANTS FROM AIR: THE INVISIBLE CONTAMINANT

**SHELL
LUBRICANT
SOLUTIONS**



AIR IS THE UNSEEN ENEMY OF EFFECTIVE LUBRICATION AND CAN BE EQUALLY DAMAGING TO EQUIPMENT. WE HAVE DEVELOPED GTL HYDRAULIC FLUIDS FOR FASTER AIR RELEASE AND BETTER FOAM CONTROL.



Bubbles in a lubrication system can undermine operating efficiency, inhibit heat removal, increase wear, and, thus, lead to higher maintenance costs. Too often, equipment operators dismiss air contamination as inevitable. But there are steps that maintenance personnel can take to reduce or eliminate the harmful effects of air contamination. GTL hydraulic oils offer faster air release and better foam control compared with mineral base oils of the same viscosity.

Air intrusion can take many forms, but foam and entrained air represent the biggest threats to equipment. Entrained air refers to bubbles suspended below the fluid's surface that create air pockets in the lubricants. Foaming results when the bubbles rise to the surface of the hydraulic fluid or other lubricants. In both cases, the air pockets can impede the flow of fluids and leave equipment vulnerable to wear.

Surface foam in well-designed and correctly filled oil sumps rarely causes issues during

equipment operation. However, foaming may indicate more fundamental problems such as oil contamination or degradation. Excessive foaming can cause the oil level to drop so much that the system inlet becomes exposed at the surface, which results in oil starvation. Excessive foaming also can cause the oil to overflow onto potentially hot surfaces.

Although foaming is more visible and tends to concern maintenance personnel most, entrained air causes the most damage and the greatest loss of efficiency.

Entrained air in a lubrication system can be harder to identify because it has few external or visual indicators. Air becomes entrained through normal engine vibration, flow surges from retracting cylinders, leaks, incorrect oil level control and working on slopes. Entrained air can cause cavitation, microdieselling and increased noise or vibration, all of which can lead to excessive component wear. It may also reduce equipment power, responsiveness and efficiency.

TACKLING FOAMING

The nature and extent of foaming result from the properties of a lubricant's base oil and the additive packages in the formulation. Consequently, antifoaming additives are typically used to control excessive foaming. Unfortunately, most of these additives rely on large silicon particles that reduce the surface tension and cause the bubbles to rupture. Industrial applications such as hydraulic systems typically have filtration systems designed to screen out such large particles, which undermines the effectiveness of the additives.

Shell Lubricants has studied the causes and effects of air contamination and has developed a deep understanding of foaming and entrained air and how they interact with a wide variety of systems.

Working with equipment manufacturers and researchers, Shell Lubricants identified and tested almost 10 plausible antifoaming candidates, 5 of which had good filterability performance. The most promising, which are based on silicon antifoaming agents, have excellent foam control and product compatibility, and, importantly, remain effective after filtration.

Shell's tests found that adding silicon-based antifoaming agents to an industrial lubricant could reduce foaming by 50%, even when the fluid was cycled several times through a fine filtration system that screens out particles greater than 3 µm.

Optimising the antifoaming chemistry with a supplementary antifoaming agent also helped to suppress foaming after fine filtration, although it often needed a mixture of antifoaming agents to achieve the desired results.

UNDERSTANDING AIR ENTRAINMENT AND FOAMING

To improve fuel and energy efficiency, manufacturers are making equipment designed for higher loads and pressures with smaller reservoirs and tanks.

This means that the oil spends less time in the sump, so must have better air and water separation properties. At the same time, most equipment operators demand longer oil-drain intervals to reduce maintenance and lubricant costs. Consequently, the oil must work harder for longer, which results in higher temperatures that can affect its ability to release air. All these factors mean that lubricants with excellent air-release properties are more important than ever.

In tests conducted at RWTH Aachen University, Germany, hydraulic fluids using synthetic base oils, such as gas-to-liquids (GTL) fluids, combined with a performance additive package, had bubbles with much larger diameters than fluids using mineral base oils. These larger air bubbles in GTL fluids rise to the surface quicker than smaller air bubbles, which results in GTL fluids having superior air release performance.

However, balance needs to be struck in a lubricant formulation for both good foaming and good air entrainment properties. Silicone-based additives, for example, are excellent anti-foaming agents but are poor for air release.

To address this problem, Shell's statistics and chemometric group, working with researchers at Shell Technology Center Houston and Milwaukee School of Engineering, USA, helped to find, map and screen multiple base-oil combinations of the same viscosity to determine the best formulas for faster air release. They found that GTL base oils had exceptional air-release properties compared with mineral base oils of the same viscosity. The group developed fully formulated, prototype GTL hydraulic fluids using an optimised base-oil mixture and performance additive package. The fully formulated GTL hydraulic fluid had a much better air-release time than a fluid with a standard base oil and the same additive package.

Shell scientists also undertook to understand the fundamental mechanics behind foam rupture by carrying out a joint collaborative project with Stanford University, USA to study bubble rupture dynamics. The team conducted single-bubble rupture studies on a range of base-oil systems using a technique developed at Stanford and recorded the time for each bubble to coalesce. The bubble rupture rates correlated well with the bulk foam measurements from industry-standard tests such as ASTM D892. Furthermore, the

team observed that multicomponent base-oil systems stabilised the bubbles more than the single-component systems. In multicomponent systems, as the lighter components evaporated, the surface tension of the oil increased and created small flows on the bubble surface like wine droplets clinging to the side of a glass. These flows drew more oil to the top of the bubble, thereby thickening its wall, which made it less likely for it to burst. However, in single-component systems such chemically driven flows were missing, which resulted in faster bubble rupture through gravitational drainage.

The research team is now developing mathematical models for determining the effects of antifoaming agent distribution and evaporation on foam stability that will enable them to simulate how pure or blended oils might perform before and after filtration. They will then apply their findings to designing formulations that reduce foaming.

Shell is incorporating many of these findings into its product development and continuing to research this vital issue. It believes that these ongoing studies will have a significant impact on the development of foam-resistant lubricants and combat the unseen enemy of air contamination in lubricants.





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THIS UNSEEN ENEMY OF AIR CONTAMINATION.



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