

BLACK-RESIDUE IN DIRECT ACTING TENSIONERS

Symptoms

Degradation of water-glycols (accelerated pH drop) has been observed in some DAT/N-Line systems. Such degradation includes the formation of sticky, high viscosity, black residues that contain metal fines. Metal fines have been shown to react with organic acidic additives in the fluid under certain conditions*, this can result in the observed black residues. Although it has become common to refer to this as "Black-Goo", it can be misleading as these could simply be metal fines bound by contaminants such as silicone oils & greases.

Concern

These residues are of concern as they may deposit around sealing elements, leading to leakage. It is also of concern that deposits might reach the interiors of anti-recoil valves and cause the system to fail.

System Design & Materials

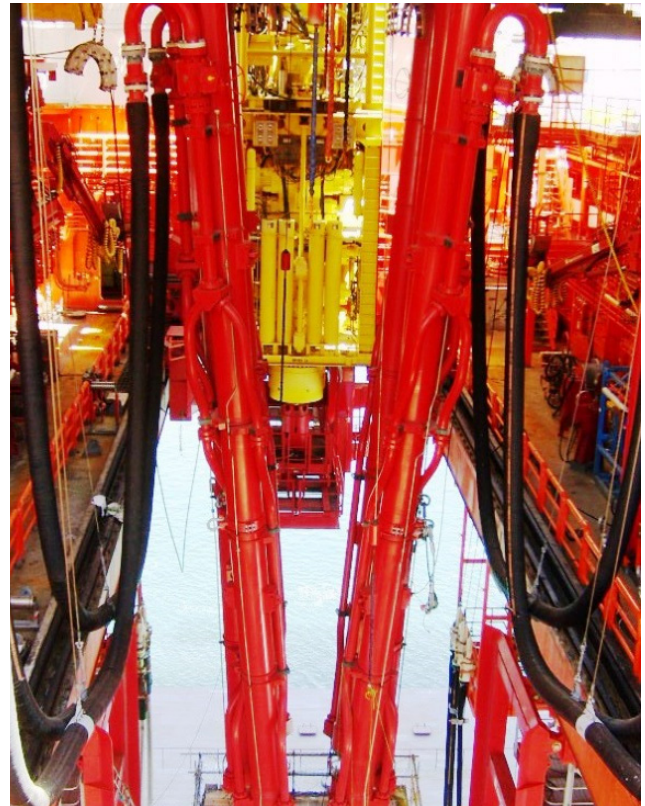
Earlier generations of piston rod design in riser tensioner systems exploited the application of very "hard" thermally sprayed coatings which can have some surface porosity and encourage the hydraulic fluid to be retained in the coating surface profile.

This promotes hydrodynamic lubrication of seals and guide bands during short/slow rod movements in certain ocean conditions (deep water, long wavelength and high ambient temperature).

Later generations of DAT/N-Line piston rods are made from carbon steel coated with either a solid super duplex stainless steel (UNS S32750) or an overlay welded cobalt based alloy (typical UNS R31233). These have very good corrosion resistance properties in seawater and marine environments but have reduced surface hardness. The latter can lead to polishing, of the rod surface, particularly around the mid-stroke (main working) area. Some work-hardening may be experienced and some wear marks are often observed if the system is not cleaned regularly.

Short piston rod movements combined with mid-section polished surfaces indicate that surface retention of hydraulic fluid has been reduced. This leads to boundary lubrication rather than hydrodynamic lubrication.

Boundary lubrication is less likely to promote sufficient exchange or flow of hydraulic fluid in "gaps" between seals and guide bands inside tensioner cylinders. At lower velocities, a thinner lubricating fluid film is generated that may lead to higher friction. This friction creates heat which raises the temperature in the system.



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*Factors that drive **residue** formation include:

- DAT/N-Line Tensioners. Long rods acting at an angle
- Welded Cobalt-based overlay rod coating
- High Ambient Temperatures–35°C
- Sea State–long wavelength in deep water
- Seal Configuration & Materials
- Chemistry & Lubricity of the fluid

Concern: if arriving in seals or valves – black, sticky, viscous, Fe rich; reactive fines; root cause of solids.

Fe source: cylinder bore bare carbon steel; low corrosion & wear resistance; especially susceptible at low pH

Cylinder: corrosion & wear => Fe fines; Fe fines: react with fluid additives; form solids.

Reaction: faster in degraded (low pH) fluid



What is the Black-Residue?

Wear inside the cylinder can lead to the formation of highly reactive iron fines from the carbon steel surface of the cylinder bore.

These fines can react with organic acids in the water-glycol additive package to form Iron Soaps. Together with unreacted metal fines, including wear particles from the rod coating, this constitutes the **Black-Residue**.

This reaction is further driven by heat generated from friction within the cylinder and on the rod surface as it passes through the seal configuration. Compared to mineral oil, the rod can be wiped dry so that the primary seal sees lubrication, the secondary seal less and the wiper seal virtually none. This has led to polishing of the rod, particularly at the mid-section.

What can be done about it?

Iron fines are the root cause and these can only be produced by wear at the cylinder bore surface. Prevent wear and the reaction cannot occur as long as pH and corrosion inhibition are maintained and that frictional heat is minimized, particularly at the rod surface.

HOUGHTO-SAFE® NL1 has been proven to give the highest level of lubrication of any water-glycol tensioner fluid, both in general (pump and other lubricity tests) and specifically in Bosch Rexroth cylinders with the cobalt-based welded overlay rod coating.

Statement: Water Glycol products in **Bosch Rexroth** large hydraulic cylinders

In relation to the tribological system (seals–bearings and surface structure) we have

Investigated different water glycols, HFCs. At the moment (in relation to the tribological

System we recommend the following products:

- HOUGHTO-SAFE® NL1
- HOUGHTO-SAFE® RAM2000N*
- HOUGHTO-SAFE® 273CTF

* Became HOUGHTO-SAFE® WL1–modified for environmental registration.

