Barbara McGrath, Wire Rope News & Sling Magazine (February 1994 Issue)

“Lubricating Wire Rope, Inside and Out”

Getting a handle on the ins and outs of wire rope lubrication can be almost as tough as holding a well-lubricated rope while it’s in use. A collection of experts in the field make the subject a bit easier to understand.

Envision wire rope as a complex mechanical system. Whether used as a dragline, tow line, elevator cable, or bridge guy line, it is made up of moving parts. Those parts are forced to continuously adjust to one another during often high stresses in hostile environments.

Consider a hoist rope on a large dragline. As the rope moves over the sheave, it is pulled, bent and compressed simultaneously. Metal to metal contact stresses the outside of the rope as it enters and leaves the sheave. Inside, wires contort and abrade one another.

Sometimes the hoist rope is forced to then move over another sheave in a reverse bend. The closer the two sheaves are, the more stress the rope will experience because the strands will not re-adjust themselves.

The best lubricant for the job

Almost anyone in the wire rope industry would agree that, with few exceptions, wire rope needs lubricant protection. According to the Roebling Wire Rope Handbook1, fatigue tests were conducted with two sections of 9/16″ diameter 6 x 19 wire rope. One was lubricated and one was dry. The lubricated rope lasted 2.4 times longer on the 10″ tread diameter sheave, and 5.2 times longer on the 24″ tread diameter sheave.

	10″ Tread	**24″ Tread**
	Sheave/Rope Dia. Ratio = 18	Sheave/Rope Dia. Ratio = 43
Dry Rope	16,000 Bends	74,000 Bends
Lubricated rope	38,700 Bends	386,000 Bends

But when users and manufacturers begin to discuss specifics, such as types of lubricants, additives, environmental issues and application methods, opinions diverge. For instance, here are some basic lubricant compounds used for manufacturing or re-dressing:

- asphaltic
- petrolatum based
- combination (asphaltic and petrolatum)
- soap (stearate) thickened

- inorganic thickened
- greases (pumpable)
- amorphous polypropylene
- resin based
- linseed/castor oil

And here are some of the additives:

- corrosion inhibitors
- anti-wear additives
- water displacing additives
- polymers (tack and adherence)
- plasticizers (low temp)
- anti-oxidants
- polar additives (wetting)

Lubricants must not be highly acidic or alkaline, which can deteriorate the rope and threaten the environment.

Hostile environments

Key to choosing the correct lubricant is knowing the rope's application and in what environment it will be used.

For instance, with applications like the dragline discussed above, the lubricant must have additives that cause it to remain pliable as the rope is used. As the strands inside the rope move against each other, the lubrication can wear off in spots. "A good lubricant will re-distribute itself evenly between the strands — a characteristic known as 'self healing'," says Bill McAlaine.

The marine environment is one of the most hostile for wire rope. At sea, the wire is subjected to high corrosion from wind-blown salt air, as well as from short immersions in salt water during lowerings. The zinc corrodes first, and how quickly it corrodes depends on a number of factors: the depth of water in which the rope is used. Oxidation is a kind of corrosion. The closer the rope is to the surface of the water, the higher the temperature, and the more reactive the oxygen is. So, the rope will corrode faster when it is closer to the surface of the water.

The temperature and chemical content of the water. In a study by Grignard Company in 1969, with the assistance of the Woods Hole Oceanographic Institution, Oregon State University, the Halan Company and U.S. Steel, an experiment was performed where specimens of bright steel wire, galvanized wire and electromechanical cable were submerged for three months in three different locations. The results showed "accelerated rates of corrosion…ultimately traced to a combined effect of chemical levels in the water and the temperature of the sea water."3

Location	Solids (Sodium Chloride)	Temp.
Oregon	3.71% Total Solids	44 Degrees F
Mass.	3.61% Total Solids	40 Degrees F
Anitqua	3.98% Total Solids	84 Degrees F

How thick, how hot?

In many applications, the lubricant's tolerance to fluctuations in temperature is a major concern. In hot desert climates, for instance, the wrong lubricant will literally drip off the wire. At low temperatures, it may flake or crack. Lubricants very in viscosity, and viscosity always varies with temperature.

"There are many different standards for measuring lubricant viscosity,", explains **Bob Kirkpatrick, President of The Kirkpatrick Group, Inc.** Most commonly used are: "NLGI" (National Lubricating Grease Institute), "Saybolt" (Sus), and "Centistoke" (Cst). Laymen and experts alike have difficulty making conclusive comparisons between the standards. There are few, if any, complete comparison charts that provide accurate cross reference between the standards. Most lubricant manufacturers use only one or two measurement specifications when preparing technical data. To avoid confusion…we…use the terms "Pourable" for low viscosity and "Nonpourable" for high viscosity when referencing given wire rope dressing ranges. Pourable (Low Viscosity) wire rope dressings range from SAE 90 weight oil density upwards to NLGI #0 a near equal to molasses. Nonpourable (High Viscosity) wire rope dressings range from NLGI #1 (consistency of soft butter) to NLGI#3 (consistency of thick peanut butter).

"Ambient temperature must be considered when measuring dressing viscosity..As an example: NLGI pourable dressing grade #0 at 85 degrees may easily become #1 or #2 nonpourable at 40 degrees. Prior to operation, check you viscosity…In extremely cold temperatures, it may be necessary to pre-heat wire rope dressing to assure it is easily pumped and applied to the wire rope."

Where ropes are being stored, Nonpourable lubricant may protect the rope with a heavier film. Relatively recent advancements in pressure lubricators manufactured by companies like The Kirkpatrick Group make it possible to force heavier oils into the inner parts of the wires. When this is possible, it is sometimes preferable, since more highly viscous lubricant affords greater strand-to-strand protection.

But, for certain applications, and where a pressure lubricator is not available, thinner oils are preferred. They can be applied by spraying or simply pouring, and drip into the inside of the rope readily. Lower viscosity lubricants must be re-applied frequently. In confined spaces, or where motors might produce sparks, avoid using inexpensive petroleum solvents. They have a low flash point, which can present a serious fire hazard.

From the first drawing

Before considering field dressing (relubricating), a user may need to start where lubrication begins: with the wire rope manufacturer (OEM). At intervals while the rope is manufactured, the OEM applies lubricant. This lubricant differs from the type used to re-dress the rope. But it is important to be aware of

the OEM lubricant applied, since the re-dressing lubricant may interact with it, causing unforeseen problems.

The type of lubricant and the amount added is determined by the manufacturer based on his information about the future use of the rope.

“A wire rope may be lubricated at three intervals during its manufacture,” explains Bill McAlaine, Vice President and Business Manager of Allied Kelite, “once at ‘stranding’ (when the wires are joined to form strands), once at ‘closing’ (when the strands are formed to make rope) and sometimes after the rope is made, to provide an added level of protection.”

“As the wire is drawn, it passes through a ‘soap’, Bill adds, “which is designed to facilitate lubrication between the wire and draw dies.

“However, it is not designed to protect the wire in use. If anything, it actually causes us problems, because the soap left on the wire often absorbs water. (Many drawing soaps contain borax, which is highly hydrophilic). Applying a lubricant at stranding over a moisture laden soap/borax film can cause moisture encapsulation and result in premature corrosion. We build water displacing properties into our stranding lubricants, which helps address this problem. However, the best practice is to take the last wire reduction without lubricant to help minimize the amount of water-absorbing residual film left on the wire surface.”

If a termination is added, lubrication should be re-applied. “It is important that the juncture of the strand and socket be inspected periodically,” advises Emile Grignard “because of torsional twisting, which subjects it to corrosion.”

The core of the problem

Once the customer receives new rope, he should store it inside a building and away from direct sunlight, or at least cover it with a tarp if it has to be left outside. Turn the storage reel periodically to prevent the lubricant from seeping to the bottom, especially where temperatures are high or the lubricant is very fluid.

When the rope is put to use, field dress it immediately. Like devious enemies, moisture and pollutants can invade the wire quickly, corroding the core of the rope. (Note that we are referring to a wire, rather than fiber, core.)

“Corrosion damage is impossible to estimate and must be avoided in order to maintain necessary strength and safety. A corroded rope is reduced in strength for various reasons. First, metallic area is lost by chemical or electro-chemical action. Second, corrosion mars the smooth finished wire surfaces, resulting in erratic contours which form stress raisers. These stress concentrations are very susceptible to failure by crack propagation as the rope bends and stretches during operation. Third, corrosion hinders normal movement between wires, creating a binding condition which increases stresses to an indeterminable extent and speeds corrosion-fatigue fracture growth.”

A major concern in re-dressing should be the compatibility of the lubricant with the OEM lubricant. Incompatible materials can cause dangerous results: the re-dressing lubricant may not penetrate the wire sufficiently; components of the OEM lubricant may leach out; or the re-applied dressing may flake away.

If in doubt, consult the OEM. According to law, the wire rope manufacturer should tell the customer how to field dress the rope.

And, cautions Al Lucht, President of Wire Rope and Metallurgical Engineering Services, “a basic requirement for all lubricants is that it must stick to the rope and not fall off. Strange as it may seem, this is not always an easy problem to resolve. One can read all the advertisements and listen to the vendor, but the only way to find out is to use the wire rope and try it in the intended application. If the lubricant does not stick (adhere), it will do absolutely no good at all.”