

# Expectations Regarding Rope Lubrication Today

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- Born in 1952 in Athens (Greece)
  - Studied at the Federal Institute of Technology in Zurich (Switzerland) concluded by a Diploma-Thesis. (Diploma of Mechanical Engineering)
  - Scientific Officer at the “Institute of Lightweight structures and Ropeways” at the Federal Institute of Technology in Zurich(ETH-Z) 1985 – 1996
- Main Projects:
- Fatigue behaviour of locked coil ropes under forced bending
  - Influence of lubrication of the endurance of locked coil ropes
  - Interpretation of Gamma Ray examination of locked coil ropes
  - Degradation mechanisms of steel wire ropes
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- Head of the department “Ropeways Engineering” of IWM Glattbrugg - (CH) 1996 - 1999
  - Independent technical consultant for the Rope- and Ropeway Industry / 1999 – to Present
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- Regarding the:
- inspection of ropeway ropes and their end connections
  - mechanical equipment of ropeways
- Inventor of the following granted / applied patents No:
    - CH - 02996/94-0
    - CH - 07741/94-5
    - Europa -15810339.2
    - US - 08/455332
    - J - 160159/95
    - China - CPME954925



Abstract:

## **Expectations Regarding Rope Lubrication Today**

George A. Kopanakis<sup>1</sup>

The necessary properties demanded of steel wire rope lubrication are demonstrated on the basis of the current state of the art, service experience and multiple investigations carried out over the past years.

These properties and their importance are then employed to establish a list of expectations regarding steel rope lubricants for the use of the ropeway operator, the ropeway manufacturer and the rope manufacturer.

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Why must a ropeway rope be lubricated at all?

The answer is: To prolong its service life!

This goal can be reached, on the one hand, by reducing the coefficient of friction among the wires and the strands, and by corrosion protection on the other hand. However, these two methods of achieving the goal should not be dealt in the same way! Although it is evident that the prevention of any corrosion always extends service life, it should not be concluded that also the elimination of all the friction between the wires is advisable: In respect of a wire rope, this conclusion would be wrong; A rope whose inner friction is close to zero acts almost like a bundle of parallel wires and thus, would no longer possess the characteristic property of a wire rope, which is, that a broken wire is able to carry full load again after some lays away from the breakage.

Something similar happens with the importance of lubrication and preservation: although both above methods used to be equally important, over the last 20 years the emphasis shifted more and more in favor of lubrication. The improvements in both the quality of the wire material and in various wire coatings have gradually reduced the importance of preservation. Conversely, the long rope life expectations and increased operational stresses and load cycle numbers have definitely raised the importance of lubrication.

The requirements demanded of the lubricant and the preservative are determined by the existing boundary conditions in respect of

- the rope itself
- the ropeway facility and
- the operation of the ropeway

## Boundary Condition: Rope

The following requirements are demanded of the lubricant in respect of rope:

- **Workability:** The lubricant and preservative must be respectively workable during the rope making process. Dripping point, viscosity and resistance to pressure at rope making conditions are the most important criteria during basic lubrication. Upon re-lubrication the lubricant and preservative must be easily applicable, should not cause any disturbing or health-endangering emissions, and its availability must be guaranteed at all service locations (Transportability and Despatch ability; Keyword: Hazardous Materials).

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- **Adhesive Power:** Once applied, the lubricant should remain adhering to the wire surface, but at the same time wiping ability is also desired during rope making to enable easy removal of the surplus lubricant. Since these requirements contradict each other, it is necessary to find an intelligent compromise.
- **Resistance to pressure:** Resistance against high pressure is an essential property of a lubricant. In order to fulfil its role as a third body between the friction partners, the lubricant must be able to withstand operating pressures.
- **Flow-Back Ability:** if the lubricant should be displaced as the result of too high pressure, it should be capable of flowing back between the contact surfaces after pressure reduction. This is particularly important as it has proved to be scarcely possible to develop any lubricant for rope areas which experience intensive pressure, being capable of withstanding the pressure during the rope's entire service life respectively during a large number of load cycles.
- **Preventing stress corrosion cracking:** Care should be taken that the used lubricant prevents the occurrence of stress corrosion cracking.
- **Corrosion protection:** Corrosion protection depends, on one hand, on the kind of wire material used and, on the other hand, on the respective environment. While it can be assumed that the wire materials used are well-known, the environment, however, must be scrutinized each time anew, if one would like to avoid unpleasant surprises.
- **Compatibility with plastics used:** Since the most different kinds of plastics are already a firm component of today's ropes, the lubricant's compatibility with such plastics is gaining more and more in importance.

### **Boundary Condition: Ropeway Facility**

The following criteria are of substantial importance in respect of the ropeway facility:

- **The Coefficient of Friction:** The coefficient of friction between the rope and the drive sheave is the first and most important boundary condition that the lubricant must under all circumstances fulfil, as not only the function, but particularly the safety of the facility during operation depends on this. Also, in case of systems using track rope brakes, care should be taken, that neither the initial lubricant nor the re-lubricant do contain any solid lubricants.
- **Compatibility with plastics in use:** The lubricant's compatibility with the sheave and bull wheel linings must be ensured. Especially with re-lubricants that essentially consist of a base substance dissolved in solvent, it is important that not only the base substance fulfils the compatibility requirements with plastic, but also and particularly the solvent used does.
- **Viscosity progress as a result of temperature and dampness:** Certain climatic conditions such as a sudden rise in temperature occurring with a simultaneous rise in humidity should not lead to an excessive decline of the viscosity. In case this would occur, it would lead, on the one hand, to the facility getting soiled, and on the other hand, to the grip tongues sticking onto the sheaves and, in extreme cases, subsequent breaking.



## **Boundary Condition: Operation:**

The following requirements are to be taken into account in respect of ropeway operation:

- **Viscosity:** The lubricant's viscosity within the operation temperature range must be so chosen as to avoid the removal of the lubricant from the rope as well as to avoid the lubricant's soiling the facility.
- **UV-Resistance:** When it comes to ropeway ropes, the lubricant's UV- resistance is of particular importance, since the ropes are almost exclusively employed in higher altitudes where ultraviolet-radiation is even more intensive than in lower areas.
- **Resistance to the techno-climate:** Resistance towards the substances encountered in the air environment is also gaining more and more of importance. This is especially the case for facilities operated near industrial areas.
- **Stability towards time and temperature:** Ropes used in ropeway applications remain in service for a relatively long time. For this reason, the lubricants used must not suffer from decomposition over these periods and the continually occurring temperature changes within the permitted temperature range must not negatively affect the quality of the lubricant.

## **Further requirements:**

Two more points must be underlined:

- **The unity of basic lubrication and re-lubrication:** The lubrication of the core, basic lubrication of strands and rope and finally the re-lubrication should all form a unit. Many problems encountered during ropeway operation could have been avoided if this simple rule had always been fulfilled.
- **Product consistency:** The complexity of the demands on the lubricant and not least the fact that many of the demands are contradictory, make their fulfilment very difficult. For this reason, once a good result has been achieved it should be treated as a valuable, but unfortunately an unstable equilibrium. Any change carried out can destroy this equilibrium and thereby the quality of the result. In this context, eventually necessary changes for legal, technical and not the least for economical reasons should be carried out with additional care, and only after consulting the rope maker and the ropeway operator.



