Success Story
COMET

XTribology
Excellence Centre of Tribology
Programme: COMET – Competence Centers for Excellent Technologies
Program line: K2-Centers
COMET subproject, duration and type of project:
Tribological assessment, 04/2015 – 03/2020, multi-firm

From deep sea to high mountains: Steel ropes under extreme conditions

Steel ropes are used in various fields of applications (cranes, cable cars, mining or subsea cable winches). A variety of influences are affecting steel ropes (e. g., temperature, salt water, number/size of pulleys). In order to increase service life or safety (e. g., for passenger cable cars), their influence must be determined.
Selected influences on the service life of steel ropes (lubricant type and coatings, salt water) were specifically quantified and evaluated by means of a modular laboratory setup for characterizing the "steel rope lubricant" system.

Parameters influencing steel rope lifetime

A broad variety of parameters and their combined effects were taken into consideration in order to understand in-situ conditions of steel rope systems, such as: mechanical wear, fatigue, corrosion protection, performance at high and low temperature, adhesive properties of the lubricant and its resistance to centrifugal forces for environmental preservation.

By coupling a specific designed model test system with a corrosion chamber, the biodegradability of lubricating greases (especially for offshore applications) was investigated.

Tribological characterisation

The test concept was designed for a lab test-rig. Contact conditions of a steel rope are simulated using a specimen holder design that positions single wires (Fig. 1). The design is based on the standard 3 mm single wires that form a steel rope.

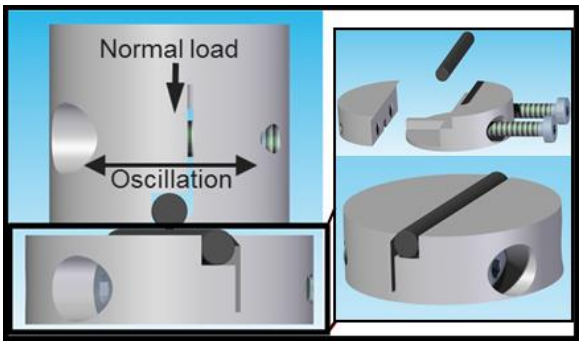

Fig. 1: Sketch of the sample holder (© AC2T research GmbH)

Maximum temperatures observed in-situ for steel ropes in specific applications related to this project were reported to be around 80 °C. In order to mimic sub-zero conditions experienced in ski resorts, cold mining zones, etc. a cooling system was integrated (in both lab test-rig and corrosion chamber) to reach -20 °C.

Different types of wires (with/without coatings) used for ropes were selected and tested with a broad variety of greases (e. g., biodegradable grease, grease for offshore applications). Tem-

Bundesministerium für Digitalisierung und Wirtschaftsstandort
bmvit Bundesministerium für Verkehr, Innovation und Technologie

peratures were varied in the given range. In addition to constant-load tests, stop-and-go tests were conducted in order to observe characteristics of the steel rope system.

Rope surface and bulk material were investigated using light microscopy. Apart from differences in the coating thickness, the predominant failure mechanism has been identified (Fig. 2) demonstrated as follows.

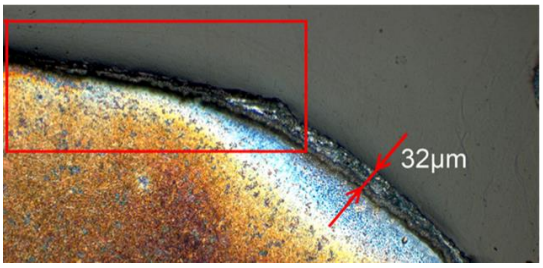

Fig. 2: Light microscopy image of a wire cross-section (© AC2T research GmbH)

Environmental effects on lifetime and tribological behaviour

All greases were analysed chemically before and after the tests in order to detect alterations. Wear scars (Fig. 3) were inspected by 3D optical microscopy to quantify the wear volume. Wear volume was calculated with a programme designed in-house, using 3D optical microscopy measurements.

To investigate possible corrosive effects, samples were exposed to artificial seawater and subsequently kept in an oxidation chamber. Following this treatment, single wire samples were placed in the test rig (Fig. 1) and studied under defined temperature and loading conditions. Both pre-treated and not pre-treated were analysed using high-end surface analytics.

The corrosion by-products themselves showed a high variation in their morphology (Fig. 4) and chemical composition, providing input for rope material and grease selection for the specific environmental conditions.

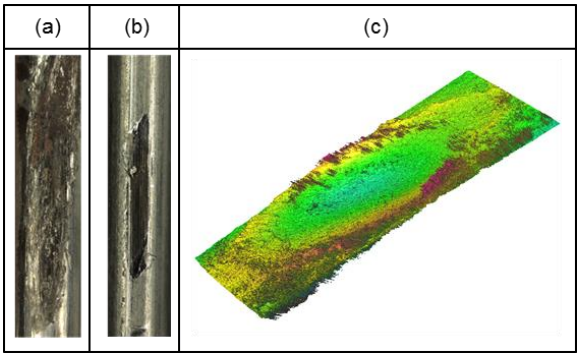

Fig. 3: Wear scars from experiments at a) -20 °C and b) 80 °C; c) 3D optical microscopy image (© AC2T research GmbH)

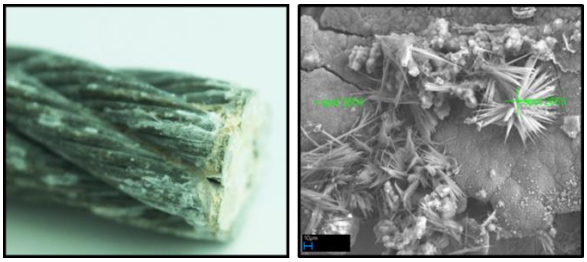

Fig. 4: Corroded steel rope (left) and corrosion products in detail (scanning electron microscopy image, right) (© AC2T research GmbH)

Impact and effects

The obtained results show a good correlation with ropes in real applications. Based on the determination of unfavourable chemical reactions and mechanisms limiting the service life, the safety of steel ropes is further increased.

Contact and information
K2-Center XTribology

AC2T research GmbH
Viktor-Kaplan-Straße 2/C, Wiener Neustadt
T +43 2622 81600
E office@ac2t.at, www.ac2t.at

Project coordination
Hakan GOCERLER

Project partners

Organisation	Country
Teufelberger Seil GmbH	Austria
Buntmetall Amstetten Ges.m.b.H.	Austria
Maschinenfabrik Albert GmbH	Austria
Wieland-Werke AG	Germany