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Wire ropes condition monitoring: conception and embodiment

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Abstract

Non-destructive inspection of steel wire ropes becomes quite common for onshore and offshore operations, and relevant equipment is now available on the market. The reason for growing interest to this inspection is increasing in prices for wire ropes, especially for ropes of large diameter, which may not considered as consumable product anymore, but as assets, and thus should be discarded for reason, i.e. according to discard criteria and their actual technical condition. The key issues for wire rope non-destructive inspection are prompt equipment and correct data interpretation. Rugged and reliable equipment capable to make data interpretation with computer without human intervention is of interest of many customers. INTRON PLUS LTD. has developed MFL instrument INTROS-AUTO, that is a successor of widely used wire rope tester INTROS. It is designed for non-destructive inspection of wire ropes with automatic data interpretation. Following criteria are used to discard rope – number of broken wires along lay length and loss of metallic cross section area in percentage. Discard criteria can be adjusted according to agreement with the customer. INTROS-AUTO stores detailed data, which can be downloaded and interpreted in regular manner. The instrument is ready for inspection of ropes as large as 135 mm in diameter and can be used for periodical or permanent wire rope monitoring onshore and offshore.

Keywords: Wire ropes, MFL, automatic data interpretation, monitoring.

Ropes produced from carbon steel wires are used in cranes, elevators, mining hoists, etc. to carry people and freight. The bigger and longer is rope, the more expensive it is. Degradation of ropes happens due to different reasons, e.g. friction between internal wires, friction between external wires and sheave surface, corrosion of wires, bending of the rope over the sheaves, and always leads to reduction in rope breaking strength. When the breaking strength is less than permissible level, further rope operation becomes dangerous and the rope must be discarded to replace with a new one. Rope degradation down to permissible level may last over years, but sometimes degradation accelerates dramatically and may cause accident and even kill people if rope is not under proper supervision.

Non-destructive inspection of rope is important mean to provide rope safety, it may allow to timely discard rope to prevent accident as well as to extend rope life to avoid unreasonable costs related to its exchange. Visual inspection of rope is obvious, but its capacity is limited due to specific rope design, thus comprehensive inspection of rope with only visual means is not possible. Non-destructive magnetic inspection of ropes enables to collect considerable data for making reasoned decision. Magnetic flux leakage (MFL) equipment with strong magnetization can inspect ropes reliably, and smart software facilitates data interpretation. MFL equipment can measure loss of metallic area (LMA), i.e. relative amount of steel missing from wires due to corrosion and friction, and detect local flows (LF) in form or broken wires, strands, core, pitting corrosion. When LMA value and number of LF reach

certain amount, the rope must be discarded; knowledge of LMA and LF may also be used for assessing rope remaining breaking strength. Relevant national and international norms and standards [1, 2, 3] describe requirements for equipment, inspecting personnel, discard criteria, etc.

Magnetic flux leakage principle of operation with strong applied magnetization of rope (fig.1) allows inspecting ropes in the best way, i.e. providing high measuring accuracy and sensitivity.

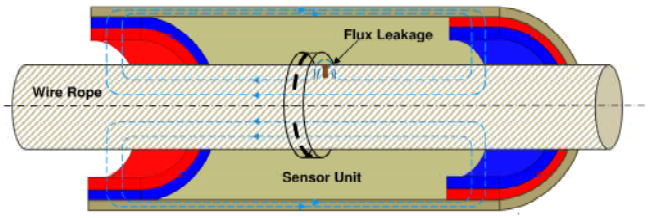
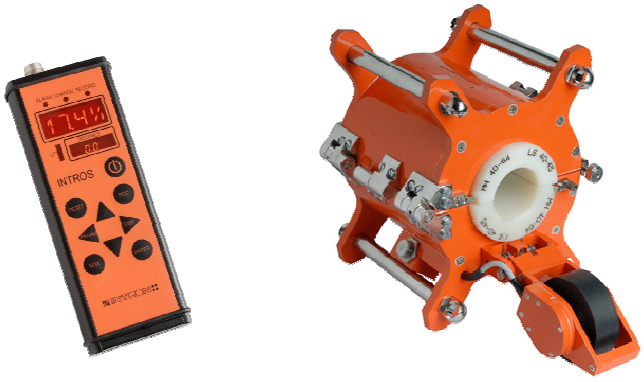


Fig.1. MFL principle of wire rope inspection

During inspection, when rope is inside magnetic system, it is magnetically saturated, and the magnetic field above the rope surface is uniform until rope contains no defects. Any fracture in the rope distorts magnetic field and creates flux leakage, which is picked by sensors.

The wire rope tester INTROS is based on MFL principle of operation and can measure LMA in percentage and reveal inner and outer broken wires. It comprises basic unit and magnetic head (fig.2) of different sizes to accommodate on rope up to 158 mm in diameter.



a) b)

Fig.2. Wire rope tester INTROS comprises basic unit (a) and magnetic head (b).

Inspection data are performed in form of LMA and LF traces, i.e.signal diagrams obtained along the whole length of rope (fig.3).

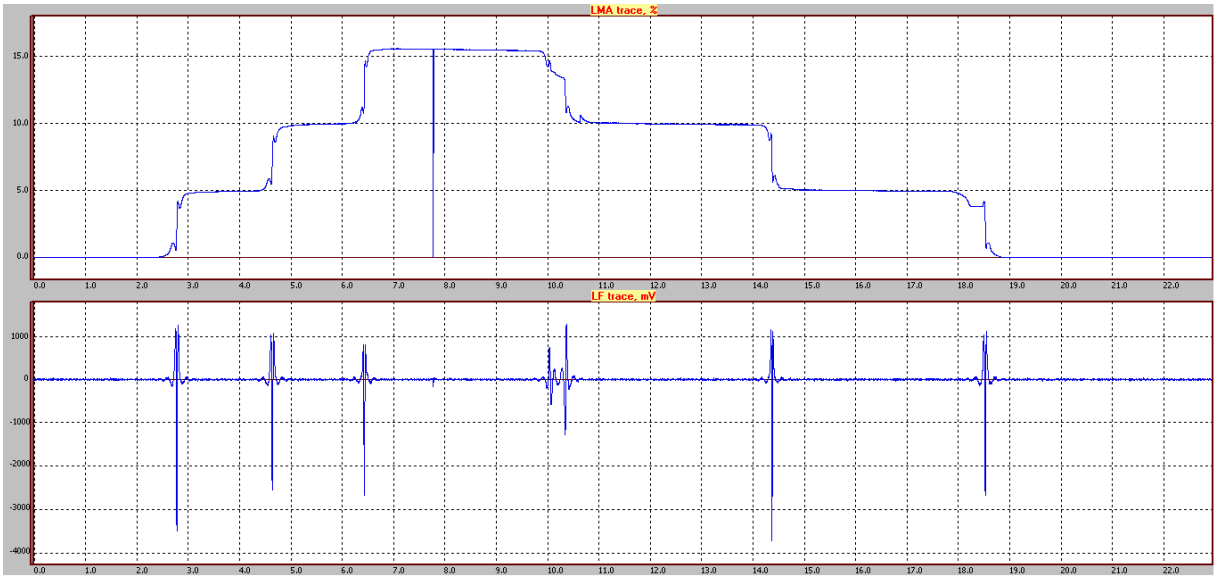


Fig.3. LMA and LF traces.

The main issues arisen during wire rope inspection are availability of reliable equipment and correct data interpretation, which requires qualified and skilled personnel and takes time. Usually inspection is carried periodically with given interval, which duration depends on rope degradation speed – when it is obvious that rope starts intensively degrade then more frequent inspections are recommended. Monitoring of wire rope condition can help customer to make timely actions in regard to continuing rope operation.

Two general approaches to wire rope monitoring can be considered:

- periodical monitoring providing fast and easy mounting and dismounting of equipment with instant data interpretation;
- permanent location of the equipment on the rope and continuous measurement with on-line data interpretation.

Intron Plus has developed the instrument INTROS-AUTO (fig.4), which is successor of wire rope tester INTROS and utilizes MFL principle of operation. The magnetic head was been considerably upgraded to improve performance while the air gap between sensors and rope surface is increased for safe operation, and can inspect ropes from 25 to 36 mm in diameter. Instead regular basic unit INTROS-AUTO comprises control and display unit (CDU), which main feature is automatic data interpretation immediately following inspection. Data are performed as “traffic light” form, i.e. by means of green-yellow-red indications on CDU front panel, and this makes interpretation of rope condition easy for people, who are not skilled with NDT and have poor knowledge about nature of rope degradation, e.g. for operators of rope installation – crane, drilling rig, etc. During inspection process the instrument measures LMA, detects broken wires and analyses amount of LFs per reference length of rope, e.g. 6 or 30 rope diameters. If any of parameters exceeds limit set prior to inspection, the alarm is on and moving test displays detailed information about defect.

a) b)

Fig.4. INTROS-AUTO consists of magnetic head (a) and CDU (b)

The INTROS-AUTO was delivered to customers for operation at onshore drilling rigs (fig.5). Magnetic head for inspecting ropes of 35 mm in diameter is mounted on the rope at the beginning of a working shift to inspect the whole rope length at speed up to 4 m/s. The CDU is permanently accommodated at drilling rig cabin, from which the operator can control inspection procedure. The INTROS-AUTO is customized instrument, i.e. it can be adjusted according to discard criteria accepted by the customer, and can be re-adjusted by the customer afterwards [5].

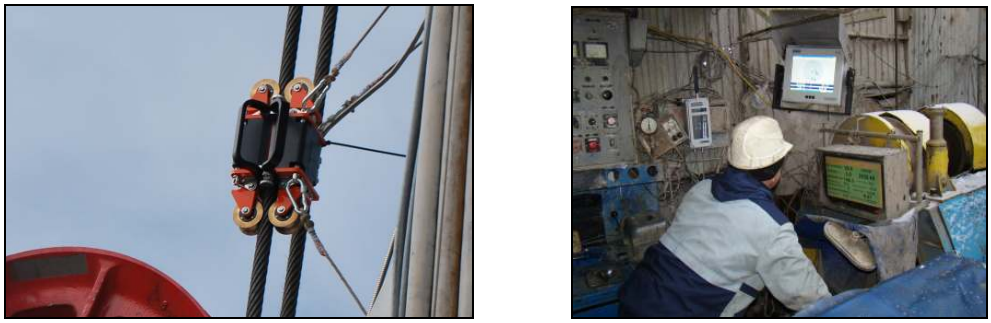


Fig. 5. INTROS-AUTO to inspect 35 mm rope at drilling rig.

Intron Plus has large experience with non-destructive inspection of mining ropes, and has recently developed and commissioned wire rope inspection system INTROS at coal mine to test 4 ropes of hoisting machine at once (fig.6). The main advantage of using such system is considerable reduction of inspection time, which is very important in order to increase duration of production run. This system is located in direct proximity to the ropes, and its mounting on the ropes takes few minutes. Presently data interpretation is carried manually, i.e. by inspector; the new system with automatic interpretation, based on INTROS-AUTO conception, is expected soon. This system will be capable to inspect multi-ropes mining hoist and high speed to provide automatic data interpretation, will have explosive proof design.

Fig.6. System INTROS to simultaneously inspect 4 mining ropes.

Many ropes of large diameters are used at offshore vessels, and are subject of deterioration not only due to aggressive environment, but also because of using heave compensation system on board. When heave compensation is in progress, the section of rope frequently moves around the sheaves, and accumulate metal fatigue, which cause multiple broken wires very soon. In such case monitoring of rope condition is vital, as accident may happen not only with rope itself, but also with expensive equipment carried with this rope. The system for inspection of wire ropes up to 135 mm in diameter with continuous measurement for onshore and offshore application has been developed and is now ready for delivery.

Thus, new smart MFL instruments INTROS-AUTO intended for monitoring of wire ropes with diameter from 25 to 135 mm are now available. These new equipment has automatic interpretation option, can be customized, and may considerably increase safety of rope installation.

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