MATERIALS AND TEST METHODS FOR POWER CABLES EXPOSED TO HEAVY OPERATING CONDITIONS

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ABSTRACT

Power cables used for industrial applications are often exposed to heavy operating conditions. For this kind of cables, the use of high-grade polymeric materials is necessary, which provide a broad range of properties to face even extreme requirements caused by the according field of application. These demands are usually defined in standards. To assure that the products are able to fulfill them, often very specific and exceptional test methods have to be applied. In this paper, an overview of typical heavy operating conditions is given, accordant tests are described and two examples of recent developments in this field are presented.

KEYWORDS

Abrasion, Bending, Chemical Resistance, Crane, Electrical Properties, EMC, Fire Behavior, Flexible Cable, Gasoil Resistance, Halogen Free, Locomotive, Loop Cable, Mechanical Stress, Reeling, Thermal Ageing, Torsion, Wind Turbine

INTRODUCTION

Industrial assets and areas like underground and open pit mines, transportation means like ships, trains, cars and aircrafts, handling systems for ports, refineries, wind turbines and others often are linked with heavy operating conditions for the equipment used in this environment. For example, cables used for handling systems (cranes) or for tunnel drilling machines are reeled and unreeled during their lifetime for many times. So the cable is exposed to mechanical stresses like tensile forces, bending stresses, torsion impacts and abrasion forces. Other examples are cables which can be contaminated with chemicals (oil, gasoil, acids, bases etc.) like in trains, cars or refineries as well as cables which are for outside use without any protection, so that they are directly exposed to humidity, UV, ozone and maybe salty atmosphere.

IMPACTS ON CABLES & TEST METHODS

Heavy operating conditions in industrial assets and areas are a synonym for an operating environment with different kinds of stress on the power cables or other equipment. These stresses can be separated in (quasi-)permanent or sporadic (maybe even singular) impacts. The former may result in a medium-term breakdown of the cable if its materials and design are not dimensioned for this type of impacts. For example, cables in wind turbines connecting the rotating nacelle with the fixed tower are exposed to torsion. If not an appropriate cable design has been chosen, damages on the cable elements would be the consequence. Examples for sporadic or singular impacts are fires or overvoltages due to lightning strokes. The right choice of materials and design may also in this case prevent severe damages or at least guarantee a minimum remaining operation time (like for safety cables in case of fire). A non-conclusive overview of possible impacts on power cables for industrial applications, which are usually low or medium voltage types, is shown in Figure 1.

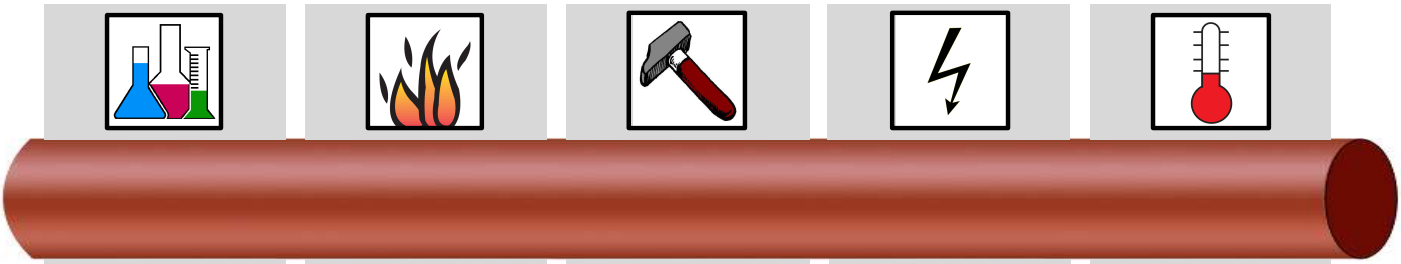
Mechanical impacts

Many industrial applications like automation robots, cranes, drills etc. go along with some kind of movement. The dominant forces in this case are:

Tensile stress

Pulling forces cause tensile stress on cables. If they are (partly) hanging free, e.g. inside a shaft of a mine, these forces are caused by the cable weight itself. Also friction between cable and contact surface evokes tensile stress, when the cable is pulled (e.g. movement of the connected machine or reeling of the cable).

Pulling tests can be done using a setup with a spindle drive to pull the cable until break and a load cell to measure the corresponding force. Since this test is quite laborious, usually the well-known maximum tensile loads of the cable elements including appropriate safety margins are used as limits for cable operation.



Oil Mud Diesel Acid Base UV Ozone Water	Fire (+ Water) (+ Shocks)	Bending Shocks Tension Friction Vibration Torsion	Over-voltages Transients EMI	Ambient temperature -60℃ … ~250℃

Fig. 1: Possible impacts on a cable