SLOVENSKI STANDARD
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Aeronavtika - Elektriļ ni kabli za uporabo v zraļ nih plovilih - Preskusne metode - 418. del: Toplotna vzdrģljivost za vodnike

Aerospace series - Cables, electrical, aircraft use - Test methods - Part 418: Thermal endurance for conductors

Luft- und Raumfahrt - Elektrische Leitungen für Luftfahrtverwendung - Prüfverfahren - Teil 418: Thermische Gebrauchsdauer fur Leiter

Série aérospatiale - Câbles électriques à usage aéronautique - Méthodes d'essais - Partie 418: Endurance thermique des conducteurs

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Foreword

This document (EN 3475-418:2007) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2008, and conflicting national standards shall be withdrawn at the latest by May 2008.

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1 Scope

This standard specifies a test method to value the thermal endurance of bi-metal conductors, by valuation of the influence of metallic migration on the electrical resistance per unit length.

It shall be used together with EN 3475-100.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 3475-100, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General.*

EN 3475-301, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 301: Ohmic resistance per unit length.*

3 Introduction

3.1 General

Various bi-metal conductors exist among which the most usual are tin-coated copper, copper clad steel and copper clad aluminium.

Inter-metallic compounds may appear at the interface of the various layers of such conductors. As these compounds have generally an increasing growth rate when exposed to elevated temperature, the characteristics of the cables (mechanical and electrical) can be affected depending on the time and the temperature of exposure.

A good example is tin-coated copper where the diffusion of tin into copper is a fast, well-known and important phenomenon between ambient temperature and 230 °C.

3.2 Theory

The inter-metallic layer formation at the interface of the various layers in the wires is due to a diffusion mechanism in association with solubility phenomenon.

The diffusion rate is characterized by a coefficient of diffusion of the two metals in contact at a given temperature. This coefficient of diffusion has generally the form of an Arrhenius law and is given by the formula.

$$D = Do.e^{-\frac{Q}{R.T}}$$

where

R is the ideal gas constant;

Q is the activation energy for the diffusion process; and

T is the absolute temperature;

Do is a constant given for a couple of diffusion.

Furthermore, in the case of the electrical wires, the calculation shows that there is a relation between the coefficient of diffusion D and the time t of exposure at different temperatures:

$D.t = \text{Const}$

So that $D1.t1 = D2.t2$

This say that it is possible to calculate an equivalent time of exposure at a higher temperature but this must be done at a temperature for which the solubility limit and the metallurgic mechanisms involved are not too different, generally in a domain below 280 °C. If the test temperature is too high there is a risk of obtaining a degradation mechanism not representative of reality.

For example, on a copper clad aluminium conductor to assess the behaviour for:

— 10 000 hours at 180 °C, a test of 2 200 hours at 200 °C can be performed;

— 140 000 hours at 150 °C, a test of 2 500 hours at 200 °C can be performed.

3.3 Technical consequences on conductors

When appeared, such inter-metallic compounds will affect the mechanical and electrical behaviour of the conductor. Even if all these characteristics do not evolve proportionally in relation with its thickness, it has been shown that an easy way to survey the growth of the inter-metallic part is to measure the increase of the linear resistance.

4 Preparation of specimens

4.1 Specimens

A sufficient length shall be taken from the same batch of a finished cable. Generally, the test is run on gauge 20.

4.2 Conditioning

This length shall not be bent with a radius less than 50 times the overall diameter of the cable, during temperature exposure.

4.3 Initial measurement

On this initial length take a minimum length of three meters to make three samples of at least one meter, make three measurements of the electrical resistance per unit length, according to EN 3475-301. Record the arithmetic mean value, of this sampling corrected to 20 °C, as the initial measurement without thermal ageing.

NOTE The temperature correction coefficient is generally given in the relevant conductor product standard.

5 Apparatus

An air-circulating oven shall be required for this test. Its size must be sufficient to hold all necessary specimens during the complete duration of the test.

6 Method

The initial length shall be placed in the oven for the time and the temperature specified in the product standard.

Each month, or specified period in the concerned product standard, after having cut 10 cm at the extremity, one specimen of three meters minimum length shall be removed from the oven and cooled for at least 1 h at ambient temperature. Then, make three samples of at least one meter and performed three measurements of the electrical resistance per unit length, according to EN 3475-301. Record the arithmetic mean value as the value of the concerned sampling corrected to 20 °C. All specimens shall be kept in order if necessary to be able to measure the thickness of the inter-metallic interface.

7 Requirements

a) the electrical resistance increase of each mean measurement shall be less than x % of the initial mean measurement.

b) the electrical resistance increase of each mean measurement shall be less than y % of the maximum resistance requested in the product standard.

x and y values shall be specified in the product standard.