CONSIDERATIONS REGARDING THE TORQUE TEST FOR BUSHINGS AND THERMAL SHOCK TEST, APPLICABLE TO ELECTRICAL EQUIPMENT DESIGNED FOR USE IN EXPLOSIVE ATMOSPHERES

Moldovan Lucian, *Phd .Eng., INCD INSEMEX Petrosani, Romania*

Burian Sorin, *Phd. Eng., INCD INSEMEX Petrosani, Romania*

Friedmann Martin, *Phd .Eng., INCD INSEMEX Petrosani, Romania*

Magyari Mihai, *Phd. Eng., INCD INSEMEX Petrosani, Romania*

Fotău Dragoş, *Phd. Student, Eng., INCD INSEMEX Petrosani, Romania*

Colda Cosmin, *Phd. Eng., INCD INSEMEX Petrosani, Romania*

ABSTRACT: *Electrical equipments designed for use in explosive atmospheres must fulfill the requirements imposed by ATEX Directive 94/9/EC. These equipments have special characteristics that shall be preserved on their entire lifetime.*

In order to evaluate the explosion protection characteristics these equipments shall be submitted to type tests. In the type tests category are also included the torque test for bushings and thermal shock test for glass parts of luminaires and windows of electrical equipment.

This paper has the purpose to present the importance of the torque test for bushings and thermal shock test and, also, to underline the testing methodology developed based on the requirements imposed by the applicable standards.

KEY WORDS: *type test, torque test for bushings, thermal shock test*

1. INTRODUCTION

Evaluation and testing of equipments designed for use in explosive atmospheres, in purpose of certification, is very important considering the existing explosion risk which has to be minimized to ensure people's health and security, as well as to prevent goods damage and, not in the last instance, to protect the environment[1].

Equipments that operate in hazardous explosive atmospheres must be subjected to certification procedures, according ATEX Directive 94/9/EC[4] [4](transposed in Romanian legislation by Government Decision no. 752/2004) [3].

In order to evaluate the explosion-proof characteristics of electrical apparatus, the prescriptions of harmonized standards from the SR EN 60079 series are used. In this matter, are used the standard SR EN 60079-0 (Explosive atmospheres. Part 0: Equipment. General requirements) and one or more of the standards containing the specific requirements for the type(s) of protection applied to equipment (ex. SR EN 60079-1 for the type of protection flameproof enclosure "d", SR EN 60079-7 for the type of protection increased safety "e", SR EN 60079-11 for the type of protection intrinsic safety "i"). For evaluation of explosion-proof electrical equipment, these shall be subjected to type tests[1].

In the SR EN 60079-0 standard are indicated the type tests to which all the explosion-proof electrical equipments shall be subjected and the order in which these tests shall be performed.

In the type tests category, are also included the torque test for bushings and the thermal shock test.

2. TORQUE TEST FOR BUSHINGS

2.1 Requirements for the torque test for bushings

The torque test for bushings applies to multi-compartmented equipments to which the passage from one compartment to another is made through some passage terminals (bushings). The compartments between which the electrical connection is to be made may have the same type of protection (for example flameproof enclosure "d"[2]) or different types of protection (for example flameproof enclosure "d" and increased safety "e", flameproof enclosure "d" and intrinsic safety "e", increased safety "e" and intrinsic safety "e" etc.). In technological installations operating in areas classified as with hazard of explosive atmospheres there are many examples of such kind of multi-compartmented electrical equipments (for example: luminaires in which the connecting terminals are placed in a compartment with type of protection increased safety "e", but the light source is placed in a compartment with type of protection flameproof enclosure "d"; mining starters in made with the type of protection flameproof enclosure "d" that are using bushings for the passage from one compartment to another) [1].

The bushing contains inside a metallic stem that creates the electrical connection between those two compartments. These bushings (terminals) shall ensure a good fastening and maintaining the mounting position, in order not to negativelly influence the insulation distances, but also not to facilitate the transmission of mechanical stress from terminal to conductor.

Bushings used for connection facilities and which are subjected to torque during connection or disconnection of conductors shall be tested for resistance to torque.

In case non-metallic materials are used it is necessary that the torque test for bushings to be conducted after their conditioning by tests to thermal endurance to heat and cold.

The stem in the bushing or the bushing, when mounted, shall be subjected to a torque of the value indicated in table 1, according SR EN 60079-0:2010[5].

Table 1 – Torque to be applied to the stem of bushing used for connection facilities[5]

Stem diameter	Torque Nm
M 4	2,0
M 5	3,2
M 6	5
M 8	10
M 10	16
M 12	25
M 16	50
M 20	85
M 24	130
The torque values for other dimensions than specified above can be determined from a graph plotted using these values. In addition, the graph may be extrapolated to allow torque values to be determined for stems of bushings larger than those specified.	

When mounted, neither the stem in the bushing, nor the bushing itself, shall turn when the stem is subjected to a torque[5].

2.2 Testing technology

Considering the specific requirements for performing the torque test for bushings previously described, it was found that before performing the specific test is required that, in case of bushings that use elements made of nonmetallic materials (other than glass and ceramics), to undergo thermal conditioning (thermal endurance to heat and cold). The thermal conditioning is performed in a climatic chamber, capable to achieve the necessary conditions for the test[1].

The torque test for bushings requires the use of equipment by which the torque is applied to the stem of the bushing. This torque can be applied using a torque wrench that covers the torque range prescribed in the standard SR EN 60079-0: 2010 and to have also the necessary accessories for transmitting torque from the torque wrench to the stem of the bushing.

To the purpose of the test two high precision torque wrenches are used, Stahlwille, Manoskop type 714 (for the range 2-20 Nm) and type Manoskop 730D (for the range 20-200 Nm) with the required accessories[1].

Fig. 1 Torque wrench Stahlwille, type Manoskop 714

Fig. 2 Torque wrench Stahlwille, type Manoskop 730D

In order to use the obtained test results for certification of explosion-proof electrical equipment, and according the INSEMEX-GLI procedures, the torque wrenches were calibrated at a calibration laboratory, certified by BRML according to EN ISO 17025: 2005.

3. THERMAL SHOCK TEST

3.1 Requirements for the thermal shock test

From the operational safety point of view, the explosion-proof electrical equipment that contains glass parts (windows or light dispersers) shall maintain explosion protection characteristics even in environmental conditions different of normal conditions. For example, there is a possibility that in case of a luminare, mounted outside, to reach after a period of operation a specific temperature (maximum service temperature) and, because of some unfavorable environmental conditions, to be exposed on splashing with water at a low temperature (for example cold rain drops). The glass from which the disperser of the luminaire is made shall resist, without breaking or cracking to the thermal shock generated by the rain drops action (cold rain drops) that come in contact with the ligth disperser (that is at a high temperature, sometimes more than 100°C) [1].

The thermal shock test is part of the thermal tests, as described in the SR EN 60079-0:2010. For the porpose of this test, it is necessary that the glass elements to be verified, to be previously brougth to the maximum service temperature. Thus, before performing the thermal shock test, the maximum service temperature shall be determined, in all points in which maximum temperature values can occur (including the temperature on glass parts and plastic materials). Thermal shock test shall be applied on explosion-proof electrical equipment that contains parts made of glass. Glass parts of luminaires and windows of electrical equipment shall withstand, without breaking, a thermal shock caused by a jet of water of about 1 mm diameter at a temperature (10 ± 5) °C sprayed on them when they are at not less than the maximum service temperature. In practice, there are a lot of equipments operating in areas with hazard of explosive atmospheres that use glass parts in their construction (for example: luminaries, analogic or digital measuring instruments for which the local reading of the displayed value is needed, etc.).

3.2 Testing technology

Analyzing the specific requirements of achieving thermal shock test, it was found that, before performing the specific test, it shall determine the maximum temperature that can be reached in normal operating conditions (at nominal parameters of the device, taking into account the maximum ambient temperature for which the equipment is intended to operate) by the component subassembly of the housing containing parts made of glass (light disperser globes or windows for measuring electrical equipment used to monitor various parameters)[1].

In order to determine the maximum temperature in normal operation the testing laboratory has the necessary equipment (adjustable power source, multimeter with thermocouples etc.) and specific procedures.

For performing the thermal shock test the glass parts that will be subjected to this test shall be conditioned (heated) until they reach a temperature at least equal to the temperature reached in normal operation (at nominal parameters of the device, taking into account the maximum ambient temperature for which the equipment is intended to operate). The glass parts of luminaires and windows of electrical equipment must withstand, without breaking, a thermal shock caused by a water jet with a diameter of about 1 mm, at a temperature of (10 ± 5) °C, developed with them when they are at a temperature not lower than the maximum temperature.

For heating of glass parts of the equipment to the maximum temperature reached in normal operation a climatic chamber is used.

For conditioning of water (at a temperature of 10±5 °C) necessary to spray the glass parts of the equipment, in case that the tap water temperature does not meet these requirements, other equipment can be used to bring the water temperature in the required standardized range (for example. other climatic chamber, a refrigerator, a water purifier capable of heating / cooling water, etc.).

For splashing of glass parts subjected to thermal shock test, a test rig was conceived (Fig. 3). For achieving the test rig were used: water pump, power supply, 1 mm nozzles, water hose, voltage indicator, push button etc.

Spraying the glass part that is intended to be tested can be achieved even within the climatic chamber used for heating through the visiting windows of them (fig. 4).

Fig. 3 Test rig for performing the thermal shock test

Fig. 4 Spraying the light disperser inside the climatic chamber

4. CONCLUSIONS:

The torque test for bushings and the thermal shock test are two important tests in order to verify the explosion protection security characteristics of electrical equipment designed for use in explosive atmospheres.

The torque test for bushings applies to multi-compartmented equipments to which the passage from one compartment to another is made through some passage terminals (bushings).

The thermal shock test applies to those parts of explosion-proof electrical equipment that are made of glass (windows or light dispersers).

The testing technologies developed for those two tests take into consideration all the aspects with respect to the standardized requirements, provided by SR EN 60079-0.

5. REFERENCES

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