Annals of the University of Petrosani, Electrical Engineering, 20 (2018)

REQUIREMENTS FOR TESTING AND VERIFICATION FOR BREATHING AND DRAINING DEVICES

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Abstract: The evaluation of explosion-proof electrical equipment for certification is particularly important given the risk of explosion and must be minimized. This in order to ensure the safety of life, health of workers, to prevent damage to goods and the environment when they meet the essential security requirements at European level.

Directive 2014/34 / EU states that equipment used in explosive atmospheres must be designed to operate without endangering the environment for which it is intended.

This paper proposes the study and evaluation of the requirements for the breathing and drainage devices. In order to verify explosion protection, the representative samples made available by explosion-protected equipment manufacturers are tested under the worst possible conditions that may occur in practice.

Keywords: Flameproof enclosure; explosion protection; breathing and draining devices; explosive atmosphere; permeable metallic materials.

1. INTRODUCTION

The paper deals with the study of the requirements for the testing of drainage and breathing devices used in electrical equipment with flameproof enclosures type of protection. Several studies have been conducted on the reliability of electrical equipment and installations.

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Types of protection are all the specific measures applied to electrical equipment to avoid the ignition of an ambient explosive atmosphere.

According to Directive 1999/92/EC, users of technological installations in areas with explosive atmospheres have to follow successively three stages: preventing the formation of explosive atmospheres, avoiding the ignition of explosive atmospheres, limiting the harmful effects of an explosion to ensure the health and safety of workers [6].

2. REQUIREMENTS FOR DRAINAGE AND BREATHING DEVICES

2.1. General

Drainage and breathing devices are generally used for electric motors with a flameproof enclosure protection. For the design and construction of motors with a type of flameproof enclosure protection, it is necessary for the beneficiary to formulate precisely and in detail the requirements regarding the operation of the motors in accordance with the ATEX Directive [5].

Being designed to operate installations in explosive atmospheres (chemical industry, petroleum industry, mining industry, etc.), these engines are often built into the flameproof enclosure protection module, its outer part (case, shields, terminal box, clamping elements) having to withstand an internal explosion of an explosive mixture that penetrated the interior without suffering deformations and without transmitting the flame from the inside out to an explosive atmosphere surrounding the enclosure.

For this, it is necessary to have maximum admissible gaps at joints or other flamepaths, depending on explosion categories and subcategories [1]. The engines are distinguished by a robust mechanical construction, made in a wide range of constructive shapes normalized by the major manufacturers of electric machines. The external shape of the casing depends on the type of motor protection as well as on the cooling mode In the case of a closed machine equipped with an axial cooling system, the casing is constructed with ribs to increase the cooling surface. In the case of an internal cooling machine, the casing is smooth outside. [2]

Standard SR EN 60079-1 shows all types of possible joints encountered when making flameproof enclosures as well as joint parameter values. The standard also mentions the materials used for the enclosures.

3. BREATHING AND DRAINING DEVICES WHICH FORM PART OF A FLAMEPROOF ENCLOSURE

3.1. General

Breathing and draining devices shall incorporate permeable elements which can withstand the pressure created by an internal explosion in the enclosure to which

they are fitted, and which shall prevent the transmission of the explosion to the explosive atmosphere surrounding the enclosure [3].

They shall also withstand the dynamic effects of explosions within the flameproof enclosure without permanent distortion or damage which would impair their flame-arresting properties. They are not intended to withstand continuous burning on their surfaces. [2]

These requirements apply equally to devices for the transmission of sound but do not cover devices for relief of pressure in the event of internal explosion, use with pressure lines containing gas which is capable of forming an explosive mixture with air and is at a pressure in excess of 1,1 times atmospheric pressure.[4]

3.2. Openings for breathing or draining

The openings for breathing or draining shall not be produced by deliberate enlargement of gaps of flanged joints [3].

The composition limits of the materials used in the device shall be specified either directly or by reference to an existing applicable specification.

The elements of breathing or draining devices for use in an explosive gas atmosphere containing acetylene shall comprise not more than 60 % of copper by mass to limit acetylide formation [3].

The dimensions of the breathing and draining devices and their component parts shall be specified.[4]

4. TYPE TESTS FOR BREATHING AND DRAINING DEVICES

4.1. General

Attachment of the sample device under test shall be made on the end of the test rig enclosure in the same manner as it would normally be mounted on a flameproof enclosure. The test shall be performed on the sample after the impact test. [3]

The impact test may be performed on the sample, separate from the test enclosure, when it is mounted on a plate that forms the end part of the test rig enclosure.

For devices with non-measurable paths, the maximum bubble test pore size of the sample shall be not less than 85 % of the specified maximum bubble test pore size. [3]

4.2. Bubble test

For bulloscopic verification of sintered materials, materials used for making drainage and breathing devices, is shown in Fig. 1.

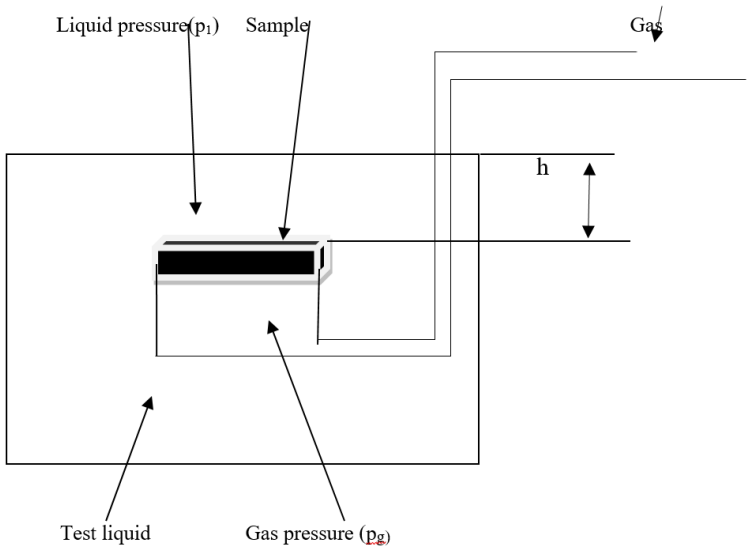

Fig. 1. Block diagram for buloscopic determination

The buloscopic hair size corresponds to the minimum differential pressure at which the first bubbles appear continuously. For this reason, this pressure is sometimes called the minimum bubble pressure or the first bubble. The appropriate capillary diameter is called maximum pore diameter or maximum pore size.

When the pressure exceeds the minimum burst pressure (the first bubble point), more bubbles appear on the sample. For a given aspect, the corresponding pressure can lead to the definition of a conventional pore size. [7]

4.3. Thermal tests

4.3.1. General

After the bubble test, breathing and draining devices as Ex components shall be subjected to the thermal tests based on the maximum intended flameproof enclosure volume, but no less than the volume of the test rig in Figure 2. [3]

Breathing and draining devices intended for multiple use in any single flameproof enclosure shall be tested additionally with the enclosure.

4.3.2. Test procedure

For enclosure volumes of less than or equal to 2,5 l, the test rig assembly with all four sections, as shown in Figure 2, shall be used, and the test procedure shall be carried out as follows [3]:

a) the position of the ignition source shall be at the enclosure inlet and 50 mm from the inside of the end-plate housing the device and the results observed;

b) the test mixtures shall;

c) the temperature of the external surface of the device shall be monitored during tests;

d) any device shall be operated as specified by the manufacturer's documentation. After each of five tests, the explosive mixture shall be maintained external to the device for a sufficient time to allow any continuous burning on the face of the device to become evident, for at least 10 min, so as to increase the temperature of the external surface of the device or to make temperature transfer to the outer face possible; and

e) the tests shall be carried out five times for each gas mixture for the gas groups in which the device is intended for use.

For enclosure volumes of greater than 2,5 l, a representative enclosure of the intended volume shall be used, and the test procedure shall be carried out as follows [3]:

- the test mixtures shall, as appropriate;
- the temperature of the external surface of the device shall be monitored during tests;
- any device shall be operated as specified by the manufacturer's documentation.

After each of five tests, the explosive mixture shall be maintained external to

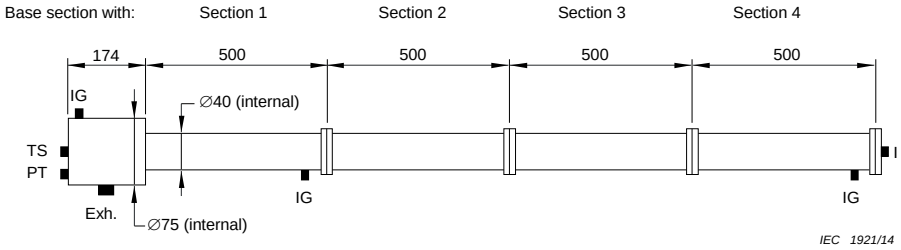

Fig 2. Component test rig for breathing and draining devices

the device for a sufficient time to allow any continuous burning on the face of the device to become evident, for at least 10 min, so as to increase the temperature of the external surface of the device or to make temperature transfer to the outer face possible; and the tests shall be carried out five times for each gas mixture for the gas groups in which the device is intended for use. [3]

4.3.3. Acceptance criteria

During the thermal tests, no flame transmission shall occur and no continuous burning shall be observed. The device shall show no evidence of thermal or mechanical damage or deformation which could affect its flame-arresting properties [3].

The measured external surface temperature rise of the device shall be multiplied by a safety factor of 1,2 and added to the maximum service temperature of the device for the determination of the temperature class of the electrical equipment.

4.4. Test for non-transmission of an internal ignition

4.4.1. General

After the bubble test, this test shall be carried out on a standard test rig, as illustrated in Figure 2, with the following additions and modifications [3].

4.4.2. Test procedure

The position of the ignition source shall be as shown in Figure 2:

a) at the inlet end; and

b) at 50 mm from the inside of the end-plate housing the device.

For the purposes of the test, the test rig shall be assembled for each gas group, in accordance with Figure 2, and have the following number of sections:

–Group I and Group IIA: one section of test rig assembly;

–Group IIB and Group IIC: four sections of test rig assembly.

–The gas mixture within the test rig enclosure shall be ignited and the tests shall be made five times at each ignition point.

–For breathing and draining devices of Groups I, IIA and IIB having either measurable paths or non-measurable paths.

–For breathing and draining devices of Group IIC with measurable paths,.

For breathing or draining devices of Group IIC with non-measurable paths.

4.4.3. Acceptance criteria

During the test, no ignition shall be transmitted to the surrounding test chamber [2].

4.5. Test of the ability of the breathing and draining device to withstand pressure

4.5.1. Test procedure

The reference test pressures in each gas group are:

Group I	1 200 kPa,
Group IIA	1 350 kPa,
Group IIB	2 500 kPa,
Group IIC	4 000 kPa.

For the purpose of the test, a thin flexible membrane is fitted over the inner surfaces of the breathing and draining devices. The reference pressure shall be one of the relevant pressures given above for the gas group for which the component is intended [2]. One of the following overpressure tests shall be applied:

- 1,5 times the reference pressure for a period of at least 10 s. Then each component shall be submitted to a routine test; or
- 4 times the reference pressure for a period of at least 10 s. If this test is successful, the manufacturer is not required to apply the routine test to all future components of the tested type.

4.5.2. Acceptance criteria

After the overpressure tests, the device shall show no permanent deformation or damage affecting the type of protection.

4.6. Ex component certificate [3]

The Ex component certificate shall include, in the schedule of limitations, the details necessary to properly select a breathing or draining device for attachment to a type tested flameproof enclosure. The schedule of limitations shall include, as a minimum, the following:

a) the maximum recorded surface temperature obtained during the type test corrected to 40 °C, or to the higher marked ambient;

b) service temperature range for non-metallic enclosures and non-metallic parts of enclosures;

c) the maximum permitted enclosure volume (based on the thermal test) if greater than 2,5 l;

d) a requirement that each Ex component or package of Ex components be accompanied by a copy of the certificate, together with the manufacturer's declaration stating compliance with the certificate conditions, and confirmation of the material, maximum bubble test pore size and minimum density, where applicable; and special mounting instructions, if any.

5. CONCLUSIONS

As a result of the work titled: "Requirements for testing and verification for breathing and draining devices", the following conclusions were drawn:

- the requirements of standard SR EN 60079-0 for electrical equipment used in explosive environments have been analyzed;
- the requirements of standard SR EN 60079-1 for drainage and breathing devices have been analyzed;
- the requirements of standard SR EN 60079-1 have been analyzed regarding the necessary tests to be performed on drainage and breathing devices;

- the test requirements for the drainage and blowing devices in bulk, correlated with the other specific tests to which the equipment is to be subjected, have been presented in the paper, establishing the order of the tests in accordance with the specific standard;
- the components required to achieve the test bench for the pressure and non-explosion test for the drainage and blowing devices have been established;
- the required components for the test stand were prepared for the buloscopic test of drainage and breathing devices;
- the block diagram of stalls for pressure, explosion-proof and buloscopic test stands that meet the test requirements specified in the standard.

Acknowledgements

This work is part of the Core Program: "Researches for the development of evaluation capacity, testing of technical equipment for use in explosion risk areas and protective equipment" - PN 18 17 02 01.

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