Aspects regarding the surface temperature for luminaires used in potentially explosive atmosphere

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Abstract. Assessment for certification purposes of explosion-proof electrical equipment is considerd to be very important taking into account the risk of explosion that needs to be maintained at a safe level in order to provide both safety and health of workers and to prevent the damage over property and the environment; and also free movement of goods meeting the EU essential safety requirements. Even if luminaires intended to be used in explosive atmospheres are designed and built using some of specific principles as those used for luminaires intndended to be used in normal environment, they also present other specific characteristics related to their area of use. Therefore, specific requirements and tests are needed to be taken into account in this case. The surface temperature is a very important component on which the explosion protection depends. The surface temperature is the highest temperature reached in running conditions, under the most unfavorable circumstances by any component of the electrical luminaire. The maximum surface temperature may appear on an internal component or on the outer surface of the equipments which operate in explosive atmospheres generated by gases, that can occur in technical installations endangered by the presence of explosive atmospheres. In the case of electrical equipment used in (potentially) explosive atmospheres, in order to provide explosion protection, it is essential that the tests carried out on the equipment during the certification process are performed in accordance with the requirements of the standards referring to the protection types used in the construction of the equipment.

1 Introduction

Taking into account all technical, economic, and occupational safety aspects, all regulations relating to the design, construction, operation, inspection, and maintenance of lighting fixtures used in hazardous areas with flammable substances must be taken into

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consideration. Because of this aspects it must be considered, that the luminares used in these areas are properly tested to verify that the requirements of the standards referring to the types of protection are fullfilled, in purpose of certification. Some improvements that can be made are presented in the paper, related to testing facilities in laboratories with regard to determining the operating temperature and maximum surface temperature of luminaires used in explosive atmospheres.

According to European regulations on lighting fixtures for use in hazardous explosive atmospheres, accurate assessment during the certification process is extremely important, due to the risk of explosion that must be minimized. [1].

The assessment of explosion-protected electrical lighting fixtures is carried out through tests and checks performed based on reference standards [2]. For the type of protection flameproof enclosure “d”, the specific standard is SR EN 60079-1, and in case of increased safety type of protection “e”, the specific standard is [3].

This document will specifically indicate the need to perform the appropriate test required for determination of the maximum surface temperature applicable to luminaires with type of protection “d” and “e”.

2 Aspects concerning the the maximum surface temperature determination for luminaires used in explosive atmospheres generated by gases or dust

Explosion-proof luminaires are designed to be used in potentially explosive environments where is present a risk of explosive atmospheres forming from gases, vapors, or dust. These fixtures comply with ATEX standards and offer a high level of protection against fire and explosions[4].

Explosion-proof luminaires are designed and manufactured to prevent the ignition of the explosive atmosphere around them by limiting the surface temperature and avoiding sparks. They are constructed of robust materials that are resistant to impact, vibration, and mechanical shock, enabling them to operate in harsh industrial environments. [5]

These luminaires have a high degree of protection against dust and water ingress, making them suitable for use in damp or dusty environments.

The equipment’s surface temperature represents a is very important characteristic and the explosion protection of the equipment is dependent to it. The maximum surface temperature is defined to be the highest temperature in running conditions, considering the most unfavorable circumstances by any component of the electrical luminaire. The maximum surface temperature can occur on the internal or external surface of the equipment [6]

Including the equipment in a temperature class is the most common practice regarding the indication of maximum surface temperature for Group II electrical equipment. The relationshup between autoignition temperature and the allowable temperature is presented in Table 1. The test to determine the specific maximum surface temperature is very important to ensure the protection to explosion and the temperature has to be determined as accurately as possible. In general, testing of equipment is made in testing laboratories, acredited accordin EN ISO 17025 standard. [7], [8].

Table 1. Relationshup between autoignition temperature and the allowable temperature

Temperature class	Ignition temperature for gases or vapors (°C)	Temperature classes admitted for equipment
T1	450	T1 - T6
T2	300	T2 - T6
T3	200	T3 - T6
T4	135	T4 - T6
T5	100	T5 - T6
T6	85	T6

In potentially explosive atmospheres, a luminaire's external surface temperature must remain below the autoignition temperature of the surrounding flammable gas, vapor, or dust. If the luminaire surface becomes too hot, it can ignite the atmosphere even without a spark. [4] [8]

For luminaires that can be mounted in different positions, the operating temperature and maximum surface temperature have to be considered and determined in each operating position.

The equipment used to perform the measurements (thermometers, thermocouples etc.), as well as connecting cables shall be chosen and mounted not to affect (significantelly) the thermal characteristics of the luminaire. The final temperature of the equipment is considered to be achieved when the temperature gradient (rise) does not exceed 2 K/h. [2]

Also, it is mandatory that the service temperature to be determined. Both of the tests are included in the test program to which electrical luminaires intended for use in explosive hazardous areas are subjected. [2]

In order to perform the service temperature determination test the luminaire shall be supplied at the rated voltage and current (with no consideration of faults). The hottest point of the metallic parts of the enclosure and non - metallic parts of it shall be determined. If there is no direct influence of the supply voltage over the temperature rise, the test current to be used for the test has to be 100% of the rated current. [2], [5]

The test, performed in the laboratory, for the maximum surface temperature determination, shall be performed at the most unfavorable values of the nominal parameters.

In accordance with the provisions regulated by the specific standard for determining the maximum surface temperature, this test voltage should be 90% or 110% of the rated voltage of the luminaire wichever determines the maximum surface temperature. [4].

3 Testing facilities

During the process of certification of a equipment designed to be used in potentially explosive atmosphere, at INCD – INSEMEX laboratories are performed tests regrding measuring of surface temperature for luminaires designed for use in hazardouse explosive atmospheres. The tests are carried out in accordance with applicable standards, which describe the specifications of the equipment to be used in performing the tests, as well as the method for performing correct tests.

In figures 1 and 2 are presented some of the equipments that are used to to perform the test for determination of the surface temperature: voltage/power source, thermovision camera, laptop and data acquisition system with thermocouples.

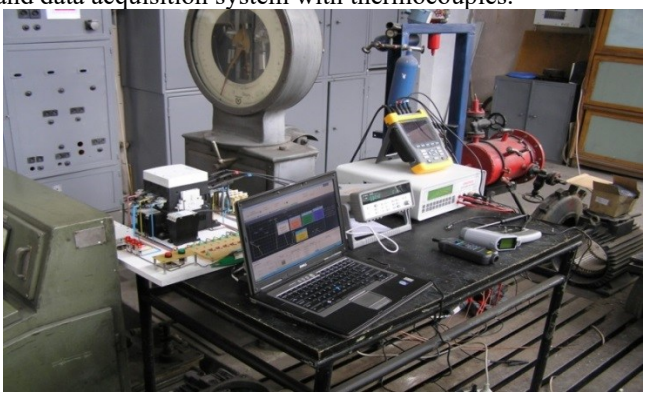

Fig. 1. Testing facilitiesfor for determining the maximum surface temperature of the luminaires

Fig. 2. LED Luminaire subjected to the test for surface temperature determination

For economic reasons and for the safety and health of workers, LED luminaires are increasingly used in environments with a risk of explosion. LEDs do not heat up as much as classic light sources, but due to the electronic components that are incorporated into these luminaires, there is a risk of ignition of the potentially explosive atmosphere around them.

Tests were carried out in the laboratory on luminaires with increased safety protection type, built in different configurations. In this case, tests were carried out on two luminaires. Table number 2 records the temperatures measured on a luminaire without safety lighting, and table number 3 records the temperatures measured on a luminaire without safety lighting. The second luminaire has a built-in battery, a component that can lead to an increase in temperature inside the housing.

Table 2. Temperatures measured on a luminaire without safety lighting

Equipment	Maximum determined temperature (°C)				Temperature determination location
	T_{max}pt. U=U_N	$T_{ambient}$U=U_N	T_{max}pt. U=0.9U_N	$T_{ambient}$U=0,9U_N	
Antiex LED 52W;	26,15	21,46	28,33	23,55	sealing gasket cable introducer
	28,51	21,46	31,20	23,55	power cable branch
	32,01	21,46	34,78	23,55	contact power supply cord
	28,30	21,46	30,34	23,55	hinge rubber gasket
	29,37	21,46	31,76	23,55	sealing gasket glass door and casing
	45,23	21,46	47,91	23,55	TC driver
	45,17	21,46	47,86	23,55	back driver
	42,27	21,46	44,65	23,55	LED bar
	28,40	21,46	30,90	23,55	locks
	31,30	21,46	33,99	23,55	outer casing

Table 3. Temperatures measured on a luminaire with safety lighting

Equipment	Maximum determined temperature (°C)				Temperature determination location
	T_{max}pt. U=U_N	$T_{ambient}$U=U_N	T_{max}pt. U=0,9U_N	$T_{ambient}$U=0,9U_N	
56W antiex LED luminaire with safety lighting	27,02	22,43	27,05	21,76	sealing gasket cable gland
	28,82	22,43	28,98	21,76	Power cable branch pc.
	32,42	22,43	32,77	21,76	contact power supply cord
	28,18	22,43	28,11	21,76	Hinge rubber gasket pcs
	29,78	22,43	30,22	21,76	sealing gasket glass door and casing
	44,15	22,43	44,44	21,76	TC driver
	44,69	22,43	45,04	21,76	back driver
	44,50	22,43	44,75	21,76	LED bar
	30,20	22,43	30,50	21,76	Pc. battery pack for damage lamp
	29,02	22,43	29,07	21,76	locks
	32,06	22,43	32,66	21,76	outer casing

4 Conclusions

In installations operating in potentially explosive environments, many luminaires with different types of protection are installed, introducing a risk of ignition to the explosive atmosphere in which they are installed. In order to avoid this, they shall be properly designed, manufactured, installed, and maintained.

Surface temperature represents a very important component on which the explosion protection depends. The surface temperature is the highest temperature reached when running, considering the most unfavorable circumstances by any component of the

electrical luminaire. The maximum surface temperature may appear on an internal component or on the outer surface of the equipments which operate in explosive atmospheres generated by gases, that can appear in technical installations operating hazardous areas (for example in oil and gas industry).

Besides the determination of maximum surface temperature of the liminaire, it is mandatory to determine service temperature. Testing for service temperature and maximum surface temperature is a part of the tests to which electrical luminaires intended for use in explosive environment is subjected..

The test for determination of maximum surface temperature is very important to ensure the protection to explosion and has to be determined as accurately as possible. In general, testing of equipment is made in testing laboratories, acredited accordin EN ISO 17025 standard.

During the tests for for determination of maximum surface temperature performed in the laboratory, it was found that the temperature measured on both the internal components and the external casing of the luminaires can be influenced by the equipment mounted inside. It was also found that if a larger number of luminaires are connected in series, a higher temperature was measured on the power connector of the first luminaire than the one previously measured. Therefore, it is very important that users of this equipment take into account the installation and use instructions recommended by the lighting manufacturer.

According to European regulations on lighting fixtures intended for use in explosive atmospheres, accurate assessment of equipment during the certification process is extremely important, given the risk of explosion that must be minimized.

According to European regulations, for certification, luminaires used in explosive atmospheres, must be subjected to tests, in order to assess if that the characteristics contributing to explosion protection are properly maintained at an appropriate level. The paper describes the method for testing luminaires to determine their operating temperature and maximum surface temperature.

To prevent an explosion, which can have devastating effects, it is important that luminaires used in such areas comply with applicable requirements and are properly designed, manufactured, installed, and maintained..

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