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DETERMINATION BY STANDARDIZED TEST METHODS OF THE DRUM FRICTION RESISTANCE PERFORMANCE OF CONVEYOR BELTS USE IN THE UNDERGROUND AND AT SURFACE

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Abstract: *The field of use of conveyor belts is varied, they can be found both in the composition of installations operating in normal environments as well as in environments with the danger of potentially explosive atmospheres. The use of conveyor belts in environments with the risk of potentially explosive atmospheres requires the fulfilment of those safety requirements aimed at preventing sources of initiation of explosive atmospheres. In order to ensure the highest level of security, in these spaces with the danger of potentially explosive atmospheres, the conveyor belts used must have adequate protection properties against sources of ignition that may appear during their operation. At the same time, in this context, the application of test methods that allow determining the specific performance of conveyor belts, such as, for example resistance to friction on the drum, resistance to flame propagation, electrical resistance, is also important. The paper essentially aims to deal with the issues related to the application of standardized test methods, developed in the laboratory, necessary to determine the performances regarding the friction resistance on the drum of the conveyor belts used in the underground and at surface.*
Keywords: *explosion hazard, conveyor belts, drum friction, laboratory tests, environments Ex.*

1. Introduction

Conveyor belts are widely used for the transport of solid materials, which are a component of transport facilities and systems. At the same time, the field of use of conveyor belts is vast, conveyor belts can be found both on the surface and underground. The wide field of use of conveyor belts means that they can be encountered both in normal environments, where the presence of potentially explosive atmospheres is not possible, and in environments with the danger of potentially explosive atmospheres [1].

In the case of potentially explosive atmospheres, unlike normal environments, the danger of explosions/fires occurs as a result of the initiation of potentially explosive atmospheres generated either by the transported material or by other external sources. Potentially explosive atmospheres of gases, vapors, mists or dusts and air are generated by combustible/flammable substances processed, transported, stored in industrial premises, even under normal working conditions, due to processes or accidental releases occurring at a given time.

The presence of potentially explosive atmospheres in these industrial spaces leads to the occurrence of the risk of explosion. To reduce the risk of explosions in industrial premises with potentially explosive atmospheres, both equipment and their components must be used in explosion-proof construction, which are not capable of producing sources of ignition that could initiate an explosion.

Therefore, conveyor belts that are used in environments with potentially explosive atmospheres must meet the essential safety requirements related to the risk of explosions.

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These requirements aim on the one hand to prevent the formation of a potentially explosive atmosphere around the conveyor belts, and on the other hand to prevent sources of ignition of the explosive atmosphere such as, for example, electrostatic discharges, hot surfaces and incandescent particles resulting from friction between the belt conveyors and the metal elements of the transport facility [2].

Working conditions, inadequate maintenance, non-existence or inefficiency of systems that allow the detection and monitoring of possible friction, make possible the occurrence of such a situation, during the operation of conveyor belts, within various industrial activities.

Therefore, an important role to ensure protection against the sources of ignition, mentioned previously, belongs to the materials used to make the conveyor belts, which must have a series of properties that do not allow the generation of such sources of ignition.

The determination of the properties referred to can be done after testing the conveyor belts through laboratory tests. Such a laboratory test refers to the determination of the resistance of the conveyor belts to the friction on the drum, by means of the test method simulating at the same time a real situation that may occur in practice [3].

The test method by which the resistance of conveyor belts to drum friction can be determined is a standardized method given in the EN ISO 20238:2019 standard. The results obtained following the application of this test method later allow the characterization of the materials in the composition of the conveyor belts from the point of view of the risk of generating sources of ignition as a result of friction, respectively the establishment of the properties that ensure protection against these sources of ignition.

2. Test method for determining the drum friction resistance of conveyor belts

2.1 The principle of the test method

The sample taken from the conveyor belt, which is to be tested, is wrapped around half the circumference of a rotating steel drum, being fixed rigidly at one end and tensioned at the other end with the help of weights.

The test is carried out at certain stresses and for a given period of time or until the specimen breaks. During the test, the presence or absence of flame or smoldering is observed, and the maximum temperature of the drive drum is reported and recorded. The test is carried out in still air and in a draft.

2.2 Description of the stand for determining the drum friction resistance of conveyor belts

Principle diagram of the stand for the determination of frictional resistance on the drum for the purpose of laboratory testing of conveyor belts, intended for use in environments with a risk of explosion, as a component of transport installations, in order to assess compliance with the essential safety requirements applicable according to the Directive 2014/34/EU - ATEx, is presented in figure 1 [4].

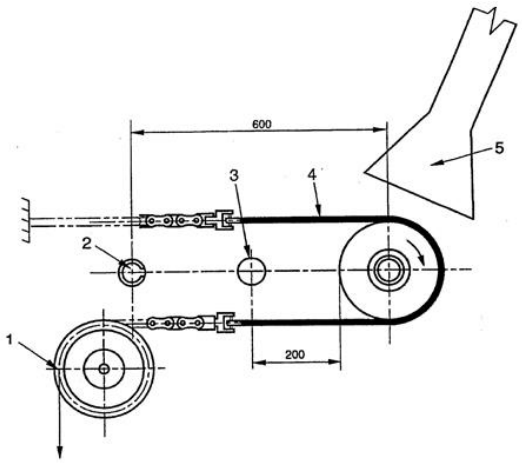

Fig. 1. Principle diagram of the test stand for determining the frictional resistance of conveyor belts on the drum
1 - guide roller; 2 - perforated pipe for air supply; 3 - anemometer; 4 - test sample; 5 - exhauster.

A device for recording the temperature of the steel drum (thermocouple wrapped in a stainless-steel casing, insulated with mineral material with an outer diameter of 2 mm, connected to a data acquisition board) is added to the components of the test stand mentioned before AGILENT 34970A, a tensioning system, emergency stop devices and a timer [5].

3. Laboratory testing of drum friction resistance of conveyor belts

Friction between the conveyor belt and one of the metal elements in the conveyor (drums, rollers) that may occur during operation due to local conditions and malfunctions such as a roller blocking, improper tensioning of the conveyor belt, etc., may be a source of ignition for potentially explosive atmospheres due to the high temperatures generated, the presence of flame and incandescent particles.

Since in practice the probability that such a situation will occur exists and all the more so as the protection systems are missing, it is very important to know the behavior of such a conveyor belt subjected to the friction process on the drum, roller or other metal element in the composition the conveyer.

Therefore, in this case, the laboratory testing of the conveyor belts to be used in environments with the risk of potentially explosive atmosphere is called for, using standardized test methods, such as the test method for determining the friction resistance on the drum, given in the EN ISO 20238:2019 standard, a test method that was developed within the INSEMEX - GLI laboratory, a laboratory accredited according to the requirements of the EN ISO/CEI 17025:2018 standard [6].

The test method for determining the friction resistance on the drum of conveyor belts applied in an accredited testing laboratory according to the requirements of the EN ISO/CEI 17025:2018 standard, allows the measurement of the maximum temperature of the drum during the period of friction between it and the respective conveyor belt specimen recording the presence/absence of flame or incandescent particles resulting from the friction process.

In order to determine the behavior of conveyor belts with friction on the drum, laboratory tests were carried out on conveyor belts compliant with the requirements of the EN 14973:2016 and EN 12882:2016 standards [7, 8].

The laboratory tests were performed according to the requirements of the EN ISO 20238:2019 standard, on several conveyor belt samples from the same belt roll.

Table 1. Obtained results

Sample	Temperature and relative humidity	No. test sample	Obtained results
1000, EP1000/4, 5+3K, class C1, roll 863/2020	22 ºC and 42 %	1	a) Method B (in air current): thin strip face: Method B2 - no flame or incandescent points appeared until the test piece broke (the break did not occur after 1 h and 50 min. at a tension of 1715 N); - maximum drum temperature: 222,3 °C
		2	a) Method B (in air current): thin strip face: Method B2 - no flame or incandescent points appeared until the test piece broke (the break did not occur after 1 h and 50 min. at a tension of 1715 N); - maximum drum temperature: 265,3 °C
		3	a) Method B (in air current): thick face tape: Method B2 - no flame or incandescent points appeared until the test piece broke (the break did not occur after 1 h and 50 min. at a tension of 1715 N); - maximum drum temperature: 256,3 °C
		4	a) Method B (in air current): thick face tape: Method B2 - no flame or incandescent points appeared until the test piece broke (the break did not occur after 1 h and 50 min. at a tension of 1715 N); - maximum drum temperature: 237,9 °C

In table 1 are given the results obtained after carrying out the tests, and in figure 2 these results are exemplified.

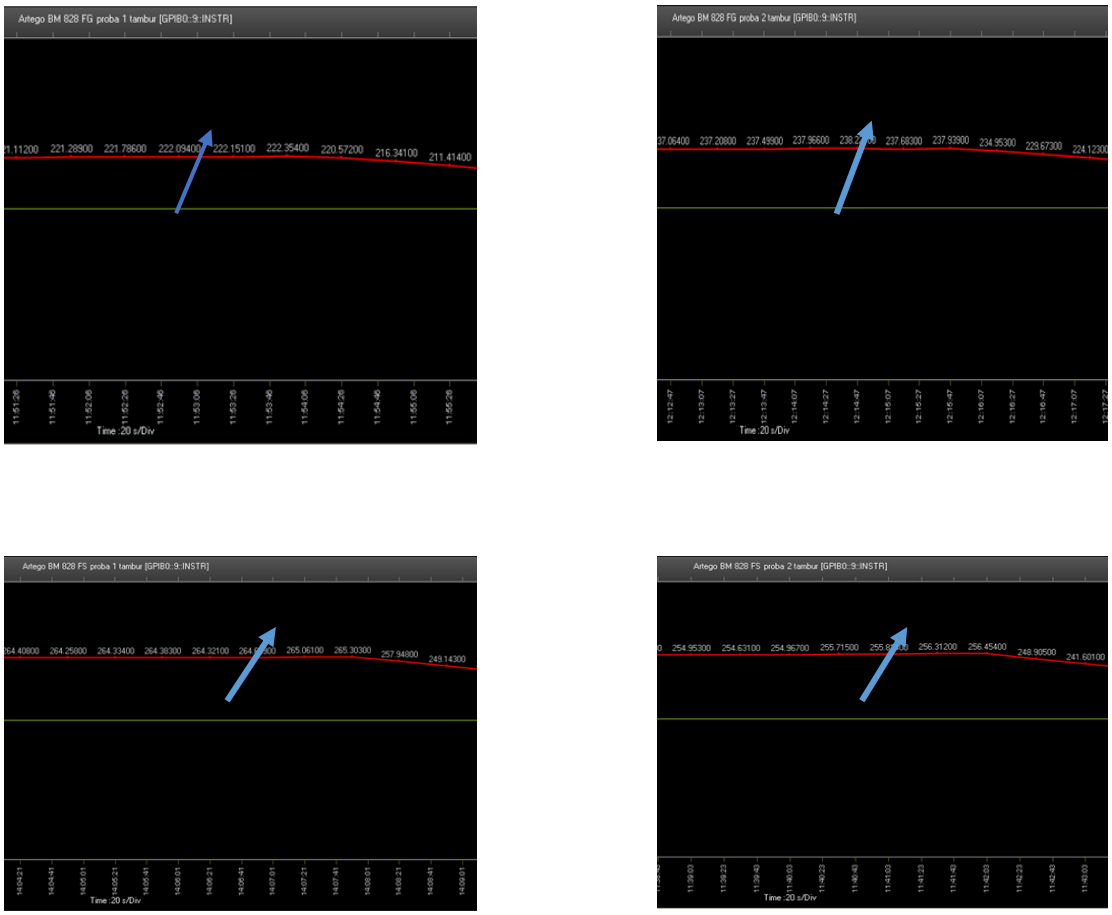

Fig. 2. Maximum drum temperature in degrees Celsius

The results obtained from the tests provide information on the behavior of the conveyor belts to be used in environments with the risk of potentially explosive atmospheres when they are exposed to the friction process on the drum or another metallic element of the conveyor.

At the same time, it was found that the drum temperature values are not influenced by the temperature and relative humidity, both of the test atmosphere and of the conditioning atmosphere; the tests being carried out under the same conditions of temperature and relative humidity as those of conditioning.

Instead, from the records made, differences can be observed between the drum temperature values for the four conveyor belt samples, tested according to the requirements of the SR EN ISO 20238:2019 standard.

Based on the results obtained, it can be appreciated that the differences recorded are mainly due to the performance of the materials used to make the conveyor belts, in terms of protection against the development of high temperatures during the friction between the conveyor belt and the drum, as well as due to the inhomogeneity of the material of the conveyor belt roll, from which the samples subjected to subsequent testing are taken.

4. Quality assurance of the results test, requirement regarding product conformity assessment in relation to applicable requirements

In order to assess the conformity of the products in relation to the applicable essential safety and health requirements, it is necessary to ensure the quality of the test results. Ensuring the quality of the test results requires compliance, both in the stage preceding the performance of the tests and during their performance, of all the requirements and conditions that may negatively influence the results obtained.

Several factors contribute to the correctness of the tests carried out in a laboratory, namely the environmental conditions, the conditioning of the samples, the test methods, the measuring equipment used, the handling of the samples, the traceability of the measurements and last but not least the human factor.

Among the previously mentioned factors that can influence the quality of the results obtained after carrying out the tests, the physical and chemical properties of the tested samples are also identified.

The quality of the test results can also be influenced by whether or not the samples to be tested have been pre-conditioned. Standards containing test methods specify that where conditioning is applied, the samples must be conditioned and then tested under the same conditions of temperature and relative humidity.

The measuring and recording equipment used to perform the tests can influence the quality of the test results if it is not periodically subjected to a program of metrological checks (calibration/calibration).

An important role in the case of use and implicitly in ensuring the quality of the results is also played by the human factor, who must have the necessary competence both for the proper use of these equipment and apparatus, as well as for the correct application and performance of the test methods and the tests themselves.

At the same time, the purpose being the same, the test methods applied to determine the protective performance of the tested products must allow and ensure the reproducibility and repeatability of the results obtained given their importance for the assessment of compliance with the applicable essential safety and health requirements.

In the sense of the previously mentioned, ensuring the quality of the results also implies the existence of necessary control procedures in the process of monitoring the validity of these results. The results obtained must be recorded so that trends are detectable and when possible statistical analysis of the results can be applied.

Ensuring the quality of test results can include, but is not limited to, the conditions in figure 3.

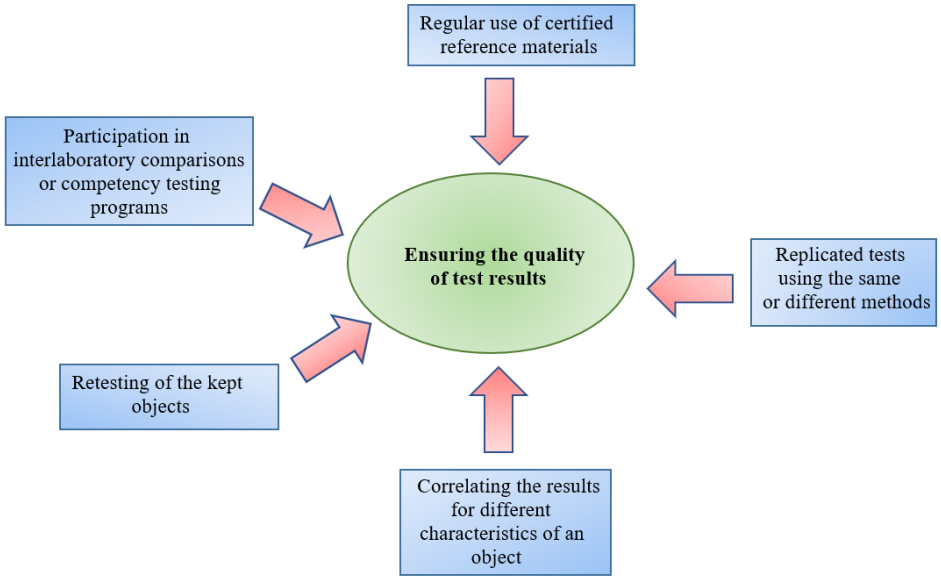

Fig. 3. Elements that contribute to ensuring the quality of test results

5. Conclusions

When using conveyor belts, in various applications, depending on their field of use, friction may occur between the conveyor belt and one of the metal elements of the conveyor (drums, rollers) due to local conditions and malfunctions such as the blocking of a roller, improper tensioning of the conveyor belt.

The friction between the conveyor belt and one of the metal elements in the conveyor (drums, rollers) can be a source of ignition for potentially explosive atmospheres as a result of the high temperatures that are generated, the presence of flame and incandescent particles.

Since there is a risk of the initiation of potentially explosive atmospheres by the sources of ignition generated by the friction between the conveyor belt and the metallic elements of the conveyor, laboratory testing is required as a necessity, using appropriate, standardized test methods of their performances to ensure protection against these ignition sources.

The results obtained from laboratory testing allow the subsequent assessment of the conformity of the conveyor belts with the essential safety and health requirements regulated by the applicable standards and norms, thus ensuring a high level of safety in environments with the risk of potentially explosive atmospheres.

For the evaluation of the conformity of the products with the applicable essential safety and health requirements, the quality of the test results is of particular importance, and this presupposes compliance with all those requirements and conditions that may negatively influence the results obtained from the tests performed.

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