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REPORT

Declaration for safe use of Filcoflex flexible connections of types PKPU and PU-UF15 in areas containing explosive dust air mixtures

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1 General Information

Report No.	EX/12639-2/18
Classification	Confidential
Title	Declaration for safe use of Filcoflex flexible connections of types PKPU and PU-UF15 in areas containing explosive dust air mixtures
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Summary	In this report the safe application of certain types of flexible connections manufactured by Filcoflex for use inside dust hazardous areas and containing explosive dust air mixtures, has been assessed. The material PKPU and PU-UF15 are just dissipative (based upon surface resistance). They can be safely used in relation to static hazards for flexible connections with maximum length of 1000 mm inside dust hazardous environments and/or containing such dust mixtures for all dust dust-air mixtures with minimum ignition energies larger than 1 mJ provided the in-and outside surface of the flexibles are connected to earth. They shall never be used in case of flammable gases and vapors, hybrid flammable gas/vapour/dust-air mixtures and in case of dusts with minimum ignitions energies less than 1 mJ. The minimum ignition energy values referring to in this report shall be determined following DIN EN 13821, IEC 61241-2-3 and without induction in the circuit. Also the temperature influence of the on the minimum ignition energy shall be considered.
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1. Introduction

Flexible connections are often used in the process industry for transport of powders and granules. In the transport through those flexible connections static charging may occur that under certain conditions may lead to hazardous static discharges. Those discharges might lead to ignition of potential explosive mixtures both in and outside the flexible and thus lead to dust explosions.

This document describes the potential ignition risks due to flexible connections and assesses whether the Filcoflex flexibles using PKPU and PU-UF15 materials can be safely used inside hazardous dust areas and/or containing explosive dust air mixtures.

2 Hazards when using flexibles

With regard to TRGS727, respectively IEC 60079-32-1, materials or objects can be classified in relation to conductivities as following:

- According to their **surface resistance** at test conditions of 23 (±2)°C and 25 (±5)% relative humidity as ***conductive*** (<10^4 Ohm), as ***dissipative*** (10^4 Ohm up to 10^{11}Ohm) or as ***insulating*** (>10^{11} Ohm).
- According to their **volume resistance** at test conditions of 23 (±2)°C and 25 (±5)% relative humidity as ***conductive*** (<10^4 Ohmm), as ***dissipative*** (10^4 Ohmm up to 10^9 Ohmm) or as ***insulating*** (>10^9 Ohmm).

When product flows through flexibles, both the product and the flexibles might become charged electrostatically. The charge on the flexibles, when they are ***insulating*** will tend to accumulate on the flexibles. At a certain point the field strength on the flexibles can become so high that spontaneous electrostatic discharges occur:

- Corona discharges which are ***not hazardous*** for dusty products.
- Brush discharges which are ***not hazardous*** for dusty products as long as we are dealing with pure dusts with MIE>1 mJ (minimum ignition measured without induction).

- Propagating brush discharges in case of extreme charging. Because of the internal charging due to product transfer the outside of the flexible might also become charged by counter charge: bipolar charge. This means that at the inside e.g. the charge has become -20 kV but at the outer side +20 kV. If the potential difference becomes higher than the break down voltage of the flexible material, finally a so-called propagating brush discharge can develop. Such discharges can reach 1 J and thus are ***hazardous*** for most combustible dusts.

- Flexibles in general are not conductive, so cannot lead to spark discharges. If they are conductive as long as they are well earthed, no sparking occurs.

Note, that when flexible connections get charged they also cause an electrostatic field radiating to the outside. This charge may affect non-grounded conductive objects by charging through influention.

In former standard EN 13463-1 for non-electrical equipment for use in potentially dust explosive atmospheres, the use of plastic materials is in fact not limited in size or surface *except* if propagating brush discharges are possible. Then additional demands for the materials are necessary.

The charge on the flexible connections, when they are ***dissipative or conductive*** will tend to run off to earth, provided of course that there is an earth path available.

So, summarizing:

- Insulating flexibles (based upon surface resistance) only may become a hazard for dusts when high charging occurs that under certain conditions may lead to *propagating brush discharges*. Also *brush discharges* can occur.
- Dissipative flexibles (based upon surface resistance) are safe but may become a hazard at charging due to *spark and brush discharges* when not earthed.
- Conductive flexibles (based surface resistance) are safe but may become a hazard at charging due to *spark and brush discharges* when not earthed.

Such high charging can generated easily by pneumatic transport but also can be expected in metal chutes with flexibles where product falls through at high flow rates (more than 2 m/s) e.g. at emptying big bags, in longer chutes after blenders which are emptied etc.

In pneumatic transport the minimum length of a flexible at which charge levels become so high that propagating brush discharges can be triggered can be as small as 100 mm for extreme cases, but in general will be more than 300 mm.

Regarding chutes there is some expert discussion about the minimum height at which the charging levels can become so high that propagating brush discharges can be generated, but at the moment is regarded as a minimum height of 3 m.

In flexibles used for sieves in general these flow rates are not very high since the fall height is small and thus also less charging expected.

The diameter of flexibles is hardly influencing static charging levels on the flexible materials since the flow rates at of the product at the interface of the hose influences charging of the flexible.

When inside an insulating or even dissipative (based upon surface resistance) flexible connection ***non-earthed*** metal reinforcement rings are imbedded, these rings may charge in case of product transport through those flexibles: this may lead to spark discharges breaking through the flexible material. The potential energy of those rings will depend upon the ring diameter and built-up voltage: in practice a ring with diameter of 200 mm may create sparks with estimated potential energy of less than 5 mJ assuming the charging voltage is 30 kV. This energy level will increase proportional with its diameter.

3 ATEX114 and flexible connections

Since flexible connections do not contain an inherent energy source or contain moving parts, they do ***not*** fall under ATEX114 and thus need no certificate when used inside hazardous area.

Of course in the same way as e.g. in simple piping they still can lead to ignition sources (static discharges) when used in a process, due a flowing and charging product when e.g. parts are not earthed well or non-conductive parts are used etc.

Flexibles may give rise to corona, brush and propagating brush discharges when non-conductive but only in combination with the product flowing through it. In case of imbedded non-earthed metal reinforcement rings, also sparking can be expected.
Such cases fall under the Machine Directive and a manufacturer shall indicate that their product is safe for its expected use e.g. by a test report that the material used is conductive or dissipative.

4 Can Filcoflex type PKPU and PU-UF15 be used safely inside dust explosion hazardous areas?

4.1 Description of Filcoflex flexibles of type PKPU and PU-UF15

The flexible connections are made out of poly-urethane based flexible materials. The several connecting PU parts are plastic welded to ensure a high strength. The thickness of the flexibles varies from 1.49 mm to 2 mm.

The PKPU and PU-UF15 materials are tested and approved for direct contact with food and drugs following all European guidelines and FDA.

The PKPU and PU-UF15 materials have been tested for conductive properties and also have been tested whether possible propagating brush discharges are possible. The results are given in the following table.

Product	Thickness (mm)	Surface resistance (DIN EN 1149-1) (Ω)	Volume resistance (DIN EN 1149-2) (Ωm)	Propagating brush discharges possible?
PKPU	2	$2\ 10^{11}$	$2\ 10^{10}$	No
PU-UF15	1.49	$2\ 10^{11}$	$5\ 10^{10}$	No

Note that propagating brush discharge testing has been done on a sheet sample of 220x360 mm and 220x440 mm, using test voltages up to 70 kV.

From the data of the table it can be concluded that the PKPU and PU-UF15 can be defined as just dissipative based upon surface resistance.

Propagating brush discharges could not be triggered. Other discharges are no issue as long as the materials are earthed on the in-and outside surface.

4.2 Can Filcoflex flexibles using type PKPU and PU-UF15 materials be used safely inside dust explosion hazardous areas?

When extrapolating the found results, propagating brush discharges also are not expected at larger dimensions of the flexibles e.g. flexibles with diameter of 1 m and/or length of 1 m. Also other types of hazardous static discharges are not expected as long as the flexible connections are earthed on the in-and outside surface.

This means that at in and outside of these flexibles no hazardous static discharges are expected and thus these types of materials can be safely used for flexibles inside dust explosion hazardous atmospheres and containing explosive mixtures. Of course when using metal reinforcement rings these rings shall be earthed well.

- The materials PKPU and PU-UF15 are just dissipative (surface resistance). They can be safely used in relation to static hazards for flexible connections with maximum length of

1000 mm inside dust hazardous environments and/or containing such dust mixtures for all dust dust-air mixtures with minimum ignition energies larger than 1 mJ provided the in-and outside flexibles are connected to earth.

- They shall never be used in case of flammable gases and vapors, hybrid flammable gas/vapour/dust-air mixtures and in case of dusts with minimum ignitions energies less than 1 mJ.

The minimum ignition energy values referring to in this report shall be determined following DIN EN 13821, IEC 61241-2-3 and without induction in the circuit. Also the temperature influence of the on the minimum ignition energy shall be considered.

5 Documentation

Documentation used:

(1)	Test reports WJI, TL12639/18, 8 August 2018. Determination of the safety characteristics of different Poly Urethane Samples for Filcoflex B.V., Kaatsheuvel, The Netherlands.
(2)	Filcoflex Product catalogue 2014
(3)	IEC/TS 60079-32-1 Ed. 1.0: 2013-08. Technical Specification. Explosive atmospheres Part 32-1: Electrostatic hazards, guidance.
(4)	ATEX 114: Directive 2014/34/EU of the European Parliament and the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres.
(5)	ATEX 2014/34/EU Guidelines: Guide to application of the directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the law of the Member States relating to Equipment and Protective systems intended for use in Potentially Explosive Atmospheres, April 2016.
(6)	EN 13463-1: Non-electrical equipment for use in potentially explosive atmospheres - Part 1: Basic method and requirements, 2009.