REPORT

Declaration for safe use of Filcoflex flexible connections of types “PKSR 2 mm Silicone with Polyester knitted inner Ply” and “PTFE 2120 Natural FDA” in areas containing explosive dust air mixtures

Report No. EX/9075/14

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INBUREX Consulting
Gesellschaft für Explosionsschutz und Anlagensicherheit mbH
August-Thyssen-Str. 1
D-59067 Hamm

Phone: +49 (0) 23 81 27 16 10
Fax: +49 (0) 23 81 27 16 20
E-mail: infos@inburex.com
Internet: www.inburex.com

Managing Director:
Dr. Bernd Broeckmann
Sitz der Gesellschaft: Hamm
Amtsgericht Hamm HRB 1523

1 General Information

Report No.	EX/0975/14
Classification	Confidential
Title	Declaration for safe use of Filcoflex flexible connections of types "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA" in areas containing explosive dust air mixtures
Author	Gerard van Laar, M. Sc.
Summary	In this report the safe application of certain types of flexible joints manufactured by Filcoflex inside dust hazardous areas and containing explosive dust mixtures, has been assessed. The materials "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA" can be safely used in relation to static hazards for flexibles up to a maximum length of 1000 mm for all situations containing dust-air mixtures with minimum ignition energies larger than 1000 mJ. In cases of low transport rates (product transport velocity less than 2 m/s) they can be used for flexibles up to a maximum length of 1000 mm for dust-air mixtures with minimum ignition energies larger than 10 mJ. In case of short flexibles (less than 100 mm) they can be safely used inside dust for all situations containing dust-air mixtures with minimum ignition energies larger than 1 mJ. 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.
Client	Filcoflex BV Veerweg 19 5171 PW Kaatsheuvel The Netherlands
Contact Person	Werner van Loon Tel +31 (0) 416 286 242 Email: werner@filcoflex.com
Contractor	INBUREX GmbH, Hamm

Section Brand- und Explosionsschutz

Place, Date Hamm, 19.06.2015

Signatures

Dr.-Ing. Bernd Broeckmann Managing Director	Ir. Gerard van Laar Project Manager

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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 "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA" can be safely used inside hazardous dust areas containing explosive dust air mixtures.

2 Hazards when using flexibles

When product flows through flexibles, both the product and the flexibles might become charged electrostatically. The charge on the flexibles when they are ***not conductive or not static dissipative*** 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 Energy measured without induction, following DIN EN 13821, IEC 61241-2-3).
- Propagating brush discharges in case of extreme charging. Because of the internal charging due to product transfer, also the outside of the flexible might also become charged by counter charge attracted from atmosphere (via charged dust particles) or created by transport of charge over the surface by conductive layers on the outside (e.g. due to wet surface): 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. Note that when the flexible is backed with a conductive and earthed layer or even spirals for reinforcements the counter charge can be formed very easily and also lead to these propagating brush discharges. Such discharges can reach 1 J and thus are ***hazardous*** for most dusty and combustible products.

- Flexibles in general are not conductive, so cannot lead to spark discharges.

Note, that when the flexibles charge they also cause an electrostatic field radiating to the outside. This charge may affect not grounded conductive objects by charging through influention.

In standard EN 13463-1 for non-electrical equipment for use in potentially 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.

With regard to TRBS 2153, respectively IEC 60079-32-1, materials or objects can be classified:

- 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).

So, summarizing, insulating or dissipative flexibles only may become a hazard when very high charging occurs that under certain conditions may lead to *propagating brush discharges*.

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 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 also less charging expected.

The diameter of flexibles is hardly influencing static charging levels on the flexible materials, since it is the speed and mass flow rates that influence the charging of the flexible surface (interaction and charging takes place at the contacting surface).

3 ATEX95 and flexible connections

Since flexible connections do not contain an inherent energy source or contain moving parts, they do ***not*** fall under ATEX95 and thus need no certification when used inside zoned areas. The situation is comparable with a simple metal pipe, which still can lead to ignition sources when used in a process, where due to flowing product static charging occurs, leading to static sparks when the metal parts are not bonded.

In the case here flexibles may give rise to corona, brush and propagating brush discharges when the materials are non-conductive or dissipative but only in combination with the product flowing through it.

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 stating that the material used, is sufficiently conductive or dissipative.

4 Can Filcoflex type "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA" be used safely inside dust explosion hazardous areas?

4.1 Description of Filcoflex flexibles of types "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA"

PKSR or Polyester Knitted-fabric Silicone Rubber:

This material consists of polyester knitted fabric with a 1 mm silicone layer on each side. This material is glued, stitched or adhered in to a flexible connector or joint. The thickness is 2.000 mm.

PTFE 2120 Natural FDA or Poly Tetra Fluor Ethylene Natural Colour FDA compliant version:

This material consists of a PTFE multi layer laminated film. This material is thermoformed or welded in to a flexible connector or joint. The thickness 0.508 mm.

Both materials are tested and approved for direct contact with food and drugs in accordance with FDA and European Guidelines.

4.2 Electrostatic test results

Both materials have been tested for conductive properties and it also has been tested whether possible propagating brush discharges are possible. This has been tried up to a foil dimension of 0.6 by 1.2 m. The results are given in the following table.

Product	**Surface resistance (DIN EN 1149-1) (Ω)**	**Volume resistance (DIN EN 1149-2) (Ωm)**	**Break down voltage (kV)**	**Propagating brush discharges have been produced during testing?**
PKSR 2 mm Silicone with	$1.9\ 10^{9}$	$2\ 10^{13}$	>20	Yes

Polyester knitted inner Ply				
PTFE 2120 Natural FDA"	1.8 10^{10}	>3 10^{13}	>20	Yes

Note that propagating brush discharge testing has been done on a sheet sample of 300 by 600 mm and on 600 by 1200 mm. The test voltage for propagation brush discharges was 30 kV or higher.

From the data of the table it can be concluded that the materials as such are both *insulating* looking at volume resistance but looking at surface resistance *dissipative*.

In spite of being dissipative in both cases it was very easy to create propagating brush discharges, even for smaller surface areas (less than 200 by 300 mm). ***This means that for powders with MIE less than 1000 mJ ignition hazards can be expected when enough static charging is involved.***

4.3 Can Filcoflex type "PKSR 2 mm Silicone with Polyester knitted inner Ply" and "PTFE 2120 Natural FDA" be used safely inside dust explosion hazardous areas?

At the testing it was possible under the given conditions to create the hazardous propagating brush discharges. This means that these types of materials shall only be used in certain situations where such discharges are not to be expected due to the flowing and/or charging processes or are no ignition hazard for the product involved. The flexibles may be used safely under the following conditions:

- Flexibles up to a maximum length of 1000 mm for all situations containing dust-air mixtures with minimum ignition energies larger than 1000 mJ.
- In case of low transport rates (product transport velocity up to about 2 m/s) they can be used for flexibles up to a maximum length of 1000 mm for dust-air mixtures with minimum ignition energies larger than 10 mJ.
- In case of short flexibles (less than 100 mm) they can be safely used for all situations containing dust-air mixtures with minimum ignition energies larger than 1 mJ.

- 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 unless specific expertise investigation proves it can be applied without hazards.

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

5 Documentation

Documentation used:

(1)	Test report WJI TL9075/14. Determination of the safety characteristics of different products for Euro-Manchetten & Compensatoren B.V., dtd. 18th. May 2015
(2)	IEC/TS 60079-32-1 Ed. 1.0: 2013-08. Technical Specification. Explosive atmospheres Part 32-1: Electrostatic hazards, guidance.
(3)	ATEX 95: Directive 94/9/EG of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres.
(4)	ATEX Guidelines (second edition): Guidelines on the application of council directive 94/9/EC of 23 March 1994 on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres, 2012.
(5)	EN 13463-1: Non-electrical equipment for use in potentially explosive atmospheres - Part 1: Basic method and requirements, 2009.