REPORT

Declaration for safe use of Filcoflex silicon bellows in areas containing explosive dust air mixtures

Report No. TL/15270-1/21

Hamm, 26/04/2021

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

Phone: +49 (0) 23 81 973 110
Fax: +49 (0) 23 81 973 1199
E-mail: infos@inburex.com
Internet: www.inburex.com

Geschäftsführer:
Dr. Bernd Broeckmann
Dr. Klaus Hermann
Dipl.-Ing. (FH) Jörg Meistes
Sitz der Gesellschaft: Hamm
Amtsgericht Hamm HRB 1523

1 General Information

Report No.	EX/15270-1/21
Classification	Confidential
Title	Declaration for safe use of Filcoflex silicon bellows in areas containing explosive dust air mixtures
Author	Gerard van Laar, M. Sc.
Summary	In this report the safe application of a certain type of flexible bellow manufactured by Filcoflex inside dust hazardous areas and containing explosive dust air mixtures, has been assessed. In relation to static hazards this silicon material can be used safely in bellows having a maximum length of less than 100 mm of pure silicon, after a chute of less than 3 m and/or for flow rates less than 2 m/s inside dust hazardous dust environments and/or containing such mixtures for only combustible dusts having 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.
Client	Filcoflex BV Luxemburgstraat 3 5171 PK Kaatsheuvel The Netherlands
Contact Person	Werner van Loon Email: werner@filcoflex.com Tel.: +31 (0) 416 764 764
Contractor	INBUREX GmbH, Hamm
Section	Brand- und Explosionsschutz
Place, Date	Hamm, 26/04/2021
Signatures	

Gerard van Laar, M. Sc.
Senior Consulting Scientist

Dipl.-Ing. (FH) Jörg Meistes
Managing Director

Contents

1. Introduction

Bellow 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 the application of bellows made out of silicon, whether the bellows 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 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 flexible materials, both the product and the flexible materials might become charged electrostatically. The charge on the flexible material, when they are ***insulating,*** will tend to accumulate on the flexible material. At a certain point, the field strength on the flexible material 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 material 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 breakdown 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 and are well earthed, also no sparking can occur.

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 not limited in size or surface *except* if propagating brush discharges are possible. Then additional demands for the materials are necessary.

The charge on 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 flexible materials (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 well earthed.

Such high charging can be easily generated by pneumatic transport but also can be expected in chutes where product falls through at high flow rates (more than 2 m/s): e.g. at emptying big bags and in longer than 3 m chutes 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 the charging levels can become so high that propagating brush discharges can be generated after 3 m of chute length.

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.

3 ATEX114 and flexible connections

Since flexible connections do not contain an inherent energy source or contain fast 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. 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.

Flexible materials may give rise to corona, brush and propagating brush discharges when the materials are 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 silicon bellows used safely inside dust explosion hazardous areas?

4.1 Description of Filcoflex Silicon Weighing Bellow and its electrostatic properties

The bellow is made from Silicon based flexible material. The Silicon bellow is fixed to connecting flanges with stainless steel clamps.

The thickness of the flexible is less than 1 mm.

The material Silicon is tested and approved for direct contact with food and drugs following all European guidelines and FDA.

This Silicon material has also been tested for conductive properties and has been tested whether possible propagating brush discharges are theoretical possible. The results are given in the following table.

Resistance over the flanges (IEC60079-32-1) (Ω)	**Resistance over the material (IEC60079-32-1) (Ω)**	**Volume resistivity (IEC60079-32-1) (Ωm)**	**Breakdown voltage (DIN EN 60243 1+2) (kV)**
>2 10^{12}	>2 10^{12}	3 10^{12}	>20 kV

From the data of the table, it can be concluded that the Silicon bellow can be defined as insulating. Based upon the break down being larger than 4 kV, propagating brush discharges theoretically can be being triggered under certain conditions.

High charging may also lead to corona and brush discharges. Only for combustible dusts with minimum ignition energy of less than 1 mJ, such brush discharges might be a hazard.

4.2 Can Filcoflex Silicon bellows be used safely inside dust explosion hazardous areas and containing combustible dusts?

In relation to static hazards this silicon material can be used safely in bellows having a maximum length of less than 100 mm of pure silicon, after a chute of less than 3 m and/or for flow rates less than 2 m/s inside dust hazardous dust environments and/or containing such mixtures for only combustible dusts having 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.

5 Documentation

Documentation used:

(1)	Test reports WJI, TL15270/21, 22 April 2021. Determination of electrostatic characteristic of sample siliconen balgen of Filcoflex B.V 5171 PK Kaatsheuvel Niederlande.
(2)	IEC/TS 60079-32-1 Ed. 1.0: 2013-08. Technical Specification. Explosive atmospheres Part 32-1: Electrostatic hazards, guidance.
(3)	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.
(4)	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.
(5)	EN 13463-1: Non-electrical equipment for use in potentially explosive atmospheres - Part 1: Basic method and requirements, 2009.