VOITH

Safe Drive Solutions with Fluid Couplings in Potentially Explosive Atmospheres

Voith Turbo fluid couplings have been used successfully for decades under the harsh conditions of underground mining. In order to handle new applications and comply with new regulatory requirements, these couplings have been reengineered. New components and locking devices have been added to increase functional reliability and equipment availability.

EC Directive 94/9/EC (ATEX 100a) has been in effect and mandatory since July 1, 2003. Areas endangered by dust are now covered in addition to applications in potentially explosive atmospheres underground and areas where gases pose a hazard. Dust that can create a risk of explosion is frequently generated when handling bulk materials (e.g., coal). Furthermore, this directive defines requirements for the safety of mechanical components in potentially explosive atmospheres.

This document discusses the basic principles and aspects that must be taken into account when handling bulk goods and when using mechanical components in potentially explosive atmospheres.

1. Introduction

Combustible dusts are frequently generated during handling, storing and processing of bulk materials in many branches of industry such as

- Grain and food processing
- Grain storage (silos)
- Transporting and storing coal
- The pharmaceutical and chemical industries
- Mining

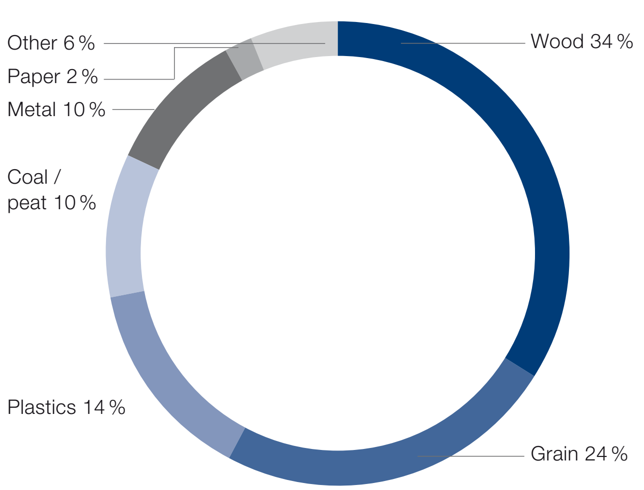
there is a significant potential for hazard involving both fire and explosion. The hazard results not only from swirling, dust-containing clouds, but also layers of dust that have accumulated over longer periods of time. Figure 1 presents a breakdown of the types of dust and their contribution to explosions [1].

Under certain conditions, these dusts can trigger explosions. These conditions require the simultaneous presence of:

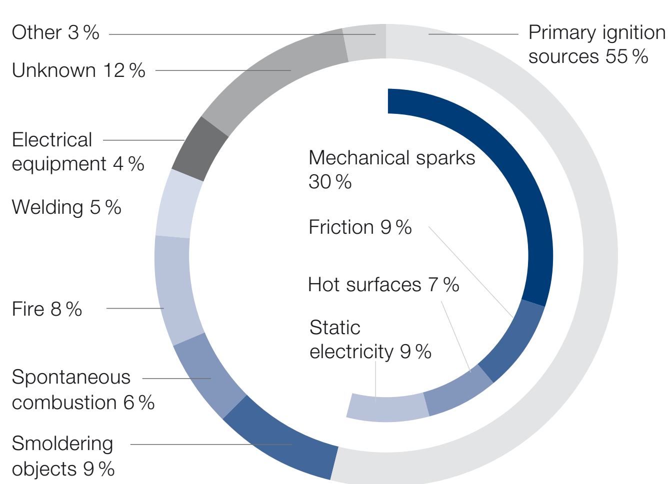
- Combustible material
- Oxygen
- An ignition source

The most important objective of explosion protection is to prevent the appearance of an ignition source. In mechanical equipment, this means mechanically generated sparks, friction, hot surfaces and electrostatic charge. These are the cause of the explosion in more than 50 % of cases (Fig. 2) [1].

Types of dust and their contribution to explosions (1)



Contribution of various ignition sources to explosions (2)



2. Legal framework and standards

Figure 3 presents an overview of current European standards. Directive 94/9/EC (ATEX 100a) describes the requirements for manufacturers of components, machinery and equipment. This standard has been in effect for all new installations since July 1, 2003. This directive applies throughout the EU, in underground mines and in potentially explosive industrial atmospheres. It applies in any situation where there is a risk of explosion from gas or dust. It includes new requirements for non-electrical (mechanical) equipment for which there were previously no uniform requirements. In addition, protective systems and safety devices come under its jurisdiction. As a consequence, explosion protection is treated much more comprehensively than in the past.

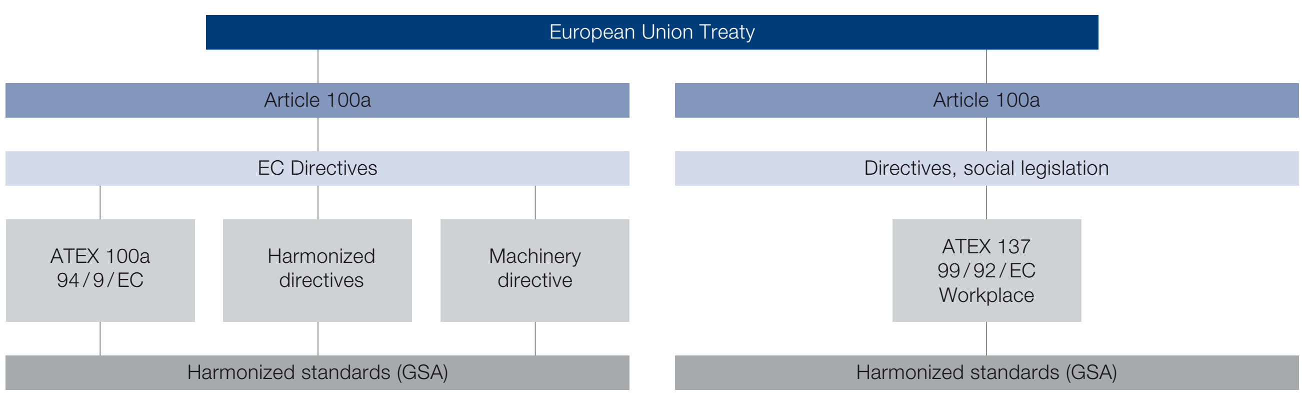
Directive 99/92/EC (ATEX 137) deals with questions relating to its appropriate application, i.e. safety in the workplace. This standard has also been in effect since July 1, 2003. It is important to note that, as of July 1, 2006, even existing equipment must be operated in compliance with the new directive.

Operation of equipment in compliance with ATEX 100a largely ensures compliance with ATEX 137. The standards have merely defined fundamental safety requirements, especially with regard to explosion protection for mechanical components. This reinforces the personal responsibility of the manufacturer, making it possible to apply the latest available technology know-how without delay and to the greatest possible extent. On the other hand, the topic of mechanical explosion protection is still relatively new, and many manufacturers, design engineers and developers must first acquire experience and knowledge about this complex subject.

When constructing equipment and machinery, the following points must be taken into consideration:

- Misuse that can reasonably be anticipated
- Design in accordance with testing/inspection and maintenance conditions
- Selection of materials in view of aging and wear
- Protection against other dangers
- Overloading of equipment
- Dangers due to outside factors

Overview of European regulations (3)



3. Zone concept – Equipment categories – Certification

Directive 99/92/EC defines certain zones (Table 1) to describe the frequency of hazard occurrence. This includes how often and for how long a potentially explosive dust atmosphere can occur in an area. The zone classifications 0, 1, 2 designate potentially explosive gas atmospheres. The zone designations 20, 21, 22 apply to dust atmospheres.

Zone 20 is the area in which a potentially explosive atmosphere exists in the form of a combustible dust cloud frequently, continuously or for long periods of time. This is the case, for instance, inside containers and pipes or inside enclosed conveying equipment.

Zone 21 is a zone where the potentially explosive atmosphere occurs occasionally during normal operation and if there is a malfunction. Examples include: Filling and discharge locations; poorly sealed transfer stations; conveying equipment in enclosed spaces where the material being stored is far away from the drive unit.

Zone 22 classifies areas where, under normal operating conditions, a combustible dust cloud seldom occurs or, if so, then only for short periods. Such areas include those where dust seeps from seals, accumulates and can be stirred up occasionally. The operator is responsible for specifying the zone.

Depending on the zone, the equipment used is not allowed to exhibit any ignition source when the equipment is operating under normal operating conditions, or experiences frequent or occasional malfunctions. Since correspondingly harmonized standards do not yet exist, it is up to the manufacturer of the equipment to specify the operating conditions that are to be considered as normal operation and those to be considered as a malfunction. By way of example, here is a definition for normal operation of a bucket lift: Operation at rated capacity, at startup and with interruptions must be taken into account. If there is a possibility of overloading or overfilling, the overloaded or blocked condition must be considered as normal operation if the frequency of occurrence is high enough. The blocked condition should in any case be classified as a frequent malfunction, which means that it must be taken into consideration for use in Zone 21.

These operating conditions must also be given appropriate consideration when designing the components of equipment. In this regard, the equipment manufacturer should supply appropriate information to the component supplier.

When equipment is used in certain zones, it must belong to the corresponding equipment category (see Table 2). The identification code G stands for gas; D stands for dust. The manufacturer is responsible for presenting an EC Type Examination Certificate for all equipment requiring certification (Fig. 4). Mechanical devices such as drive components, for instance, are used most frequently in Zone 21 or 22. In this case, submittal of the certification documents [1] (prior to delivery) to a notified body is sufficient (Fig. 5).

Safety systems such as the BTS Ex "Safety Device for Limitation of Maximum Surface Temperature of Voith Fluid Couplings in acc. with 94/9/EC" are generally constructed from type-tested components (Figs. 4, 7).

Zone definition (Table 1)

	Presence of a potentially explosive atmosphere	No active ignition sources
Zone 0 Zone 20	Continuously or for a long period of time	In normal operation and during infrequent malfunctions and in the case of two independent faults
Zone 1 Zone 21	Occasionally	In normal operation and in the case of frequent malfunctions
Zone 2 Zone 22	Seldom and for short periods	In normal operation

Equipment category – Certification (Table 2)

Zone in acc. with EC Dir. 99/92/EC	Certification required for components		Equipment category in acc. with EC Dir. 94/9EC
	Electrical	Mechanical	
Zone 0 Zone 20	Yes	Yes	Category 1GD
Zone 1 Zone 21	Yes	Yes [1]	Category 2GD
Zone 2 Zone 22	Yes [1]	No [2]	Category 3GD

[1] Documents submitted to notified body
[2] Self-certification and declaration of conformity


Prüf- und Zertifizierungsstelle
ZELM Ex

(1) EG-Baumusterprüfbescheinigung

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen – **Richtlinie 94/9/EG**

(3) EG-Baumusterprüfbescheinigungsnummer

ZELM 03 ATEX 0128 X

(4) Gerät: Näherungssensoren Typen CB..., CC..., CJ..., NC..., NJ..., SC..., SJ...

(5) Hersteller: Pepperl + Fuchs GmbH

(6) Anschrift: D-68307 Mannheim

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Prüf- und Zertifizierungsstelle ZELM Ex bescheinigt als benannte Stelle Nr. 0820 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie.

Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht Nr. ZELM Ex 0840217167 festgelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

prEN 61241-0: 2002 31H/143/CD (IEC 61241-11): 2002

(10) Falls das Zeichen "X" hinter der Bescheinigungsnummer steht, wird auf besondere Bedingungen für die sichere Anwendung des Gerätes in der Anlage zu dieser Bescheinigung hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konstruktion, Überprüfung und Tests des spezifizierten Gerätes oder Schutzsystems in Übereinstimmung mit Richtlinie 94/9/EG. Weitere Anforderungen der Richtlinie können für das Herstellungsverfahren und die Lieferung dieses Gerätes oder Schutzsystems gelten. Diese sind von vorliegender Bescheinigung nicht abgedeckt.

(12) Die Kennzeichnung des Gerätes muß die folgenden Angaben enthalten:

Ex II 1 D Ex iaD 20 T... °C

Zertifizierungsstelle ZELM Ex

Braunschweig, 28.03.2003

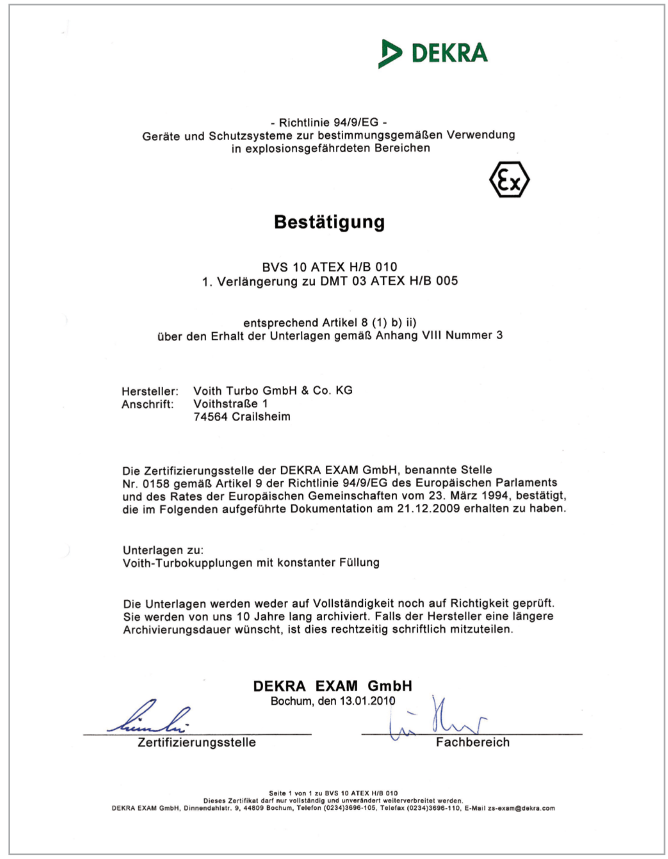
Dipl.-Ing. Harald Zelm

Seite 1/5

EG-Baumusterprüfbescheinigungen ohne Unterschrift und ohne Stempel haben keine Gültigkeit. Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung der Prüf- und Zertifizierungsstelle ZELM Ex

Prüf- und Zertifizierungsstelle ZELM Ex • Siekgraben 56 • D-38124 Braunschweig

4 Type-examination certificate
Example: Proximity switch for a non-contacting thermal switch unit for a Voith fluid coupling.


DEKRA

- Richtlinie 94/9/EG -
Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen

Bestätigung

BVS 10 ATEX H/B 010
1. Verlängerung zu DMT 03 ATEX H/B 005

entsprechend Artikel 8 (1) b) ii)
über den Erhalt der Unterlagen gemäß Anhang VIII Nummer 3

Hersteller: Voith Turbo GmbH & Co. KG
Anschrift: Voithstraße 1
74564 Crailsheim

Die Zertifizierungsstelle der DEKRA EXAM GmbH, benannte Stelle Nr. 0158 gemäß Artikel 9 der Richtlinie 94/9/EG des Europäischen Parlaments und des Rates der Europäischen Gemeinschaften vom 23. März 1994, bestätigt, die im Folgenden aufgeführte Dokumentation am 21.12.2009 erhalten zu haben.

Unterlagen zu:
Voith-Turbokupplungen mit konstanter Füllung

Die Unterlagen werden weder auf Vollständigkeit noch auf Richtigkeit geprüft. Sie werden von uns 10 Jahre lang archiviert. Falls der Hersteller eine längere Archivierungsdauer wünscht, ist dies rechtzeitig schriftlich mitzuteilen.

DEKRA EXAM GmbH
Bochum, den 13.01.2010

Zertifizierungsstelle Fachbereich

Seite 1 von 1 zu BVS 10 ATEX H/B 010
Dieses Zertifikat darf nur vollständig und unverändert weiterverbreitet werden.
DEKRA EXAM GmbH, Dinnendahlstr. 9, 44809 Bochum, Telefon (0234)3696-105, Telefax (0234)3696-110, E-Mail zs-exam@dekra.com

5 Confirmation of submittal of certification documents to a notified body
Example: Voith fluid coupling with a constant filling.

4. Areas with dust hazard

4.1 Classification

The following values characterize the conditions under which dusts pose a risk of explosion or fire:

- Ignition temperature (of the explosive gas / air mixture)
- Glow temperature / minimum ignition temperature (of a dust layer with a thickness > 5 mm)
- Explosion limits; minimum ignition energy
- Explosive force of combustion

Starting from the ignition temperature, the maximum surface temperature of the device is calculated using the following formula:

$T_{Max\ surface} < 2/3 \cdot T_{Ign}$

Starting from the glow temperature, the maximum surface temperature is calculated using the following formula:

$T_{Max\ surface} < T_{Glow} - 75\ °K$

The lower of the 2 calculated values is always the one to use when specifying the temperature class or the maximum permissible surface temperature. Standardized temperatures are used to designate the temperature class for gases (e.g. Temperature class T3 corresponds to 200 °C), refer to Fig. 6. This standardized designation does not exist for dusts. It is common to designate the temperature class in the following manner: e.g., T 200 °C.

Table 3 lists a variety of different dusts with their characteristic values for ignition temperature, the glow temperature and the maximum surface temperatures calculated from them. A comprehensive collection of values is listed in Table 3.

The properties of the dust depend on:

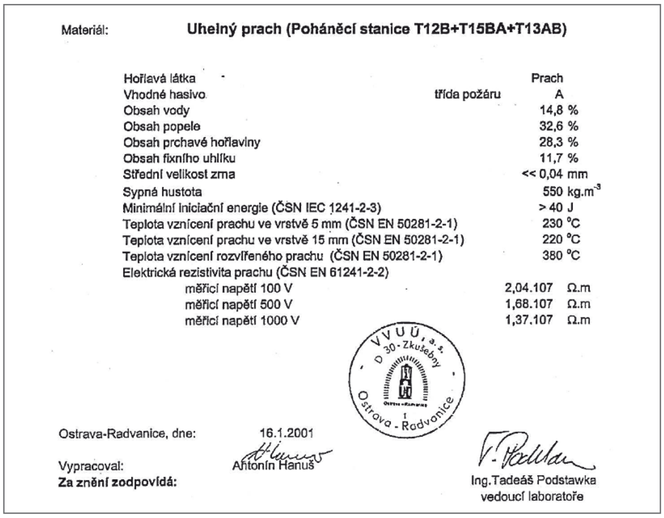
- The thickness of the dust layer (a thickness of 50 mm reduces the maximum surface temperature by up to 60 % compared to the value for a thickness of 5 mm [1]
- Particle size
- Moisture content

Determining the maximum permissible surface temperature of equipment in a potentially explosive atmosphere is the responsibility of the equipment operator.

Characteristics of potentially explosive dusts – maximum surface temperature of the equipment (Table 3)

Source: HVBG (Hauptverband der gewerblichen Berufsgenossenschaften / Federation of Commercial Employers' Liability Associations BIA Report 13/978) BIA Berufsgenossenschaftliches Institut für Arbeitssicherheit	Ignition temperature	Glow temperature	Maximum permissible surface temperature
	°C	°C	°C
	Dust		
Organic products			
Wood/wood fibers			
Cellulose	420	335	260
Paper	490	300	220
Peat	460	290	210
Wood	400	280	200
Foodstuffs / grain			
Animal feed	420	280	200
Meat-and-bone meal	400	350	260
Barley	380	280	200
Corn (maize)	380	310	230
Wheat	380	280	200
Malt	380	310	230
Sugar	310	420	200
Sunflowers	430	350	260
Cocoa	560	250	175 [1]
Coffee	470	270	195
Fat concentrate	420	350	270
Fish meal	430	Melts	280
Flowers	340	Melts	220
Fructose, glucose, lactose	340	Melts	220
Gelatin	480	450	320
Milk powder	350	320	240
Potatoes (potato flour)	420	300	220
Rapeseed	410	350	270
Rice	370	290	210
Soy	390	290	210
Starch	380	280	200
Tea	510	300	220
Tobacco	410	280	200
Coal			
Activated charcoal	540	335	250
Charcoal	520	270	195
Coke	470	330	250
Anthracite	460 … 720	250 … 450	175 [1]
Lignite	380 … 500	240 … 300	165 [1]
Synthetics / resin / rubber			
ABS	430		280
Glass fiber-reinforced plastic	490	380	300
Plastics	410	340	260
Polyamide, polyester, polyethylene	440	Melts	290
Pharmaceuticals / cosmetics / fertilizers			
Pesticides	370	320	240
Other			
Cement	630	450	370
Inorganic products			
Aluminum	560 … 820	280 … 450	200
Iron	430	350	270
Phosphorus	400	340	260
Sulfur	280	280	185

[1] A hazard and risk analysis developed specifically for these dusts (Section 4.2.) permits use of the Voith fluid coupling with a higher temperature class, e.g., 180 °C.



Materiál: **Uhelný prach (Poháněcí stanice T12B+T15BA+T13AB)**

Hořlavá látka		Prach
Vhodné hasivo	třída požáru	A
Obsah vody		14,8 %
Obsah popele		32,6 %
Obsah prchavé hořlaviny		28,3 %
Obsah fixního uhlíku		11,7 %
Střední velikost zrna		<< 0,04 mm
Sypná hustota		550 kg.m^{-3}
Minimální iniciační energie (ČSN IEC 1241-2-3)		> 40 J
Teplota vznícení prachu ve vrstvě 5 mm (ČSN EN 50281-2-1)		230 °C
Teplota vznícení prachu ve vrstvě 15 mm (ČSN EN 50281-2-1)		220 °C
Teplota vznícení rozvířeného prachu (ČSN EN 50281-2-1)		380 °C
Elektrická rezistivita prachu (ČSN EN 61241-2-2)		
měřicí napětí 100 V		2,04.107 Ω.m
měřicí napětí 500 V		1,68.107 Ω.m
měřicí napětí 1000 V		1,37.107 Ω.m

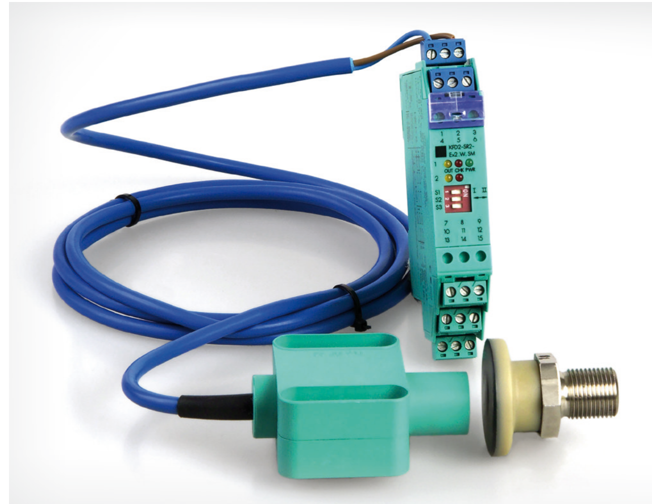
VVUÚ, a.s. D 30 - Zkušebny Ostrava - Radvanice

Ostrava-Radvanice, dne: 16.1.2001

Vypracoval: Antonín Hanuš

Za znění zodpovídá: Ing.Tadeáš Podstawka, vedoucí laboratoře

6 Material examination conducted by a power plant operator in the Czech Republic.



7 Non-contacting thermal switch unit for for limiting the surface temperature.

4.2 Use of Voith fluid couplings in a coal dust-laden environment

Depending on the type and origin, coal dusts can have different chemical compositions and thus, different material properties. The operators of power plants, coal processing and coal transportation equipment are responsible for determining the specific material properties required by ATEX for the risk analysis. Fig. 6 shows an example of a material examination of this type conducted by a power plant operator in the Czech Republic.

The material values for the coal used are:

- Ignition temperature of the coal dust/air mixture: 380 °C
- Glow temperature (minimum ignition temperature) of a coal dust layer < 5 mm: 220 °C
- Glow temperature (minimum ignition temperature) of a coal dust layer > 5 mm: 230 °C

The safety analysis for Voith fluid couplings considers the following hazard sources that can arise during use in areas with the potential for a coal dust explosion:

a) Explosion of the coal dust-containing cloud – ignition temperature 380 °C.

Here, the max. surface temperature of the component used may not exceed 2/3 of the ignition temperature. The temperature class of the fluid coupling must be lower than the specified maximum surface temperature of 253 °C.

b) Smoldering layers > 5 mm catching fire – ignition temperature 220 °C

Here, the max. surface temperature of the component on which the dust layer has collected must be 75 °K below the glow temperature (minimum ignition temperature). This criterion therefore yields a temperature of 145 °C.

The Voith fluid coupling is a rotating component on which layers capable of smoldering cannot collect over a large area. In addition, it is recommended that the surface be cleaned in the event of severe soiling in order to allow heat to dissipate from the coupling, which is necessary for proper operation and the maintenance of low oil temperatures.

The risk that coal dust deposits in the vicinity of the coupling could catch fire can be eliminated by using a BTS non-contacting thermal switch unit that is Ex-certified as a protection system for proper operation in potentially explosive atmospheres in compliance with 94/4/EC ATEX 100a. The BTS Ex prevents melting of the fusible plugs and subsequent release of the operating fluid. This ensures that no hot equipment comes into contact with layers in the surroundings capable of smoldering.

Thus, even if the Voith fluid coupling has a maximum surface temperature of 180° C, for instance, it is nevertheless possible to provide the safety required for coal, which actually requires a lower temperature class, by using the BTS Ex-certified protection system.

In most cases, Voith fluid couplings are used in Zones 21 and 22 for the temperature class T180 °C.

The BTS Ex non-contacting thermal switch unit is shown in Fig. 7. The actuation temperature of 140 °C established for the BTS Ex permits startup of long belt conveyors and high starting frequencies. This ensures a high level of operational reliability.

8 Voith Turbo fluid couplings for use in potentially explosive atmospheres. Overview of zone classification, equipment category, temperature classes.

5. Equipment

Equipment intended for use in potentially explosive atmospheres must be identified. The identification of mechanical equipment must contain the following information:

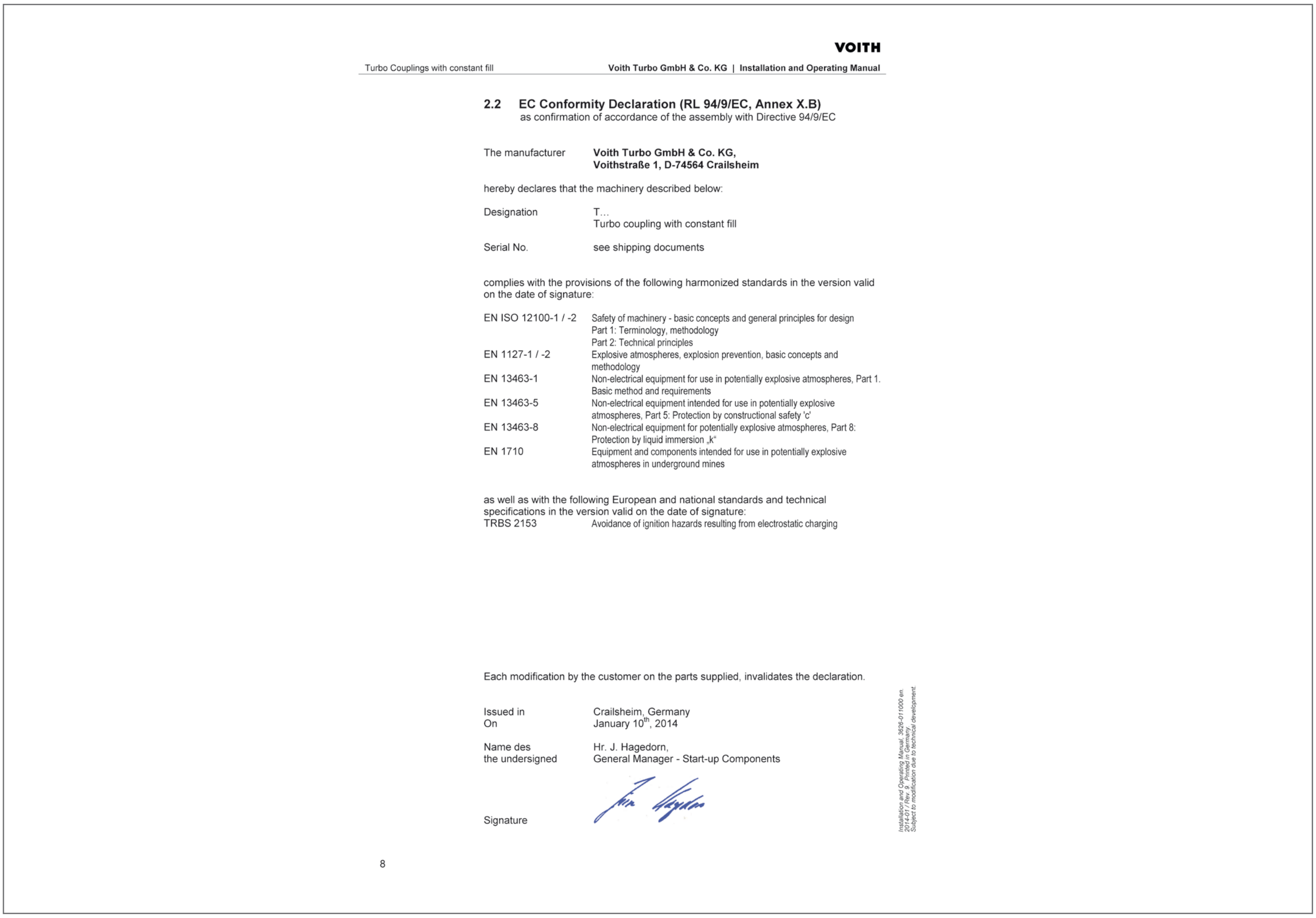
- Name and address of the manufacturer or the trade name
- Type designation
- Serial number
- Maximum surface temperature (except for equipment in Equipment Group I if this temperature is below 150 °C)
- Ex
- Equipment group
- D for dust, G for gas
- Equipment category
- Protection class
- CE

Examples of the identification used on Voith fluid couplings include:

CE Ex II 2GD cb 200 °C X for industrial use

CE Ex I M2 cb-X for mining

Additional information can be found on the poster Cr12d (Fig. 8), which be ordered from Voith Turbo, Crailsheim.



VOITH

Turbo Couplings with constant fill — **Voith Turbo GmbH & Co. KG | Installation and Operating Manual**

2.2 EC Conformity Declaration (RL 94/9/EC, Annex X.B)
as confirmation of accordance of the assembly with Directive 94/9/EC

The manufacturer	**Voith Turbo GmbH & Co. KG,** **Voithstraße 1, D-74564 Crailsheim**

hereby declares that the machinery described below:

Designation	T… Turbo coupling with constant fill
Serial No.	see shipping documents

complies with the provisions of the following harmonized standards in the version valid on the date of signature:

EN ISO 12100-1 / -2	Safety of machinery - basic concepts and general principles for design Part 1: Terminology, methodology Part 2: Technical principles
EN 1127-1 / -2	Explosive atmospheres, explosion prevention, basic concepts and methodology
EN 13463-1	Non-electrical equipment for use in potentially explosive atmospheres, Part 1. Basic method and requirements
EN 13463-5	Non-electrical equipment intended for use in potentially explosive atmospheres, Part 5: Protection by constructional safety 'c'
EN 13463-8	Non-electrical equipment for potentially explosive atmospheres, Part 8: Protection by liquid immersion „k“
EN 1710	Equipment and components intended for use in potentially explosive atmospheres in underground mines

as well as with the following European and national standards and technical specifications in the version valid on the date of signature:

TRBS 2153	Avoidance of ignition hazards resulting from electrostatic charging

Each modification by the customer on the parts supplied, invalidates the declaration.

Issued in On	Crailsheim, Germany January 10th, 2014
Name des the undersigned	Hr. J. Hagedorn, General Manager - Start-up Components
Signature	

Installation and Operating Manual, 3626-011000 en.
2014-01 / Rev. 9. Printed in Germany.
Subject to modification due to technical development.

8

9 Declaration of Conformity – Example of Voith fluid coupling with constant filling.

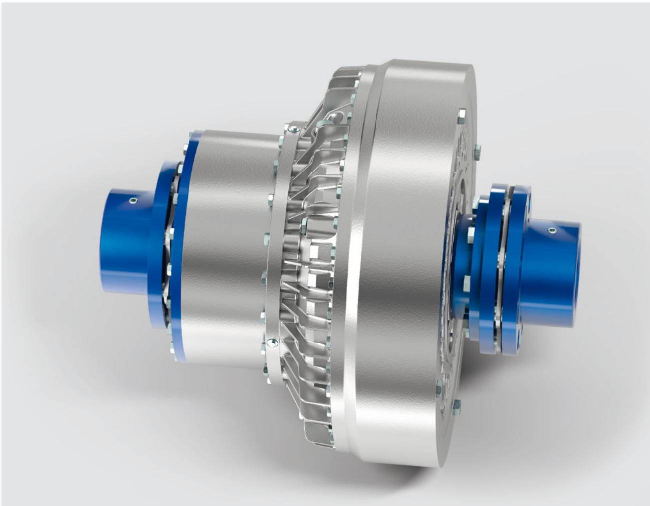
The declaration of conformity supplied with device or machine must state the office or agency where the certification documents are on file. In addition, reference to Directive 94/9/EC and the standards and guidelines used for certification must be included (Fig. 9).

The operating instructions must include the essential operating parameters and directions necessary to ensure proper

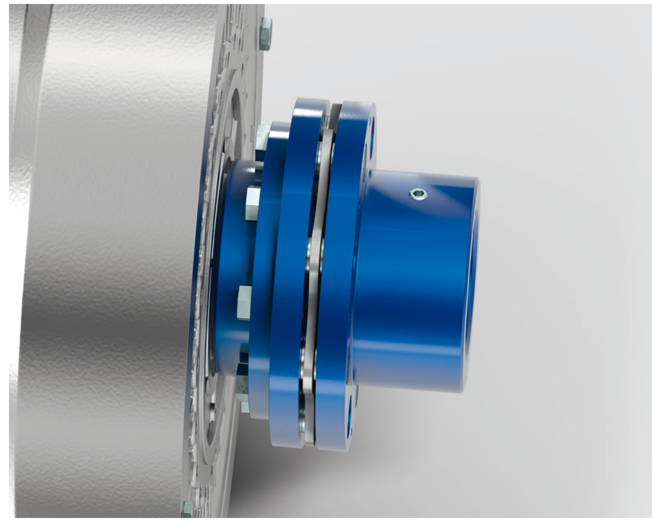
- Commissioning
- Use
- Assembly / disassembly
- Maintenance and
- Special conditions

as well as information relating to foreseeable improper use. Sales documents must not contain information that contradicts the operating instructions.

If the technical design does not provide the necessary level of safety (technical safety), the operating instructions may require additional administrative measures (administrative safety). These may include, for instance, the requirement to attach warning labels, specifications for certain modes of operation, installation of additional safety devices or frequent maintenance intervals. The following contains examples in the form of excerpts from operating instructions:
"The maximum permissible number of startups must not exceed 5/hour." (excerpt from the operating instructions for "Motors for use in potentially explosive dust-laden atmospheres")
"Perform a visual inspection and wear test on the elastic material after 2000 h, but no later than 3 months after commissioning.
… and perform subsequent inspections at regular intervals of 4000 h, but at least once a year." (excerpt from the operating instructions for a "flexible connecting coupling")
To avoid high maintenance and operating costs or undesirable restrictions on operation, the operating instructions should be reviewed prior to purchase. Alternatively, requirements for simple, low-cost maintenance can be specified.



10 GPK all-metal disk pack coupling



11 In place of elastic elements, the all-metal disk pack coupling contains maintenance-free, corrosion-resistant steel disks with a durable design.

6. Connection couplings for use in potentially explosive atmospheres

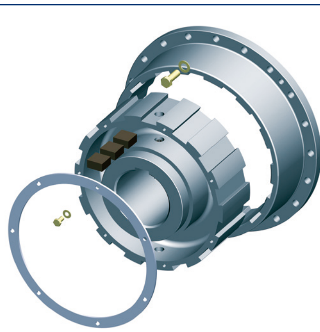
Voith can overcome the disadvantages of regular inspection of the flexible coupling described in Section 5 through use of suitably modified connection couplings.

The EPK flexible pad coupling (Fig. 12) transmits torque via elastic rubber elements that generate minimal reaction forces when displaced. The metal surfaces of the hub and flange do not contact each other even if the elastic elements fail as the result of wear (air gap A, Fig.13). Thanks to this design, it is not necessary to inspect the elastic elements yearly for wear and document the inspection. In the event of failure, the consequential costs are low, since only the elastic elements, which are identical for all coupling sizes in use, need to be replaced. The use of identical elastic elements for all coupling sizes ensures a simple and low-cost spare parts inventory. For drive solutions with a brake or when radial disassembly of the Voith Turbo fluid coupling from the drive is required, the GPK all-metal disk pack coupling can be used instead (Fig. 11).

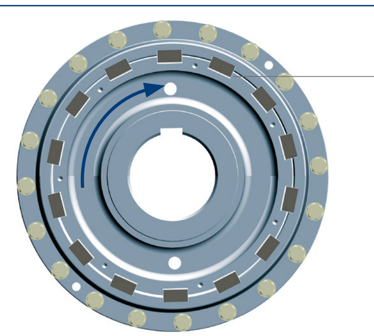
The GPK connection coupling offers the following specific advantages when used in potentially explosive atmospheres:

- As a result of the two-sided disk pack design, the coupling's weight is distributed evenly to the motor and gearbox shafts. This results in lower bearing loads than with flexible connection couplings. The consequently extended bearing change interval, which must be observed to prevent the risk of ignition during use in potentially explosive atmospheres, increases the service life of the equipment and lowers maintenance costs.
- When a GPK is used, only a visual inspection is needed instead of mandatory documentation of a wear measurement. With an appropriate drive layout, the visual inspection can be conducted while the equipment is operating. This translates into a considerable reduction in operating costs.

EPK flexible pad coupling (12)



EPK flexible pad coupling with air gap (13)



7. Literature

[1] Wolnarek, D.: Explosion Prevention and Protection. Ex-Zeitschrift No. 33/2001, pp. 37/50

Voith Turbo GmbH & Co. KG
Voithstr. 1
74564 Crailsheim, Germany
Tel. + 49 7951 32 - 409
Fax + 49 7951 32 - 213
startup.components@voith.com
voith.com/fluid-coupling

VOITH
Engineered Reliability