HOW TO PROTECT INDUSTRIAL PROCESSES FROM FIRE AND DUST EXPLOSION

PROCESS KNOW-HOW, SCIENTIFIC FACTS AND CUSTOMER ADAPTED SOLUTIONS BY FIREFLY – FOR GREATER SAFETY AND PRODUCTIVITY

PREVENTIVE PROTECTION SYSTEMS FROM
fireflyab
SWEDEN

Anything that has been transformed into fine particles can explode. Unfortunately, all too often it does.

Every year, many serious fires and explosions occur in industrial plants as a result of dust. Yes, dust. Fine inflammable material is explosive! The statistics speak for themselves. Dust explosions lead to considerable material damage and long production shutdowns. Every year there are also accidents with fatal consequences.

In order for a dust explosion to take place, the material must have a low moisture content, the dust particles must be of a certain size and the amount of fine particles per unit of volume must lie within certain critical values. An ignition source is also needed such as flames, sparks, embers or hot bodies.

The temperature needed for ignition is much lower than most people think. Almost all organic material in the form of a dust cloud will ignite at temperatures below 500° C - approximately the same temperature as a newly extinguished match.

The actual explosion does not normally occur in the conveying line in which the fine particles are being transported, but in high-risk zones such as filters, silos and cyclones. In other words, places where dust concentrations can vary considerably and easily attain critical values.

A good way to protect against fire and dust explosions is to ensure that ignition sources can not end up in these high-risk zones. Firefly offers a unique protection system which detects and neutralizes ignition sources within milliseconds.

HIGH-RISK ZONES

- Filters
- Silos
- Cyclones
- Chutes

MINIMUM IGNITION TEMPERATURES

	CLOUD	LAYER
COCOA	580° C	460° C
PAPER	580° C	360° C
COTTON	560° C	350° C
CHARCOAL	520° C	270° C
CELLULOSE	500° C	380° C
WOOD	480° C	260° C
TOBACCO	470° C	280° C
PEAT	470° C	320° C
COFFEE	460° C	450° C

Source:
Dust explosions in the process industries, second edition.
Rolf K Eckhoff

A preventative protection system must be able to detect so-called hot bodies with temperatures down to the relevant minimum ignition temperature of the material. Example: wood dust in layer can ignite at 260° C, according to Eckhoff. Compare with the temperatures of a newly extinguished match, which is around 500° C.

Flammable gas in a cigarette lighter is ignited by the sparks created when metal strikes against metal. Independent laboratory tests, however, show that a single mechanical steel spark has very little chance of igniting wood dust.

Heat of friction arises when there is direct contact between moving machine parts. This heat of friction is often transferred to a stored flammable material which, when heated, becomes a dangerous source of ignition itself.

EXAMPLE OF IGNITION SOURCE GENERATORS

- Mills
- Saws
- Fans
- Dryers
- Grinders
- Bearings

All fires and explosions have an ignition sequence

In industrial processes, ignition sources may be generated at many stages of the process or in machine components. Ignition sources exist in many different forms, but they all have one thing in common: they often cause fine particles to ignite. The consequences are costly, in the form of production downtime, mechanical damage and at worst a serious fire or explosion which can cause serious injury.

The most common sources of ignition are those which arise within the production equipment itself - when metal strikes metal, or by heat generated in the process. Mills, saws, fans, grinders, dryers and overheated bearings are the most common generators of ignition sources. It is also common for worn parts, as well as foreign objects such as stones, nails, nuts and other loose components to increase the risk of generating sources of ignition that could cause fire or explosion.

In order to prevent fires and explosions, one must have a good knowledge of the process and the process equipment. By analysing the potential areas where ignition can occur a comprehensive prevention system can be designed.

WHAT MAKES AN IGNITION SOURCE DANGEROUS?

EXAMPLES

	SPARK	>1000° C	0,005 JOULE
	HOT BODY	~500° C	1 JOULE

The type and size of the ignition source affects the risk and thus productivity

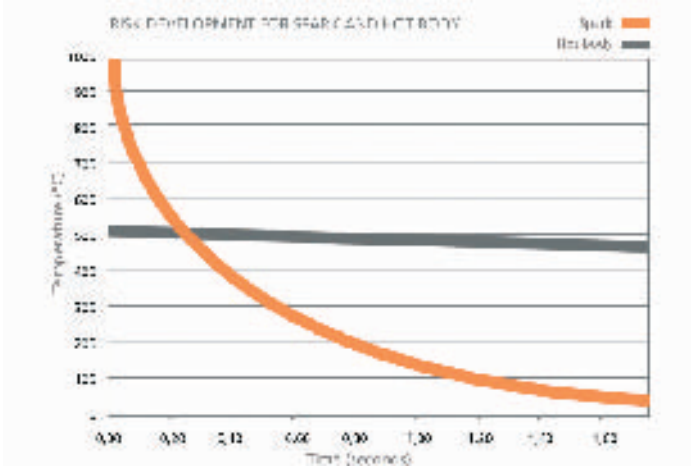
To a varying degree, sources of ignition can be found in all industrial plants. When combustible materials are present, ignition sources will have a negative effect on safety and productivity.

Experience and research show that effective detection of ignition sources is decisive in reducing risks and ensuring uninterrupted productivity in industrial processes. Effective detection, however, is dependent upon two main factors:

First ensuring that detection is not affected by irrelevant energy sources such as daylight, indoor lighting etc. is a pre-requisite to any fire safety system. With some detection systems it is not uncommon for production to stop due to a false alarm triggered by ambient conditions with full extinguishing applied as a result.

Second, it is important to be able to discriminate between different degrees of risk and the threat that they impose. Many systems are unable to make the distinction between a small spark or a hot body and thus trigger the same reaction regardless of their potential risk. Usually hot bodies are a greater hazard. They have a greater energy and longer life than sparks. For that reason, hot bodies require more comprehensive detection and extinguishing than sparks.

In a preventive protection system, it is of outmost importance to be able to indicate the radiated energy and the number of particles, since this will affect both the degree of risk and productivity. It is also essential to be able to adapt the extinguishing action to suit the size and risk of the ignition source.



Hot bodies at a lower temperature than sparks yet with a larger mass pose a higher risk.

Sparks, such as those from sparklers, have a high temperature but little mass. On the other hand, the hot stick of the sparkler has a lower temperature but much greater mass. This means that the stick, but not the sparks, can be used to light a cigarette. Firefly's preventive system detects both sparks and hot bodies.

Risk Analysis – The key to a safer process

Firefly's products are not sold as individual components, only as complete systems. Since no two applications are the same, every system is tailor-made for the particular duty.

All projects involve comprehensive design and calculation work. We benefit considerably from our process know-how and our experience of similar installations.

An important phase in each project is a Risk Analysis. In order to determine where the hazards are and how they are to be eliminated, we can make use of drawings of the plant and basic process data: the material and the quantity being conveyed, particle size, moisture in various sections of the process, temperatures, conveyor diameters, capacity of the fans etc.

Based on this information, and using our experience of similar processes, we can determine where the detectors and the extinguishing zones should be located to achieve a safety level and a cost effective solution.

It is important to design the extinguishing system in such a way that the process will have to be halted only in extreme emergencies. By using the ability of the Firefly system to measure the radiated energy of hot bodies and sparks, the extinguishing action can be adapted to conform to the current risk situation.

Detection down to the right temperature...

All fires and dust explosions have an ignition sequence. An effective means of protection is to neutralise these small amounts of energy before they manage to ignite the fine particles.

The most important component in the Firefly system is the range of patented infra-red (IR) detectors, which not only detects sparks, but also hot bodies with temperatures as low as 130° C. Conventional detectors available in the market are detecting light from a spark and are therefore incapable of detecting hot bodies with temperatures below 700° C.

The detectors have a 180° field of view. This means that a single detector is normally sufficient to cover the entire cross-section of a process conveyor.

Each detector has seven control zones. In order for the detector to trigger an alarm, an ignition source must be registred in three zones. This design provides a high level of security against false alarms, but also means that the detector reacts equally rapidly irrespective of the speed of the material flow. The alarm is triggered if the ignition source passes the detector.

Flame detection

Firefly has a range of flame detectors for different applications, in open areas and in enclosed volumes. In open areas the most reliable detector is the combined UV/IR flame detector. By combining IR and UV wavelengths the detector will efficiently recognise flames but discriminate other energy sources, such as lamps, sunlight and even arc welding. In enclosed volumes fire can easily become a big problem if time is given for the fire to grow. Therefore, Firefly uses fast acting IR flame detectors that will detect flames at a very early stage without the common problem of being daylight sensitive.

The hemispherical lens is normally self-cleaning at speeds of over 10 m/s.

The detector does not react to daylight.

Each detector contains sensor elements specially developed and manufactured for Firefly.

The detector measures both the number of ignition sources and the highest registered energy value.

...and the best extinguishing methods available

The choice of extinguishing method is determined entirely by the process. Water is the most common extinguishing agent, provided the process permits its use. The water is sprayed under high pressure through our specially manufactured full-cone nozzles which distribute the water uniformly, generating a comprehensive extinguishing zone. The full-cone nozzles are robustly built and are insensitive to wear. They have varying angles of distribution and are selected according to the type of application.

Water mist as fire extinguishing medium is gaining ground and has proven to be very effective in fighting and controlling fires. It has a remarkable potential for suppressing fires and is causing minimal residual damage. Water mist is usually used in open areas for extinguishing developed flames.

Extinguishing with steam is an efficient and convenient method, provided that steam is available.

In some processes, gas is the most suitable extinguishing agent. Carbon dioxide and nitrogen are excellent extinguishing agents provided that the affected section of the process can be isolated. This is done with the help of Firefly's fast acting valves.

Our product range includes a large number of specially designed valves in varying sizes with closure times down to 50 ms.

Another extinguishing method used in the Firefly system is mechanical diversion. When an ignition source has been detected, a diverting valve is opened which rapidly re-routes the material flow out of the process flow for collection in a container. The process itself does not even have to be stopped.

System

A Firefly system can consist of several protection zones and Firefly has chosen a de-centralised system with a network structure, thus avoiding long cable runs and vulnerability due to remoteness between control unit, detection and extinguishing zones. With the Firefly network it is possible to connect several control units, CUE, to a master unit, MUE. The MUE is used to present information centrally. The Firefly solution keeps the installation cost to a minimum.

Some other benefits are:

- Flexibility

- Self-diagnostic function

- Battery back up in each unit

- User friendly

The system is menu-operated and very easy to use.

A service contract and training – Safety in the long term

A Firefly system is easy to install. The comprehensive documentation which comes with every system contains instructions as to where the components are to be fitted. Most customers prefer to have one of our service engineers on site at start-up to make a final test of system functions and to train the operators who will be responsible for the system.

The presence of ignition sources varies significantly between different processes. This means that some Firefly systems can be triggered at regular intervals. In some cases this frequency could be weekly and in other cases at much longer intervals. At all times however, the system must be ready for action and fully reliable. The best way of maintaining the system is by entering into a service contract. On a regular basis our service engineers will go through the system: testing the sensitivity of the detectors, checking the alarm functions, functiontesting valves and water nozzles and, most important of all, training the operators.

If the plant is expanded or altered, new risk situations can easily arise. Firefly should therefore be notified of any such changes. During visits, our service engineers can, when asked, discuss if the risk situation has been affected and can suggest measures to re-establish safety.

More than 4 000 installations worldwide

Firefly was founded in 1973. Over the years we have amassed a great deal of knowledge about how to safeguard different industrial processes from fire and dust explosions.

More than 4 000 Firefly systems have been supplied for the most varied applications all around the world.

Worldwide distribution network.

What is the safety level in your manufacturer process? Are there sections where a fire or dust explosion could occur?

If you have any questions about fire and dust explosions, please contact us.

We will be happy to share our experience with you.

Firefly AB
Phone: +46 (0)8 449 25 00
Fax: +46 (0)8 449 25 01
E-mail: info@firefly.se
www.firefly.se

Postal address
P.O. Box 92201
SE-120 09 Stockholm
Sweden

Visiting address
Textilvägen 1
Hammarby Sjöstad
SE-120 30 Stockholm
Sweden

Delivery address
Hammarby Allé 24
Hammarby Sjöstad
SE-120 30 Stockholm
Sweden

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