Kidde Fire Protection

GRAVINER

EXPLOSION PROTECTION

Kidde Fire Protection has worked closely for many years with a variety of industries to raise the awareness of explosion threats and to develop the most effective protection measures available to help reduce unnecessary exposure to explosion incidents. Kidde has the expertise to promote an understanding of explosions and is able to provide a wide range of solutions to suit almost any hazard.

Benefits

- Non-explosive actuation system
- High reliability
- Plant components do not have to be near a wall or roof
- Simple to retrofit
- Lower installation costs
- Suppressed pressures allow low plant strengths
- Various suppressants available: food and people compatibility
- Minimal effect on thermally insulated processes
- Explosion incident is contained within plant component
- Safe for plant operators
- Minimal maintenance
- Fast turnaround after explosion

Broad Capability

Industries which handle flammable liquids and gases or combustible dusts are required to prevent or restrict the propagation of explosions. Many everyday materials such as sugar, grain, starch and coffee are flammable and can form potentially dangerous dust clouds.

The requirement for a 'Graviner' Industrial Explosion Protection (IEP) system is unique. The chances are that it will be installed and remain totally passive for years, unattended apart for regular servicing. Yet, on the one occasion it is needed, it must respond without any risk of failure – in milliseconds.

Kidde Fire Protection's capability lies in a systems approach to a wide variety of industrial situations, from gas and chemical plant to pharmaceuticals, from milling and grinding to spraying and drying. And it is a fact that, where installed against a defined hazard, no 'Graviner' IEP system has ever failed.

Kidde Fire Protection has over 40 years experience in protecting process

Figure 1 Unconfined explosion

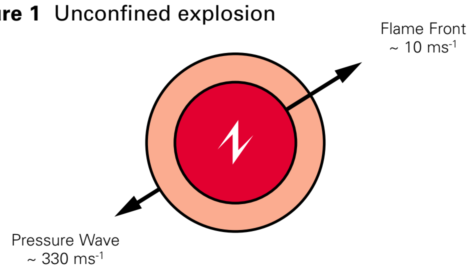


Figure 2

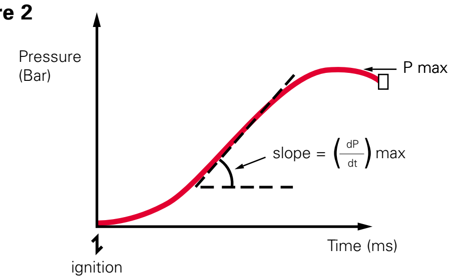
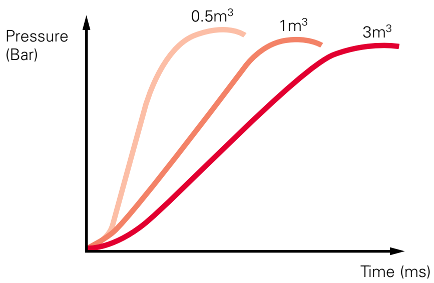


Figure 3 Confined explosion – Different volumes



industry from explosion risk, with over 3000 systems installed throughout the world. A continuous programme of research and development ensures the company is always ready to meet new industrial hazards.

Hazard Assessment

An explosion is not instantaneous but develops destructive pressures within plant components over a finite time. After ignition of an unconfined organic dust suspension, flame speed away from the point of ignition is approximately 10m/s (Figure 1). A pressure wave, which is formed ahead of the flame boundary, also moves away from the point of ignition, but at the speed of sound (approx 330 m/s). The greater speed of this pressure wave provides the basis of explosion detection.

When the same dust suspension occurs within an enclosure, instead of the pressure harmlessly dissipating into the atmosphere, upon ignition, it is confined and increased by combustion. A pressure/time graph for a typical dust explosion is shown in Figure 2. The rate of pressure rise (dp/dt max) and the maximum pressure (P max) are characteristics of the specific dust tested.

The explosibility parameters of the combustible dust must be determined before a protection system is designed. The rate of pressure rise dictates the time in which a selected protection system must be effective and this factor is dependant on the volume in which the explosion occurs; Figure 3 illustrates this, where the same explosible dust cloud is ignited in three different volumes. The rate of pressure rise is slower for larger volumes, thus allowing more time for explosion mitigation, than for smaller volumes.

Explosibility measurement of combustible dusts is undertaken in volumes of 20 litres, or 1m^3 and the results scaled up to the process vessel's volume.

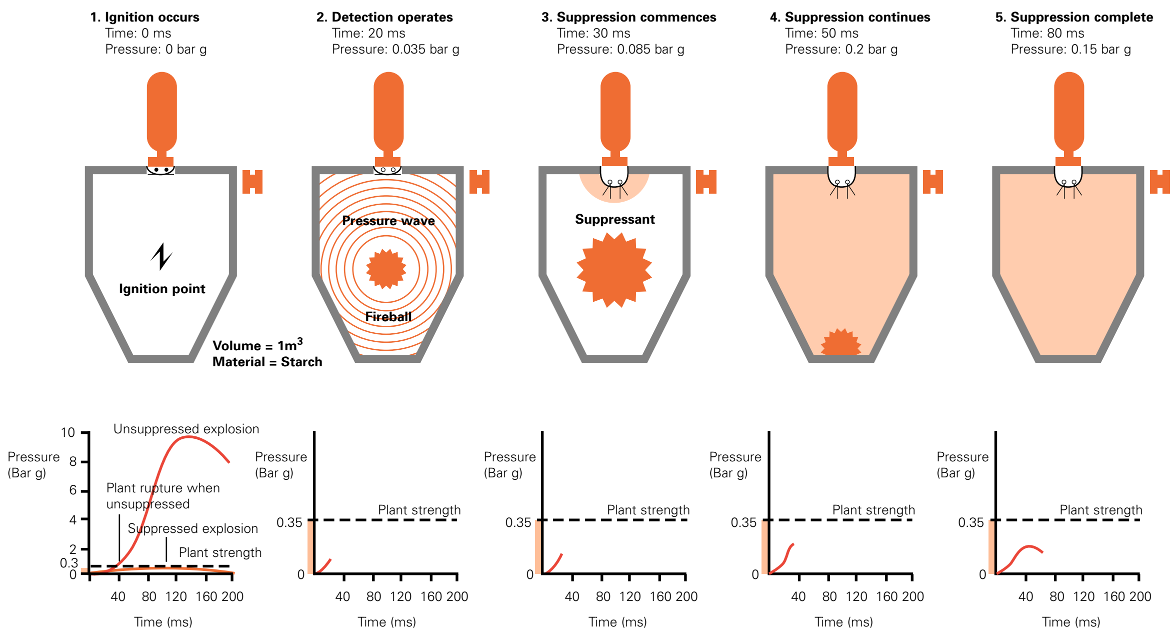
Dust Explosibility – Standard Tests

- Explosibility classification
- Minimum ignition temperature
- Minimum explosible concentration
- Minimum ignition energy
- Maximum permissible oxygen concentration to prevent ignition
- Maximum explosion pressure and rate of pressure rise

Typical Explosibility – Larger Test Apparatus

	Pmax (Bar)	Kst Bar ms^{-1}
Methane	8.4	58
Propane	8.3	103
Hydrogen	8.2	503
Coal dusts	8	70
Grain dusts	9	100
Polythene dusts	8	100
Cellulose dusts	8	140
PVC dusts	9	160
Flour	10	190
Stearate	7	225
Dyestuffs	11	340
Aluminium dusts	13	1000

Explosion suppression sequence



The Process Industry

Typical applications for explosion protection are:

- Mills and grinders
- Belt and bucket elevators
- Silos and hoppers
- Fluid bed and spray driers
- Vacuum receiving vessels
- Dust collection filters and cyclones

Explosion Suppression

Introduction of a suppressant at the earliest stage of an explosion, arrests immediately the growth of pressure before it reaches dangerous levels. Both the detection of the explosion and the introduction of the suppressant must take place within the vessel where the explosion is initiated.

The powder suppressant is discharged from cylindrical PHRD (Protractor High Rate Discharge) or HRD (High Rate Discharge) suppressors, which are available in 4, 16 and 35kg capacities.

In addition to extinguishing the explosion flame by chemical action and cooling, the suppressant inerts any unburned explosible mixture. Suppressant action removes heat from the flame front so that the temperature falls below the auto-ignition point and creates a barrier between the particles to prevent transfer of heat.

Explosion Relief Venting

This technique involves the installation of weak panels or active bursting panels on the plant component, to release the explosion flame and pressure into the atmosphere. The size of vent is dependant on plant strength, volume and potential explosion intensity. Post-venting fire protection should be considered to extinguish the subsequent fire.

Explosion Vent Suppression Hybrid

Where low strength plant components are being protected, or in the case of severe hazards, it may be necessary to fit overpressure relief panels (vents) in addition to a suppression system. This combination is also used to minimise flame ejection from a vented component.

Explosion Isolation Protection

Effective explosion protection of process components does not end with just primary explosion protection. A propagating fireball will follow the material line and accelerate along any connecting pipe as long as there is sufficient material to support combustion. Both active and passive techniques can be adopted to prevent explosion propagation.

Active explosion protection barriers are established by forming an inert chemical region within the pipe, extinguishing the flame whilst allowing pressure to dissipate further down the system; or by closing a valve within the duct, thus containing flame

and pressure in the hazard region. Passive explosion isolation can be provided by rotary valves or tube screw conveyors, provided they are suitable for the application and can be interlocked.

Offshore Protection

Active Blast Mitigation System (ABMS)

Following the Cullen Report, the offshore industry was tasked with compiling safety cases for each offshore oil and gas installation in the UK sector. The primary objectives were to protect the crew, protect the asset and prevent environmental damage.

Much work has been undertaken to increase the understanding of the mechanism of an explosion in 'cluttered' environments. In its incipient stages a 'fast fire' can increase in intensity as it travels around machinery and through pipe racks. The blast wave travelling ahead of the flame front creates turbulence as it meets obstacles in its path. This increases the rate of burning, so raising the over-pressure. In these complex geometries it is possible to create a detonation where the flame front travels at great speeds and high pressures are generated.

The Active Blast Mitigation System (ABMS) concentrates on detecting the blast in its incipient stages and releasing extinguishant at the fireball thus "snuffing out" the flame and preventing the accumulation of potentially damaging blast waves.

Active Detonation Arresting System (ADAS)

The 'Graviner' ADAS concept is designed to prevent the propagation of flame in fuel carrying pipelines such as gas networks and vapour recovery processes. The system is capable of arresting detonations travelling at speeds of up to 4.5Km/second, utilising high speed detection and suppression systems combined with either explosion relief devices and rapid acting valves.

Suppression has been shown to be very effective in quenching the intense flame during a detonation and decoupling the associated shock wave. Even when the flame is completely extinguished, high residual pressures still exist in the pipe which, if allowed to propagate onwards, can be potentially devastating to process machinery or marine vessels connected to the pipe. Explosion vents can be used to relieve pressure to atmosphere, and rapid acting valves closed, thus shutting off the path for the blast wave. This combination has been shown in tests in the United Kingdom and United States of America, to be the most effective system available in the prevention of this high risk problem.

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