Dust Explosion Risk Management

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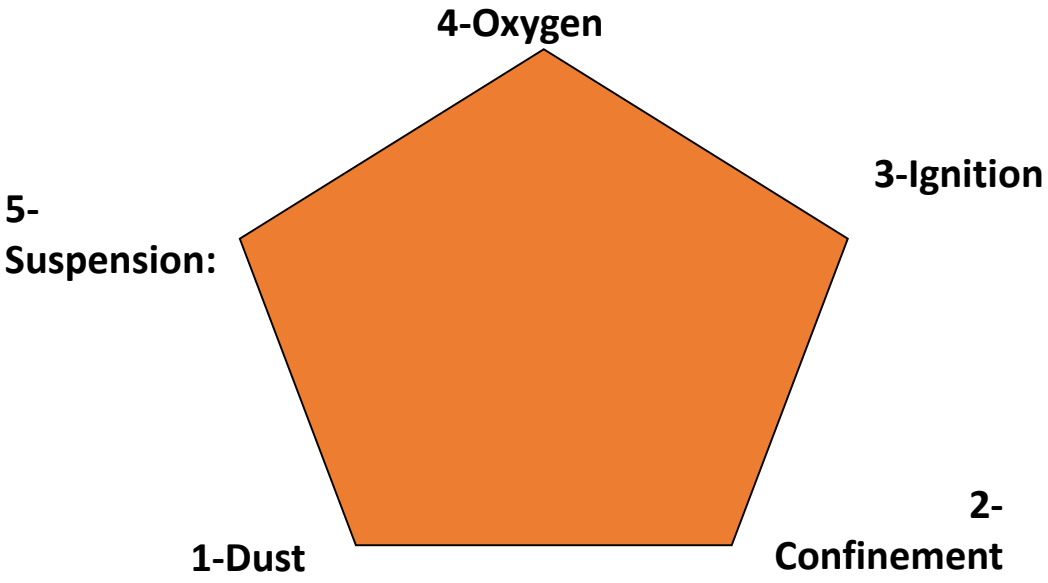
OSHA® FactSheet

Hazard Alert: Combustible Dust Explosions

Combustible dusts are fine particles that present an explosion hazard when suspended in air in certain conditions. A dust explosion can be catastrophic and cause employee deaths, injuries, and destruction of entire buildings. In many combustible dust accidents, employers and employees were unaware that a hazard even existed. It is important to determine if your company has this hazard, and if you do, you must take action now to prevent tragic consequences.

The Explosion Pentagon



How Dust Explosions Occur

In addition to the familiar fire triangle of oxygen, heat, and fuel (the dust), dispersion of dust particles in sufficient quantity and concentration can cause rapid combustion known as a deflagration.

If the event is confined by an enclosure such as a building, room, vessel, or process equipment, the resulting pressure rise may cause an explosion.

These five factors (oxygen, heat, fuel, dispersion, and confinement) are known as the “Dust Explosion Pentagon”. If one element of the pentagon is missing, an explosion cannot occur.

What is Dust Explosion? Why it is so Dangerous?

Saw / Sanding Dust Explosion Test

Coal/Sugar Dust Explosion Test

Dust Explosions produce:

Flame ball

(usually over 30 feet long in controlled venting)

Pressure Spike (usually over 100 psig if pressure contained within the equipment)-

Both occur in less than 100 milliseconds

Recent Explosions!

28 June 2015 **Taiwan Formosa Water Park explosion :**
13 deaths, over 500 injured!

Aug 12, 2015 Port of City of Tianjin Explosion ,
more than 175 deaths, hundreds injured!

Aug 22, 2015 Runxing Chemical Fty ,
Shandong,explosion 5 deaths, many injured!

Recent Accident in Japan!

Explosion at Arakawa Chemical 1 Dec 17

1 Dead, 3 wounded, 11 Lightly injured! Investigation taking place!

Pictures / Video taken on site on 18Jan18, 7 weeks after accident

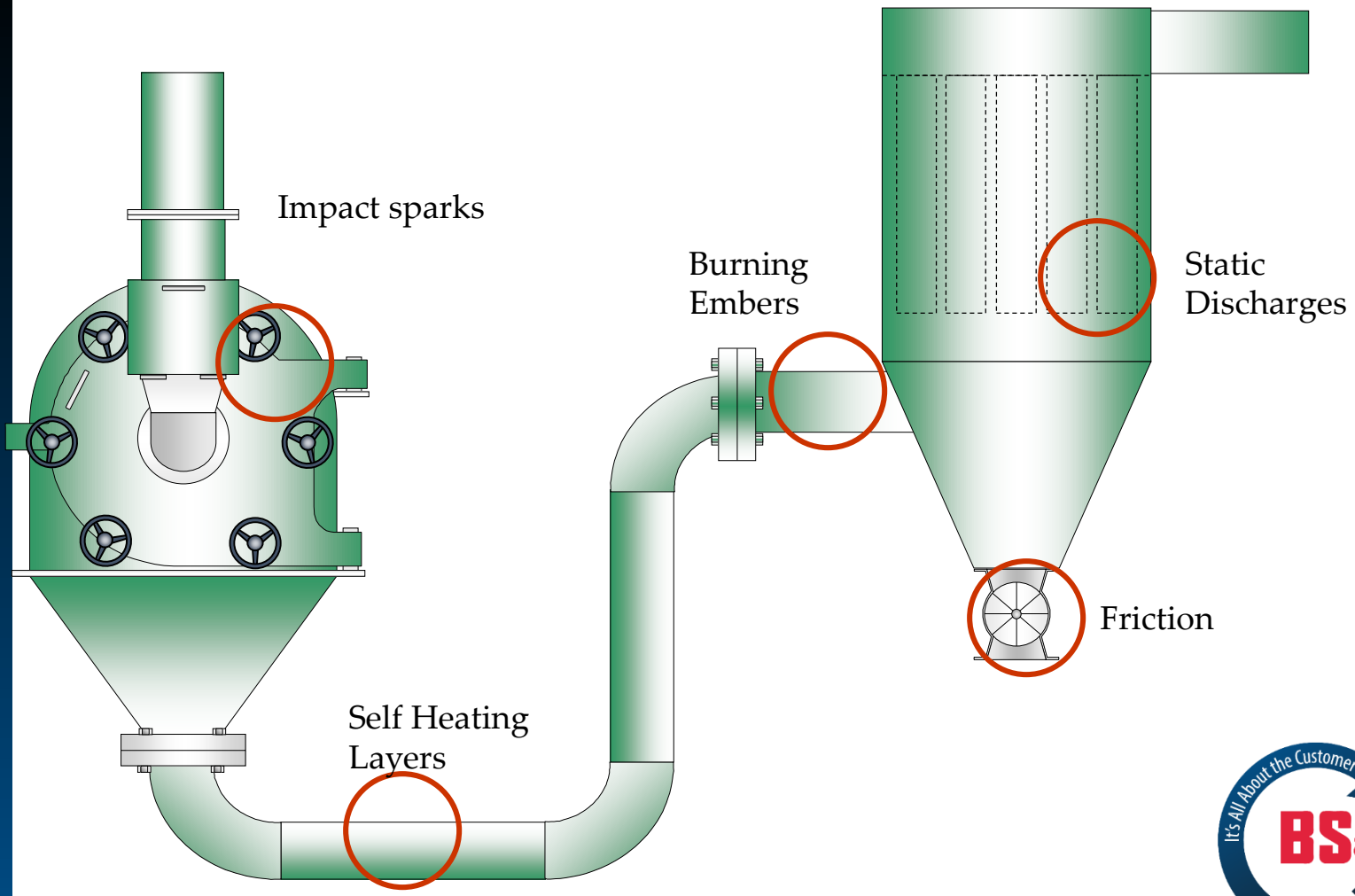
Difference between Fire Protection & Explosion Protection.

Fire
Time: Seconds.
Detection by:
Smoke detector.
Temperature.
CO monitoring system.

Dust Cloud Explosion
Time: **Milliseconds!**
Detection by:
Static Pressure Rise Sensor
Pressure Transducers

Explosion Cannot be detected by Smoke Detector. Temperature, Or CO, vice versus Fire Cannot be detected by Static Pressure Or Pressure transducers.

Example of common Ignition Sources



Key Combustible Dust parameters

Outline

Overview of Dust / Powder testing.
Kst / Pmax / MIE / MEC / MIT (Dust Cloud/Dust Layer)

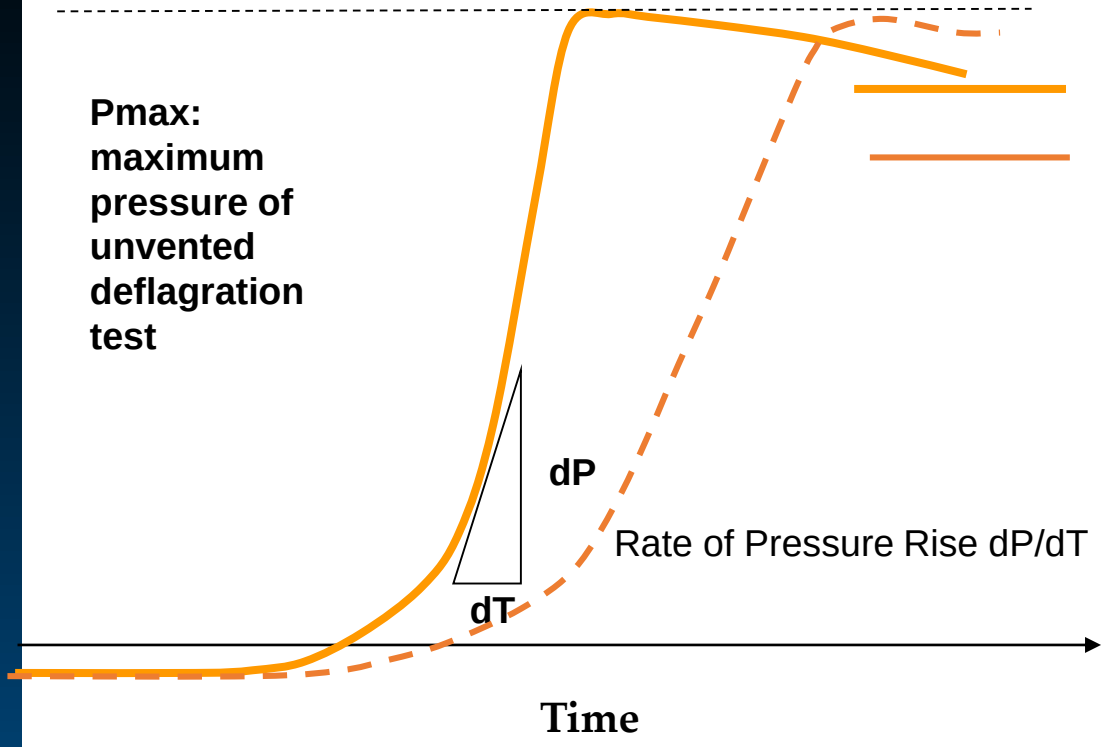
What can we learn from the test data?

Important Combustible Dust Parameter :
BPA / ABS / PVC / Coal example….

Dust Explosibility Data

What data is required?

- K_{st} and P_{max} are fundamental to the understanding of all applications.



Strong Deflagration

Weak Deflagration

20L Test sphere per ASTM E1226 Standard

Kst: factor related to rate of pressure rise dP/dt of unvented deflagration test

Evaluating the Hazard

Typical Material Explosibility Data

Material	Mass Median Diameter (Microns)	Kst (bar- m/s)	Pmax (bar ga)
Wood Flour	29	205	10.5
Sugar	30	138	8.5
Bituminous Coal	**24**	**129**	**9.2**
Corn Starch	7	202	10.3
PVC	60	98	8.3

Data Used for Suppression, Venting, Isolation and Containment design.

Evaluating the Hazard

Minimum Ignition Energy

This indicates the sensitivity of a material to start combustion process. The lower the MIE, the greater the explosion risk;

Ignition Source Examples	MIE min
Fire, Flame, Hot Surfaces	< 10,000J
Self Heating, Bearing Over Heating	< 100J
Frictional Sparks	< 10J
Electrostatic Sources	< 10mJ

Site Risk Assessment

Recognizing Dust Hazards

Recognizing Dust Hazards

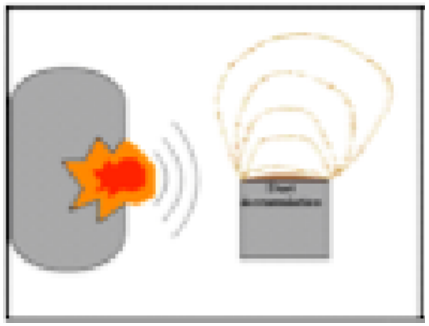
Hazard Assessment cont..

- Also pay particular attention to less obvious accumulation area's such as
- collection systems and other hidden or concealed areas during the assessment
- where conveying systems change direction or at transfer points
- on horizontal and vertical surfaces
- conduit, pipe racks, cable trays, rafters, above suspended ceilings

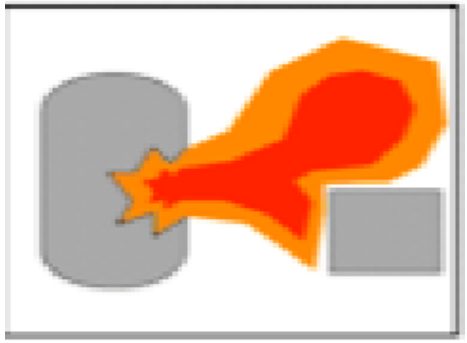
Catastrophic Secondary Explosions

An initial (primary) explosion in processing equipment or in an area where fugitive dust has accumulated may dislodge more accumulated dust into the air, or damage a containment system (such as a duct, vessel, or collector). As a result, if ignited, the additional dust dispersed into the air may cause one or more secondary explosions. These can be far more destructive than a primary explosion due to the increased quantity and concentration of dispersed combustible dust. Many deaths in past accidents, as well as other damage, have been caused by secondary explosions.

Initial Explosion



Secondary Explosion



Hazards Assessment cont..

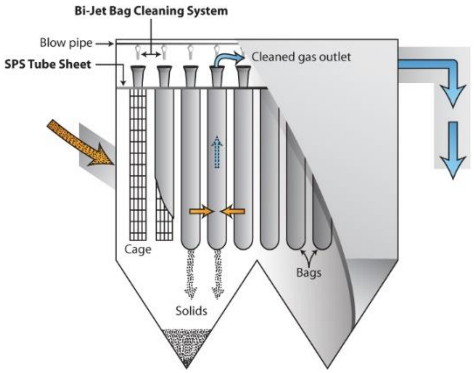
- Locations, including hidden spaces, need to be also considered under upset conditions
- Conduct internal and external audits to monitor potential dust and explosion hazards and the effectiveness of controls

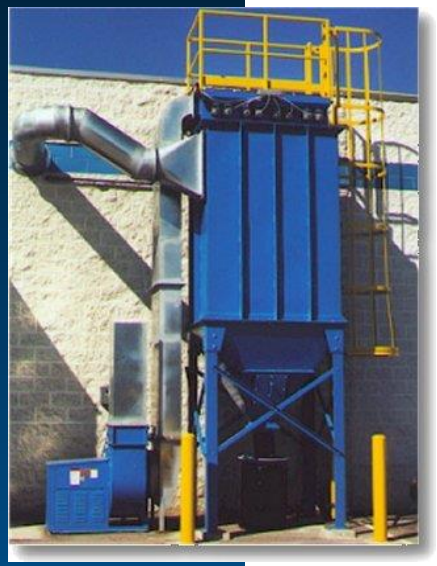
Common ignition sources

- Hot Work
- Preventative Maintenance
- Electrical Equipment
- Static Electricity
- Hot equipment and surfaces
- Smoking and Open Flames

Type of Process Equipment at Risk

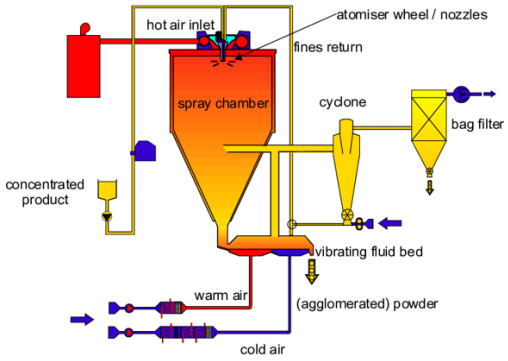
Filters / Dust Collectors





Type of Process Equipment at Risk

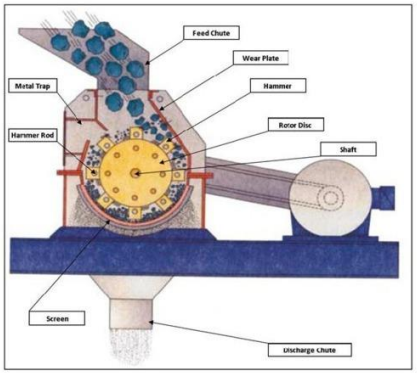
Dryers



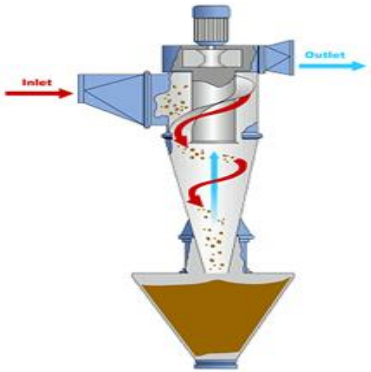
Type of Process Equipment at Risk

Storage Bunkers

Mills

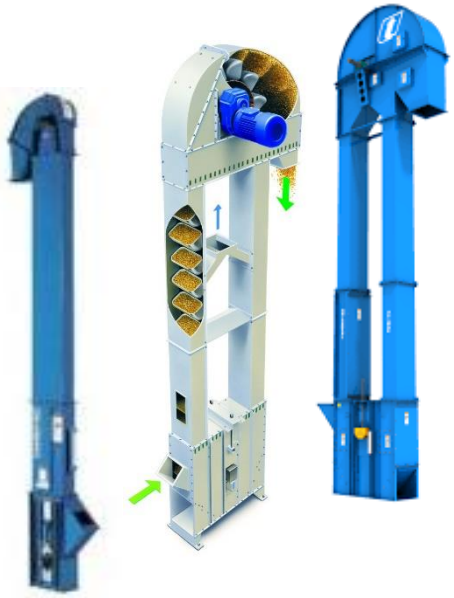


Cyclones



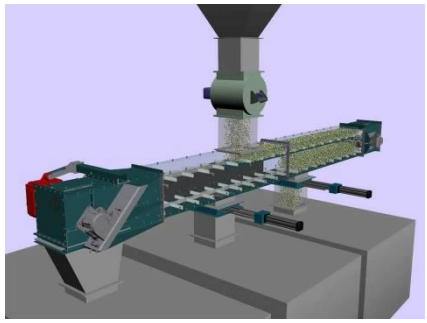
It's All About the Customer

Type of Process Equipment at Risk

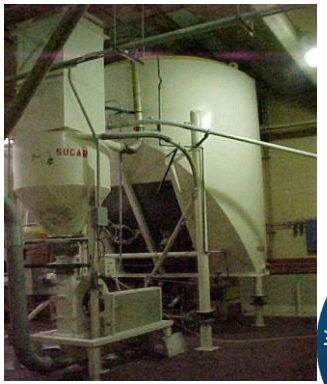


Bucket Elevators

Chain & other closed conveying systems



Silos/Day silos & Working bins



Explosion venting application & limitation of uses.

Explosion Relief Venting

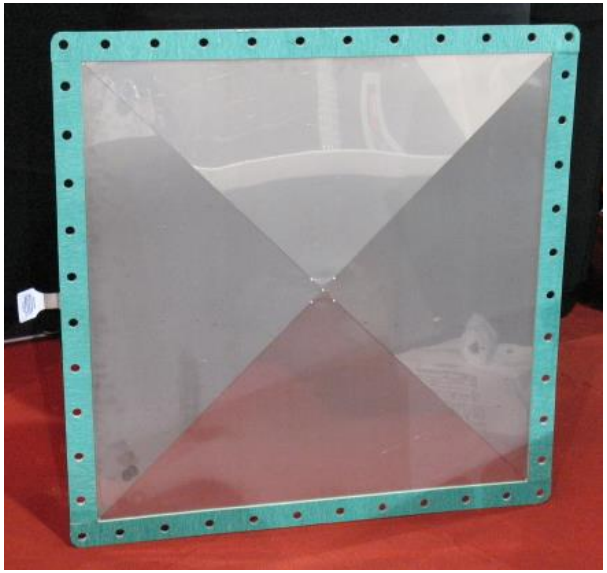
Explosion Vents

- Low burst pressure
- Wide range of sizes
- Stainless Steel –
  - one piece clean type
  - composite type
  - high temp type
- Replace after use
- Low inertia / fast to open
- No fragmentation
- Open Vent sensor option
- Sized in accordance with

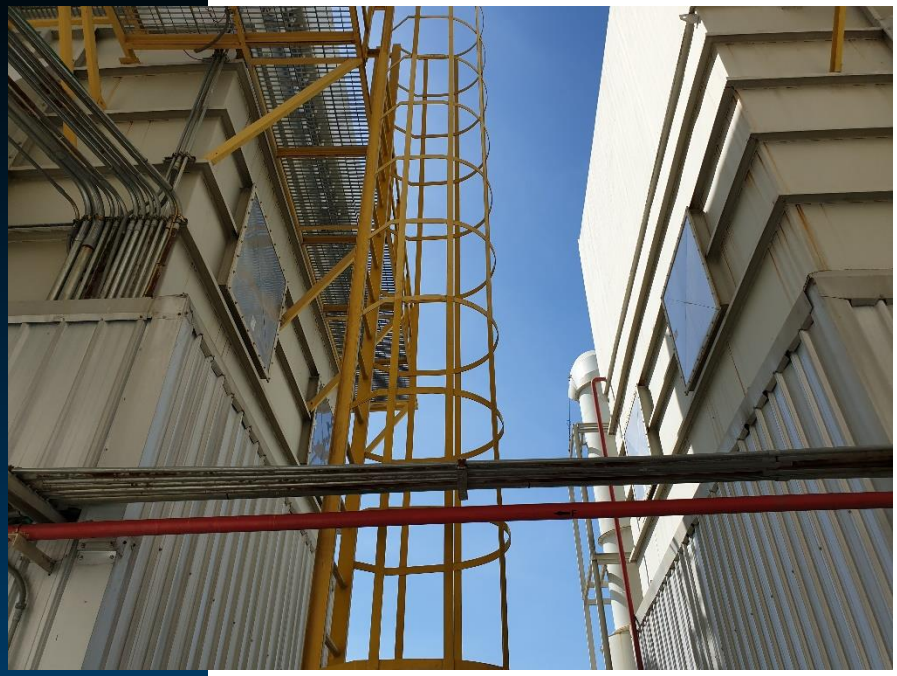
NFPA 68 or VDI 3673 or EN 14491:2012

EXP/V – Round or Rectangular

- Flat triple section construction (composite)
- The first type of explosion vent invented by BS&B



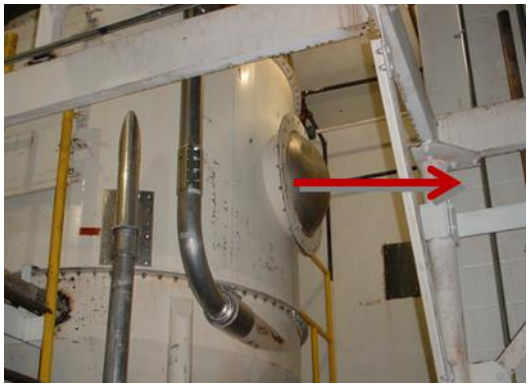
Is this ok?



Flame Free Venting applications.

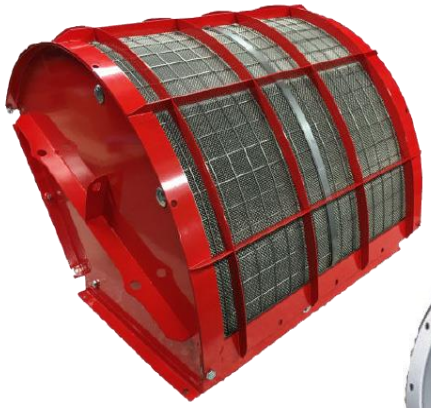
RIQ/ IQR FlameFree Venting

Why would you use FlameFree Venting?



- Flame trajectory is unsafe
- Equipment is indoors
  - Vent ducts would be too long; Pred exceeded
  - No space for vent ducts
  - No access for vent duct to outside
- Cannot release the dust to atmosphere
- Pressure shock of venting is unacceptable

R-IQ Capability / IQR



R-IQ

IQR

R-IQ = Rectangle - Intercept – Quench

The rectangular R-IQ quenches flame and partially absorbs dust.

IQR = Intercept – Quench – Retain

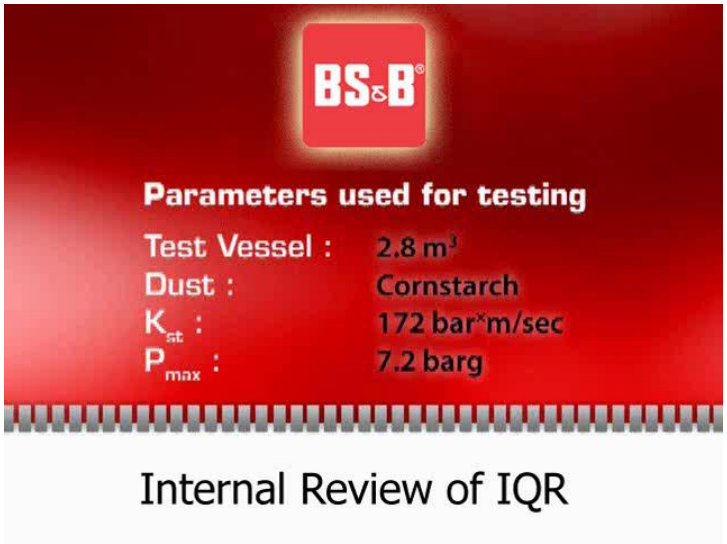
(The IQR quenches flame and near fully absorbs dust.)

Why BS&B FlameFree Venting?

Carbon Steel or Stainless Steel Body:

- Carbon Steel for standard applications
- Stainless Steel for sanitary applications

R-IQ Capability



Both R-IQ / IQR has been performance tested to confirm that no flame is ejected.

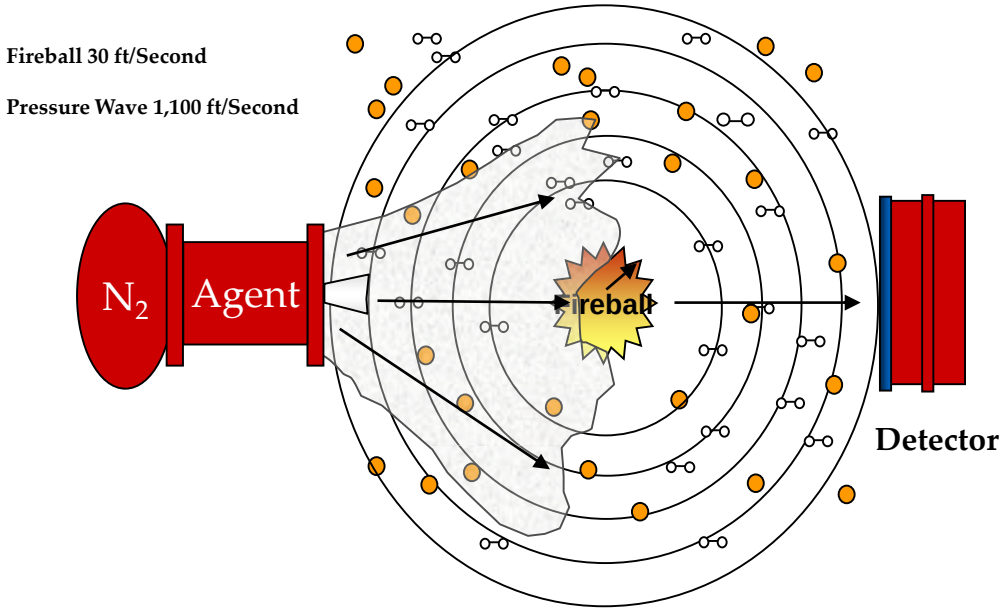
IQR FlameFree Venting

Examples of Well designed & protected Equipment of BS&B Type IQR FlameFree Vents:

Application of Flame Free vent / Flap Valve on Dust Collector

Explosion Suppression Technologies & it's applications.

Suppression System Theory



This is done using a highly sensitive & accurate pressure sensors that detects the pressure waves (1100 ft/sec) way ahead of the developing fireball (30 ft/sec) within the process and activating the Suppressing Cannons which eject the extinguishing agent, sodium bicarbonate into the process equipment to be protected and suppress the explosion by removing the heat source chemically!.

Explosion Suppression System

Demo of IPD Suppression System

State of Art : IPD System 5 Suppression System

System Controller

Field Electronic

Cannon

Transducer

Triplex Sensor

Monitor

Triplex sensor

Cannon

Power supply

IPD System 4

Application of Suppression Systems

Latest project in Thailand for automotive industries