Mec-Tric Technical Publication 081713

NFPA 68 Explosion Protection/Explosion Vents **(Page 1 of 2)**

NFPA 68 and Vent Sizing

Mec-Tric Controls and Fike Corporation are involved in the design and support of Explosion Protection Systems for many types of vessels used throughout industry. This Technical Publication gives a synopsis of some of the terms used for Explosion Protection and types of systems used to limit loss of life and facility destruction in the event of an explosion.

Explosion Vents are considered "explosion protection passive systems". Explosion vents open at a designated burst pressure to reduce pressure rise in a vessel. They are typically employed in outdoor locations unless flame arrestors or Fike Flame Quench devices are implemented. NFPA 68 provides guidelines for vent use indoors. If a dust or substance were to be involved in a deflagration and its combustion by products were toxic, a Flame Quench can not be used. Other limits apply.

The Fike EPACO (explosion protection controller), HRD (high rate discharge for suppression) containers and SRD (standard rate discharge for duct isolation) containers and pressure detectors are part of what is considered *"explosion protection active systems"*. EPACO controllers monitor conditions at all times and interface with explosion protection pressure sensors and extinguisher containers and/or Explosion Isolation Valves.

Some terms used in Explosion Protection are as follows:

Pred - reduced pressure due to venting of deflagration, "passive system". Pred is the maximum pressure that will arise in a vented enclosure or vessel during a vented deflagration. Pred is evaluated relative to the maximum allowable pressure a vessel can with stand.

TSP or Total Suppressed Pressure is analogous to *Pred* and is the term used for active systems.

Pstat – static activation pressure/burst pressure of the explosion vent. Pstat is the pressure at which a vent will open to allow the deflagration and pressure rise to "vent" out of the vessel thereby mitigating further pressure rise within the vessel.

Pact or activation pressure point for active systems is analogous to *Pstat* and is the term used to describe the activation set pressure of the active system. Once this pressure (Pact) inside the vessel is detected by the pressure sensor, the controller sends a signal to actuate the sodium bicarbonate filled HRD's and SRD's or Explosion Isolation valve thereby containing the explosion.

Kst and **Pmax** values describe the explosibilty characteristics of a dust.

Kst - relates to max pressure rise/time of a dust or substance in a contained deflagration/explosion. Kst and Pmax values of a particular dust or substance are usually established in a laboratory using a 20L test sphere apparatus (Kst value is generally on a scale of 0-500 bar-m/sec). The larger the pressure rise in a given time>>>>>>**the higher the Kst**.

Pmax - relates to the maximum pressure developed in a contained deflagration with an optimum mixture of a specific dust. Pmax values generally range from 5-12 barg (72.5-174psig) for hazardous dusts.

See the formula (A*vo*) below from NFPA 68 with regard to vent sizing. This formula **<u>is not</u>** applicable for all applications, limitations of this formula are indicated on the next page of this document.

$$A_{v0} = 1 * 10^{-4} * \left(1 + 1.54 * P_{stat}^{\frac{4}{3}}\right) * K_{st} * V^{\frac{3}{4}} * \left(\frac{P_{max}}{P_{red}} - 1\right)^{1/2}$$

As indicated in the formula, the following parameters (metric units) are required in establishing an explosion vent area:

- P*stat* (bar)
- K*st* (bar-m/s)
- V (volume of vessel m^3)
- P*max* (bar)
- P*red* (bar)

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NFPA 68 Explosion Protection/Explosion Vents (Page 2 of 2)

As the formula specifies, if Pstat, Kst, V (volume of vessel (dirty volume for dust) or Pmax increase, vent area increases. As Pred (the pressure value the end user provides relating to their vessel maximum allowable pressure) decreases, vent size increases. We cannot determine the **Pred** from the data sheets or our calculations. Be aware that the lower the Pred for a given volume, the larger the vent size. Inversely, if the given Pred is a higher value for the same vessel volume the vent size will decrease. Customers should provide the Pred for their vessel for design work to be undertaken. Typically, vessel strength can be obtained from the manufacturer of the vessel. We can solve for Pred with a given vent area or size.

Most Pred's for dust collectors range from 2.5 to 6 psig and higher for stronger cylindrical vessels. A Pred should always be lower (factor of safety) than the pressure a vessel can withstand without coming apart or deforming and becoming shrapnel and a hazard to personnel and property .

NFPA 68 Explosion Vent Formula Avo (8.2.2 NFPA 68 2013 see limitations)

Limitations listed below for Explosion Vent area equation Avo (other limitations may apply, consult NFPA 68).
Pstat ≤ 0.75bar
10bar-m/s ≤ Kst ≤ 800bar-m/s
0.1 m^3 ≤ V ≤ 10,000m^3
5bar ≤ Pmax ≤ 12bar
Avo permitted for L/D's less than 2 (NFPA 6.4)
Use Av1 (different equation) for L/D's (length to diameter ratio) greater than 2 and less than or equal to 6

Duct Work Explosion Protection

Many vessels used in industry have interconnected duct work leading to other areas of the plant. It should be noted that **NFPA 654** (Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, 2013) states in 7.1.6.1 that "*where an explosion hazard exists, isolation devices shall be provided to prevent deflagration propagation between connected equipment in accordance with NFPA 69 Standard on Explosion Prevention Systems*".

Other terms:

Deflagration - describes subsonic combustion propagating through heat transfer; hot burning material heats the next layer of cold material and ignites it. Deflagrations represent most "fire" found in daily life, from flames to explosions. Deflagration is different from detonation, which is supersonic and propagates through shock.

Pressure piling - describes phenomena related to combustion of gases in a tube (duct work) or long vessel. As the flame front propagates along the duct work, the unburned gases ahead of the front are compressed, and hence heated. The amount of compression varies depending on the geometry of the duct work as well as the hazard (fuel) traveling through the duct. Where multiple vessels are interconnected by ductwork, ignition of gases or dust (fuel) in one vessel and pressure piling may result in a transition from deflagration to detonation. Pressure piling can propagate a large explosion pressure rise and further destruction may be realized.

Please consult with Mec-Tric Controls for Explosion Protection solutions, design and dust testing.

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