ProInert™ Pressure Relief Venting – When Less is Better!

Introduction

Inert Gas fire extinguishing systems involve rapid distribution of large volumes of inert gas into a room to reduce the level of oxygen to a point where combustion of the flammable substance cannot be maintained. Depending upon the specific type of inert gas extinguishant utilised, approximately 50% of the air in the protected space is displaced by the quantity of inert gas used to extinguish the fire. To prevent structural damage of the protected space, venting becomes an essential part of the system design and the need for pressure relief is required. If this quantity of gas was discharged without ventilation then the pressure in the space would be 50,000 Pa (a solid wall cn withstand 500Pa and a 'light weight construction' 150Pa.

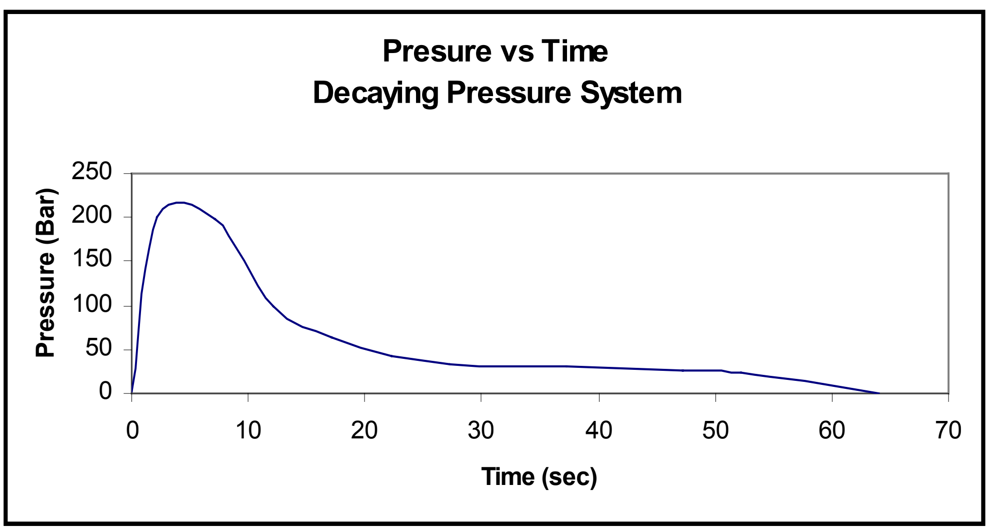
The International Organisation for Standardisation (ISO) 14520 Gaseous fire-extinguishing systems – Physical properties and system design' requires the protected enclosure shall have sufficient structural strength and that venting shall be provided to prevent excessive over pressurisation of the enclosure. The necessary ventilation cross sectional area is dependant on the inert gas system flow rate and not the quantity of inert gas flooding into the protected space. This document provides an overview on ventilation requirements by comparing a current typical inert gas system utilising an orifice pressure reducer and decaying flow rate discharge to that of the ProInert™ Fire Extinguishing system which incorporates a unique valve design which provides a constant flow rate discharge.

Standard Inert Gas Systems – Decaying Flow Rate

Fike's market research has shown that the biggest concerns with inert gas system end-users, building services contractors, and system Installers is room ventilation. There is conflicting information within the fire protection industry with respect to proper room ventilation design and these differences continue to circulate until one is faced with deciding which is the right method of implementing room venting.

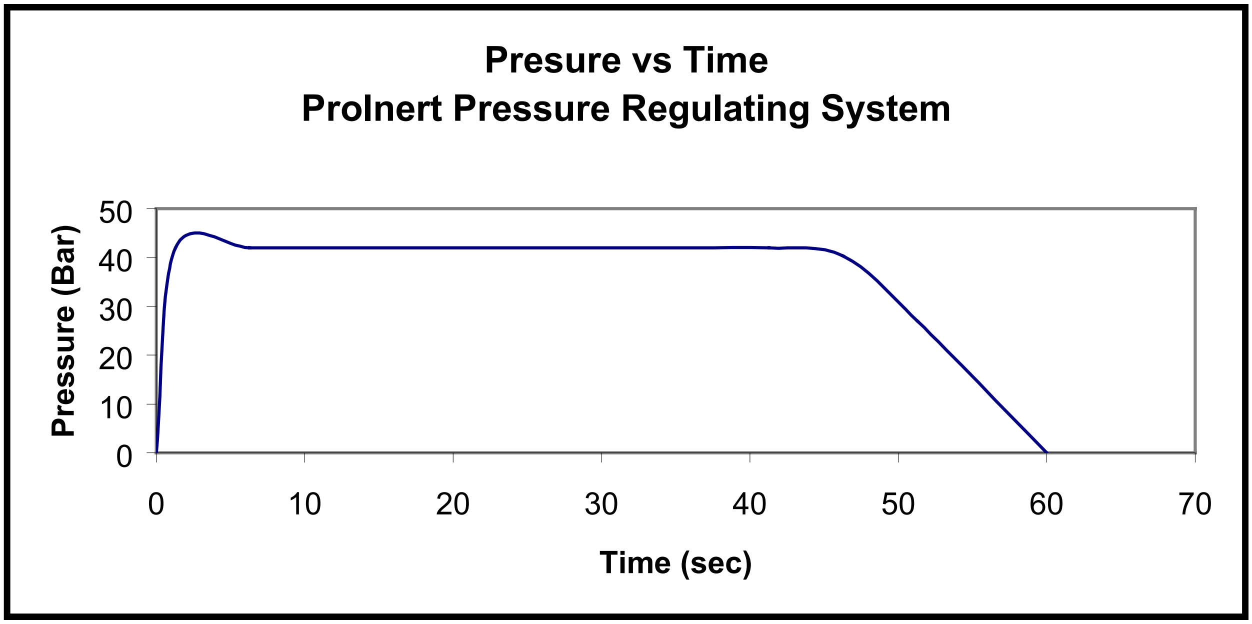
Many different types of inert gas systems are available to the market. These have various proportions of argon, nitrogen, an even carbon dioxide. Regardless of the system design and inert gas selection, all utilise concentration levels, approximately 50% by volume, which displace a high amount of air in the protected space. The design of standard Inert Gas system is to store large quantities of inert gas pressurised up to 200 and 300 bar capacities and utilise a valve that fully opens upon actuation. An orifice plate, or restrictor, will then reduce the stored cylinder pressure to approximately 60 bar and controls the discharged inert gas.

When a discharge of current inert gas systems first begins, the pressure in the cylinder is at a maximum so the pressure restriction in the form of an orifice plate must also be at its maximum. The orifice plate within the piping network must to be sized for this initial system condition, which gives the high peak flow rate into the protected space followed by a decaying flow rate throughout the discharge. The initial pressure peak (surge) occurs in the first 2-4 seconds. Figure 1 illustrates the pipe network pressure profile of a standard decaying inert gas system.



Fike's ProInert Fire Extinguishing System – Constant Flow Rate
The Fike ProInert Fire Extinguishing System supplies the same quantities of inert gas in either 200 or 300 bar cylinders. The ProInert System is much more sophisticated than standard decaying flow rate inert gas systems. The ProInert System discharge valve includes a variable orifice plate that is designed to regulate the discharge pressure of the system to a constant pressure so that the pipe pressure and nozzle flow rate(s) will be consistent for the duration of the discharge. The significantly lower smooth, consistent flow rate from the Fike ProInert system results in a less cross sectional area of any ventilation.

As the ProInert system discharge continues, the pressure in the cylinder reduces but the variable orifice plate is still providing the same pressure, which reduces the flow rate considerably. The Fike valve, which opens to allow a constant flow of extinguishant during the discharge, avoids flow rate surges on the pipe work and more importantly, the protected space. Controlling the flow from the cylinder is important to avoid over pressurising the pipe work or over pressurising the walls of the protected space. Figure 2 illustrates pipe network pressure profile of Fike's ProInert regulated flow rate system.



ProInert vs. Decaying Flow Rate System – Free Vent Requirements
The following is a comparison between Fike's ProInert constant flow rate discharge and a leading inert gas system utilsing a decaying flow rate discharge. A significant advantage of Fike ProInert system is the reduction in vent area. The comparison is for calculating the free vent area only. The free vent area is the minimum area required to prevent over-pressurisation of the protected enclosure when the opening is to atmosphere. Atmosphere is described as open air on the outside of a building.

Free Vent Area Calculation Comparison

Volume	= 113 m^3
Application	= Class "A" Hazard
Design Concentration	= 37.8%
Inert Gas Mixture	= 50% Argon / 50% Nitrogen
Discharge Time	= 60 seconds (max.)

There are multiple equations or methods to use when calculating the free vent area. To provide an equal comparison between the two examples, the VdS/CEA approved method for calculating vent area will be applied herein.

The first step is to calculate free vent area is to determine the Specific Vapour Volume of the homogenous mixture (V_{HOM}) where:

E = Final Concentration percentage
$V_{IG\text{-}55}$ = Specific vapour volume of IG-55 @ 20° C (.7081 m^3/kg)
V_{AIR} = Specific volume of air @ 20° C (.830 m^3/kg)

$$V_{HOM} = \left(\frac{E}{100} * V_{IG\text{-}55}\right) + \left[\left(1 - \frac{E}{100}\right)\right] * V_{AIR}$$

$$V_{HOM} = \left(\frac{37.8}{100} * 0.7081\ m^3/kg\right) + \left[\left(1 - \frac{37.8}{100}\right)\right] * 0\ .830\ m^3/kg$$

$$V_{HOM} = 7839\ m^3/kg$$

The second step is to calculate the free vent area by utilsing the data derived from the previous equation where:

V_{HOM} = 0.7839 m^3/kg – Specific Vapour Volume of the Homogenous Mixture
$V_{IG\text{-}55}$ = 0.7081 m^3/kg – Specific vapour volume of IG-55 @ 20° C (.7081 m^3/kg)
Massflow = 1.56 kg/sec. – Mass flow rate (Derived from VdS Flow Calculation Software)
Dp = 240 Pa – Maximum Allowable Enclosure Pressure (Pascal)
A = Free Vent Area (m^2 or cm^2)

Fike ProInert	Current Inert Gas Systems
Massflow = 1.56 kg/sec. – Mass flow rate	Massflow = 4.02 kg/sec. – Mass flow rate (Peak Flow Rate)

Fike ProInert

$$A = \frac{\text{Massflow} * V_{IG\text{-}55}}{\sqrt{2 * Dp * V_{HOM}}} \qquad A = \frac{1.56\ kg/sec * 0.7081\ m^3/kg}{\sqrt{2 * 240 * 0.7839\ m^3/kg}}$$

Current Inert Gas Systems

$$A = \frac{\text{Massflow} * V_{IN}}{\sqrt{2 * Dp * V_{HOM}}} \qquad A = \frac{4.02\ kg/sec. * .7081\ m^3/kg}{\sqrt{2 * 240 * 0.7839\ m^3}/kg}$$

Free Vent Area Requirements	
Fike ProInert	**Current Inert Gas Systems**
A = 0.057 m^2 (570 cm^2)	A = 0.15 m^2 (1500 cm^2)

Summary

For a standard pressure decaying inert gas system to overcome the initial pressure surge, approximately 2 to 3 times more vent area is required as compared to Fike's ProInert system utilising a constant flow rate. The examples provided in this document indicate the ProInert system requires 570 cm^2 free vent area which is less than the minimum required 1500 cm^2 for a pressure decaying system inert gas. Offering a reduction in vent area equates to cost savings to the end-user. Utilsing a constant flow rate from start to finish, the Fike ProInert system offers an advantage on the required amount of ventilation area designed to maintain structural integrity of the enclosure.

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