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RELIEF SIZING FORMULA FOR GAS AND DUST EXPLOSIONS

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ABSTRACT

A theoretical based generalized vapor and dust deflagration vent sizing formula is provided that provides good agreement with available experimental data. In contrast to empirical guidelines, given the theoretical basis for the formula allows reliable predictions outside the available data base.

INTRODUCTION

A large number of analytical and highly empirical correlations including nomograms reflecting changing standards have been or are being proposed separately for gas and dust explosion relief venting. An example of dust explosion predictions and data is illustrated in Figure 1 (reproduced from Eckhoff, 1998).

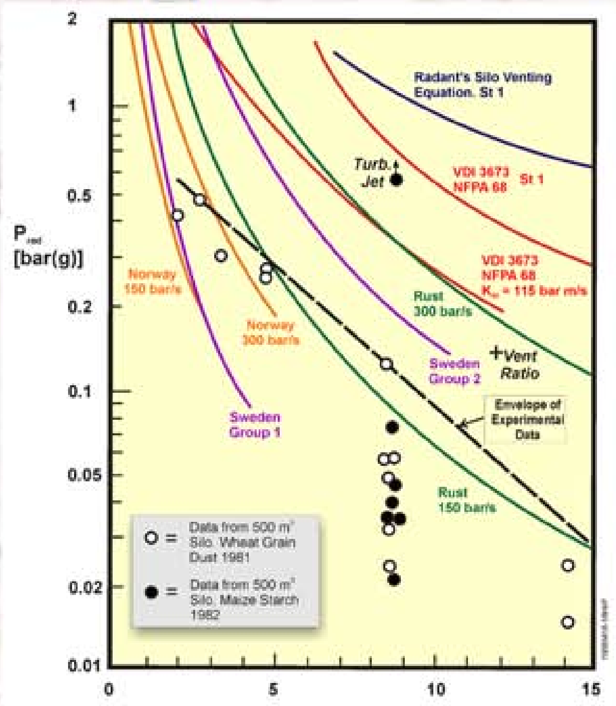

Figure 1.

In principle, modeling developed for gas explosions venting should also apply to dust explosion venting. The difference in approach arises mainly because the models or correlations for gas explosions involve the use of the laminar or fundamental burn velocity and a turbulence correlation factor which are more difficult to specify separately for dust explosions. Here we offer a generalized formula that is applicable to both gas and dust deflagrations including subsonic and sonic pressure relief conditions and is consistent with available experimental data and industry experience. Application of the model is illustrated for dust explosions.

GENERALIZED VENT SIZING FORMULA

The volumetric venting rate, $\dot{Q}_g$ ($m^3 s^{-1}$), from a deflagration event can be estimated from

$$\dot{Q}_g = \frac{V^{2/3}\, K\left(P_{max} - P\right)}{P\left(P_{max} - P_i\right) - P_{max}\left(P_s - P_i\right)} \quad (1)$$

where

P (bar a) = final venting pressure,
V (m^3) = vessel volume,
P_{max} (bar a) = maximum unvented pressure,
P_s (bar a) = relief set pressure,
P_i (bar a) = initial pressure,
K (bar m s^{-1}) = deflagration index measured in a standard non-vented spherical vessel (such as the 20 l vessel) with quiescent initial conditions and central ignition and is given by

$$K = v^{1/3}\, \dot{P}_{max} \quad (2)$$

where V (m^3) is the standard test vessel volume and $\dot{P}_{max}$ (bar s^{-1}) is the maximum measured rate of pressure rise.

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