20 Liter Screening Test (Go / No Go)

INTRODUCTION

The first step in a process hazard analysis is determining the nature of the hazard. For processes involving powders and bulk solids, it is important to understand whether a dust is explosible or not, so adequate prevention and mitigation measures may be implemented. Dust explosibility can be determined by conducting a screening test according to ASTM E1226, "Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts", in a 20 liter spherical vessel or $1m^3$ vessel, with different concentrations. A dust is explosible if the pressure ratio, PR, achieved during the deflagration exceeds 2. Over driving may occur in the 20 liter vessel due to the strong ignition source in a small vessel. This over driving concern can be more accurately defined when using the $1m^3$ test vessel.

BACKGROUND

In order for a dust explosion to take place, the dust mass suspended in air/dust atmosphere must exhibit several characteristics:

- The dust must be combustible
- The oxygen content of the surrounding atmosphere must be sufficient to sustain combustion
- The dust concentration must be within the upper and lower explosive limits
- The particle-size distribution must be capable of supporting combustion
- An ignition source of sufficient energy must be present to initiate an explosion

The first step in hazard analysis is to effectively determine the material's combustible and/or explosive nature. In order to obtain this information, testing should be conducted by a qualified laboratory using internationally accepted procedures. This can be achieved by conducting a screening test according to ASTM E1226.

Prior to performing more specific tests to determine explosibility parameters such as K_{St} and P_{max}, it is sometimes desirable to perform a preliminary test in order to determine whether the product or dust in question can produce a dust explosion at all. Based upon the screening results, additional tests can be conducted as needed.

EXPERIMENTAL

The testing procedure for the screening test follows the same method as the explosibility testing (to determine explosibility parameters K_{St} and P_{max}), except only two or three dust concentrations are investigated (typically 500, 1000 and $2000g/m^3$).

According to ASTM E1226 criterion, a dust is explosible if the pressure ratio, PR, achieved during the deflagration exceeds 2. The formula for calculating the pressure ratio is shown below.

$$PR = \frac{P_{ex,a} - \Delta P_{igniter}}{P_{ignition,a}}$$

Where:
$P_{ex,a}$ = maximum absolute explosion pressure generated during the test.
$\Delta P_{igniter}$ = pressure generated by the ignition source.
$P_{ignition,a}$ = absolute pressure in the vessel at the time of ignition (typically 1 bara).

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A schematic of the 20 liter apparatus is shown in Figure 1. The explosion chamber used is a 20 liter sphere containing a dispersion nozzle. The dispersion nozzle is connected to a sample loading cylinder and a 0.6 liter air discharge vessel. During an experiment, dust is placed in the loading cylinder and the air discharge vessel is pressurized to 290psig. The dust is dispersed through the holes of the dispersion nozzle into a partially evacuated explosion chamber by activating the ball valve in between the discharge vessel and the sample cylinder. The resulting dust cloud is ignited with chemical igniter(s) placed at the center of the spherical explosion chamber.

Two pressure transducers are used to observe the pressure history of the explosion. Proprietary operating software is used to control the operation of the ball valve and the ignition of the dust cloud, as well as to collect pressure data from the transducers during each test. The time delay between injection and ignition is held constant in accordance with previous vessel calibrations. At the time of ignition, the dust cloud is at room temperature (~25° C) and a normal pressure of 1.0 bara ±5%. A filtered exhaust is attached to the chamber to allow safe post-explosion cleanup of the chamber.

The general procedure for the experiments are shown below:

A. A weighed amount of dust is placed in the loading cylinder.
B. Chemical igniter(s) are placed at the center of the chamber.
C. The chamber is sealed.
D. The chamber is partially evacuated to facilitate ignition at 1.0 bara ±5%.
E. The air discharge vessel is pressurized to 290 psig.
F. The operating software synchronously controls injection, ignition, and data acquisition during the combustion process.
G. Data is processed and test logs are updated.
H. The chamber is vented through the filtered exhaust and flushed with air.
I. The chamber is opened and cleaned thoroughly prior to the next test.

'Over-driving' of the dust sample may occur in the 20 liter chamber due to the large ignition source in the small volume chamber. If it is suspected that 'over-driving' has occurred during the testing process, it will be recommended to the customer that additional testing take place in the $1m^3$ chamber to make a definitive determination of whether the material poses an explosion hazard.

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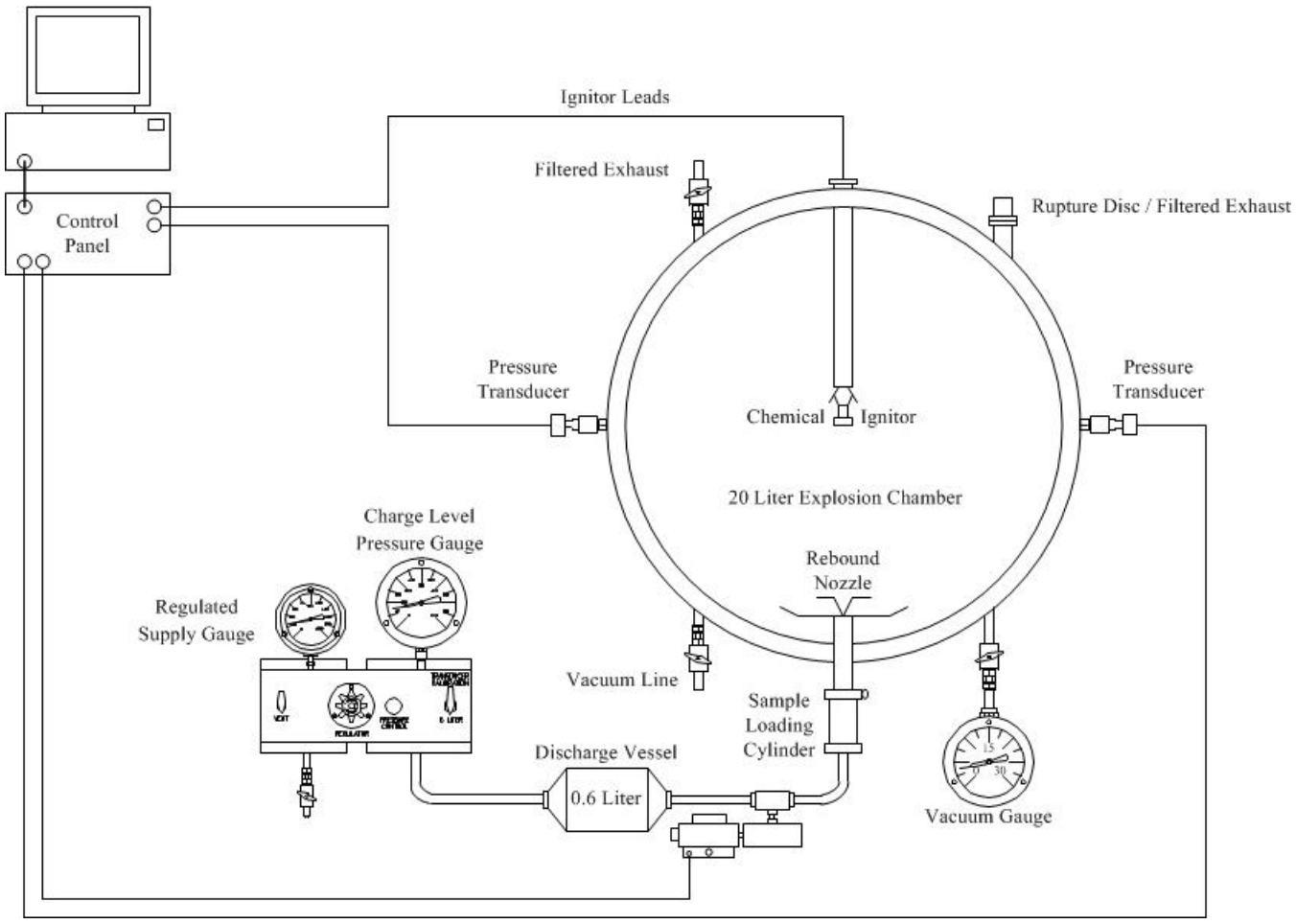

20 Liter Apparatus

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