Technews

National Dairy Development Board

For Efficient Dairy Plant Operation

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POWDER PLANT - FIRE HAZARDS

This bulletin includes technical information, latest developments on products, systems, techniques etc. reported in journals, companies' leaflets, books and based on experience. The technical information would be on different areas of plant operation in different issues. It is hoped that the information contained herein, if employed in the factory, will help in making dairy plant operations more efficient.

Your contributions and suggestions will make the bulletin more useful, and are welcomed.

The theme of information in this issue continues to be Powder Plant - Fire Hazards as in the previous issue. It may be understood that the information given here is by no means complete.

1. POWDER DUST EXPLOSION HAZARDS IN SPRAY DRYERS

In the last issue of the Technews a detailed account was given on the fire hazards in spray dryers and the measures to prevent fire.

a) Fire in spray dryers present a particular danger because often the conditions for dust explosion in the dryer are present in which case the fire may initiate the explosion. The dust explosion is the result of rapid gaseous expansion brought about by the intense heat generated by the burning powder. For explosion to occur :

In this issue

— The powder dust must be air borne in sufficient concentration (hence large surface area exposed to oxidation) to fall within the explosible range.

— The ignition source must be strong enough to initiate combustion.

— There must be sufficient oxygen in the atmosphere to support combustion.

b) Fine particles and higher ambient temp. are more likely to lead to explosion. Each fine particle represents a small heat sink.

c) Lower moisture content powder particles ignite more readily as do the aged ones.

d) There is a range of concentration of powder in the air within which the mixture is explosive whereas mixture at concentration below or above this range cannot explode. The lowest concentration is referred to as the 'lowest explosion limit' and the highest concentration above which explosion cannot take place is 'upper explosion limit'.

e) In milk spray dryers, in certain regions all the conditions for an explosion are always present during normal operation. These regions are called the "active volume".

f) Powder concentration is low at the top and high at the powder outlet.

g) For milk powders the minimum explosion concentration required is over 50 g/cu.m. (Cocks, 1980: IDF, 1987). The powder concentration in spray dryer is usually equal or less than this. Obviously much smaller quantities can form localised explosive dust clouds.

h) The most violent explosion is produced when the amount of oxygen present is close to that required for complete combustion. It occurs at a powder concentration of 1000 g/cu.m (Knipschildt, 1986).

i) During dust explosion the pressure rises rapidly. Whether the dust explosion can occur depends on the maximum pressure that can be reached in a closed vessel and the maximum rate of pressure rise. These characteristics of milk powders are given in the following table (IDF, 1987).

Explosion characteristics of milk powders

In 1 cu.m. chamber

Product	Average Particle Size	Minimum Explsn Conc.	Maximum Explsn Pressure	Maximum Rate of Pressure Rise	Dust Class	Ignition Temp	Glow Temp.
	micron	g/cu.m	bar	bar/sec.		'C.	'C.
Milk powder	83	60	5.8	28	1	440	340
Whole milk powder	66		8.7	67			
Whole milk powder spray dried	88	60	8.6	83	1	520	330
Milk powder, 25% fat, spray dried	74	60	8.2	56	1	530	350
Skim milk powder	49		9.5	108			
Skim milk powder spray dried	60		8.8	125	1	610	340
	67		8.1	117		530	385
	80	60	9	99	1	500	330
	90	60	9.7	122	1	540	340
	99	125	8.6	130			
Whey powder	152	125	7.4	41		490	410
	700	250	5.8	27			395
from cyclone	41	125	9.8	140	1	560	450

j) The maximum explosion pressure of milk powders varies from 6 to 10 bars and maximum rate of pressure rise from 27 to 140 bars/sec. Because of these characteristics the milk powders are grouped as Class I of explosion materials. This class includes low explosive powders with rate of pressure rise of upto 497 bars/second (Rust, 1980).

2. HAZARDOUS AREAS

a) Powder dust collecting system. Powder separators - bag filters, cyclones.

b) Powder conveying ductwork. The powder may accumulate in the ductwork if conveying velocity is low.

c) Unloading systems. Silos, bins.

d) Dust accumulating areas. Hidden corners, overheads, flat surface, dryer chamber.

3. EXPLOSION PROTECTION

The primary measure against powder dust explosion is avoiding the presence of a suitable source of ignition. Various measures to prevent fire taking place in a spray dryer have been detailed in VI issue of Technews (January-February 1997).

Once the fire has been initiated it is necessary to stop its spread and suppress explosion. The methods of suppressing explosion are expensive. Hence the most commonly used method for dealing with dust explosion is explosion venting or providing relief apertures. It is necessary to provide explosion relief to protect persons and to prevent or reduce the damage to the plant.

a) Explosion venting is designed to restrict the maximum pressure to an allowable level.

b) The pressure at which the panel opens is adjustable and must be below the maximum pressure the chamber can resist, which usually is 0.2 - 0.5 bars (Knipschildt, 1986).

c) When the chamber can withstand high pressure, a relatively small relief area is required.

d) The relief panels or vents on spray dryers are usually installed in the roof but can take the form of hinged doors on the walls. They should flush with the wall such that the powder dust cannot accumulate on ledges.

e) In a spray dryer the whole of the volume usually does not contain an explosible concentration of powder dust, the cone is most likely to contain powder concentration that is explosible (Beever, 1985).

f) If the vent is operated by a dust explosion burning dust will be ejected vigorously by the explosion and endangering persons and equipment in front of the vent. Hence, vents should be connected by ducting to the open air, if possible. The duct must be strong enough to withstand the maximum pressure to which they will be subjected and must be straight and as short as possible, usually limited to 3 m.

g) Sometimes powder silos are also equipped with explosion relief panels.

h) There are several methods to calculate the size of the vent areas, and the vent area should be designed carefully.

i) An emperical rule to calculate the vent area is :

$A = (\frac{1}{25}) \times V$

A = vent area in sq. m,
V = volume of cone in cu.m.

It has been reported that this method gives larger vent areas than necessary. In many modern conventional spray dryers relief areas of 2-4 sq. m. are provided for spray dryer volumes of 500-1000 cu.m (IDF, 1987).

j) Explosions in spray dryers in the dairy factories are relatively rare, and hence, when powder concentrations are low, modest measures in vent areas appear to be sufficient.

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1 bar = 1.019 kg/sq.cm	.1 micron = 0.001 mm