Chapter VI

Conclusions and Recommendation

The objectives of the present research are to design and construct a dust explosibility tester, improve and calibrate the tester until it yields reliable and accurate results compared to standard and published results, study the influence of the particle size of dust samples on the LEL. The experimental work can be summarized as follows :

1. Improvement of dust explosibility tester

1.1 Installation of silica gel adsorbent in the air line reduced the air humidity and led to better ignition. As a result, the average value of the measured LEL values was reduced to 50.7 g/m^3 , which conforms to APPIE's standard value (45±5 g/m^3).

1.2 The longer the spark delay time, the higher the average LEL. A spark delay time of 0.1 seconds gaves the best average LEL (50.6 g/m^3), which conforms to the standard value (45±5 g/m^3).

1.3 A decrease in the height of the air flow channel essentially reduced the value of the LEL down to a constant. By trial and error, a height of 1 mm was the most suitable.

1.4 A gap of 4 mm between the sparking electrodes gave lycopodium LEL values that fully conform to the standard value (45±5 g/m^3).

1.5 One piece of the filter paper (Whatman no.93) yielded a lower LEL than two pieces of the same filter paper. Therefore, only one piece was used in all subsequent tests.

2. Comparison of the experimental LEL values with standard and published values for four types of dust.

Since all the four types of dust samples show LEL values close to the published ones (see Fig. 5.1), it may be concluded that the present dust explosibility tester (named C.U. # 1) was accurate and reliable after the above improvement and calibration.

3. For the same flour type, the nominal median particle size of a flour fraction has a significant effect on the LEL. Furthermore, even cassava flour

fractions of the same nominal particle size could have different LEL values because of difference in the proportion of finest particles in the comparable fractions.

For the corn flour (Type F4) with a very broad particle size distribution (below 22.5 - above 180 microns), its LEL value showed a rather steep increase in the size range of 49 to 90.5 microns. Below 49 microns, the LEL was essentially constant at 155-160 g/m^3. In the cases of rice flour (F3) and wheat flour (F5), both of which had rather narrow size distributions, their LEL values were found to increase rather steeply in the range of 128 to >180 microns. The following sequence of increasing LEL concentration has been observed :

Low LEL value **High LEL value**

Rice flour ⟶ Wheat flour ⟶ Corn flour ⟶ Cassava flour

4. High moisture content suppressed the explosion sensitivity (increased the LEL value) of all four flour types.
5. The particle size distribution seems to have a dominant effect on the LEL whereas any possible difference in chemical composition due to different flour sources seems to have minor effect.
6. The LEL value of a photocopy toner decreased slightly after it passed through the copying process.
7. Table 6.1 lists the LEL values obtained in this study and those given in the literature.
8. Table 6.2 summarizes the LEL values for the various types of domestic flour investigated.

Recommendation

The LEL values in this investigation (Table 6.1 and 6.2) were measured according to the standard test method of APPIE, using a prototype dust explosibility tester (named C.U. # 1), which was accurate and reliable. Therefore, should be measured the LEL values of various dust samples for more results using are database. An additional studies effect of moisture content and particle size on the LEL in different from this study.

A sizable database on the explosibility characteristics of various dusts can already be found in the literature. On the other hand, it is well-known that the range of explosible concentration of a particular dust is strongly influenced by many parameters, such as the particle size, particle shape, moisture content, the position and nature of the ignition source, and more in an actual process, for example, a dryer. These relevant parameters are not always given together with the explosibility data.

The testing apparata and procedures differ from one country to the next, although there are some common features. The results obtained on a laboratory scale were extrapolated to full scale, thus giving some uncertainty. Moreover, the tests' procedures may not reflect exactly the condition in a process, for example, a particular type of dryer. Therefore published data must be used carefully and individual tests on a particular dust of interest may be required.

In view of the above facts, the following recommendations are made :

1. Thailand should study the various testing apparata and procedures established by the major industrial countries (the United Kingdom, the United States, Germany, Japan, etc.) and adopt them as her national standards, preferably after making appropriate adaptation.

2. Thailand should not only collect the published explosibility characteristics data to set up her own database but also supplement it with her own data, especially, on domestic products under local conditions.

3. Compared to the sale price in Japan of a similar tester, the present prototype was constructed at a cost only around one-seventh (excluding labor cost). So the prototype has an excellent commercial prospect if adopted by the relevant authority. Many Thai factories would also benifit from the availability of a low-priced tester.

Table 6.1 Summary of the measured LEL from experiment and standard/reference

Powder name	Experiment/ Standard	Mean particle size (microns)	Lower limit Conc. (g/m^3)
Lycopodium	Experiment	26	47
	Standard[1]	26	45±5
HDPE	Experiment	33.6	26
	Reference[2]	24	20
Dextrin	Experiment	55	58
	Reference[2]	41	60
Sulfur	Experiment	29	37
	Reference[2]	20	30
Corn starch (Absorbo HP)	Experiment	26.5	133.4
	Reference[2]	-	60
Cassava starch (CATO-304)	Experiment	20.7	134.3
	Reference[2]	-	60
Cassava starch (CATO-3210)	Experiment	24.3	128.2
	Reference[2]	-	60
Cassava starch (Purity-4)	Experiment	20.9	127.4
	Reference[2]	-	60
Fresh toner	Experiment	19.4	40.3
	Reference[2]	<10	60
Used toner	Experiment	22.8	47.5
	Reference	-	-
Bisphenol-A	Experiment	21	106.3
	Reference	-	-

1) APPIE Standard Powder (APS 002-1991)
2) NFPA 68, Report of Important Dust Explosions, (1957), National Fire Protection Association, USA.

Table 6.2 Summary of the LEL values for various types of domestic flour

Fraction name	Particle size (microns)	LEL (g/m^3)
Cas-1	<45	161.6
Cas-2	45-53	164.1
Cas-3	53-75	207.2
Cas-4	as bought (dried)	114.6
Cas-5	as bought (undried)	120.4
Cas-6	<45	121.9
Cas-7	45-53	165.9
Cas-8	53-75	289.7
Cas-9	75-106	307.5
Cas-10	as bought (dried)	251.7
Cas-11	as bought (undried)	259.7
Rice-1	106-150	103
Rice-2	150-180	122.6
Rice-3	>180	142
Rice-4	as bought (dried)	128.6
Rice-5	as bought (undried)	137.0
Corn-1	<45	155.9
Corn-2	45-53	158.6
Corn-3	53-75	166.3
Corn-4	75-106	180
Corn-5	106-150	183.9
Corn-6	150-180	189.1
Corn-7	as bought (dried)	192.8
Corn-8	as bought (undried)	356.8
Wheat-1	106-150	162
Wheat-2	150-180	188.9
Wheat-3	>180	190.1
Wheat-4	as bought (dried)	165.1
Wheat-5	as bought (undried)	183.0