CE492 Engineering Project
Dust Explosions

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Abstract

This thesis takes a detailed look at dust explosions in silos and enclosed spaces, which pose significant risks in industrial environments. It explores the causes of these explosions, their historical development, notable incidents, and the precautions that can be taken to prevent them. The focus is particularly on dust explosions occurring in silos and confined spaces in sectors such as food, flour, feed, cement, and chemicals, which often result in severe loss of life and property. Preventing these explosions requires a deep understanding of the conditions that lead to them and the implementation of effective safety measures.The study scientifically analyzes the causes of dust explosions in silos and provides recommendations for safety precautions based on international examples. Key factors contributing to these explosions include dust density, the properties of flammable materials, humidity levels, the presence of oxygen, and ignition sources such as sparks. The thesis discusses the steps needed to prevent such incidents in light of global experiences.Special attention is also given to dust explosions in silos and confined spaces in Turkey, assessing existing safety measures and identifying areas for improvement. In conclusion, this thesis thoroughly examines the causes and impacts of dust explosions in silos, offering effective strategies and solutions to prevent them. The ultimate goal is to promote safer working conditions in industrial facilities and reduce the risks associated with these incidents.

What Causes Dust Explosions?

Dust explosions occur when five critical elements come together:
Fuel: Combustible dust (grain, flour, sugar, coal, wood, chemicals, etc.).
Oxygen: Present in the air.
Ignition Source: Sparks, static electricity, hot surfaces, or friction.
Dispersion: Fine dust particles suspended in the air, forming a dust cloud.
Confinement: Enclosed space (silos, bins, hoppers) that traps pressure.

Dust Cloud Material Coefficient Table

Material type	Particle size (Average value) (mikron)	Dust Clouds parameters		
		Cmin(gr/m3)	Pmax (Bar)	Kst (Bar m/s)
Wood sawdust	44	100	7.2	24
Paper	≤15	30	5.7	18
Paper pulp	29	30	9.8	144
Wheat grain dust	80-125	60	9.3	112
Rice grain dust	50-100	60	9	143
Barley grain dust	240	70	9.6	105
Coal dust	55	60	9	143
Polyester	<10	25	10.1	194
Polyethylene	26	32	8.7	104
Polypropylene	25	30	8.4	101
Fly ash	6	125	5.9	35
Fishmeal	320	125	7	35
Sweetcorn dust	50-100	65	9	132

Which Sectors Are In Danger?

1-Food and Agriculture Sector
2-Wood and Paper Industry
3-Chemical and Pharmaceutical Industry
4-Metal and Mining Industry
5-Energy and Cement Industry
6-Plastic and Rubber Sector
7-Textile Industry

TABLE 1. U.S. AGRICULTURAL DUST EXPLOSION STATISTICS

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	TEN YEAR TOTAL
Number	7	8	5	7	12	11	8	7	10	9	84
Fatalities	0	0	3	5	1	1	1	1	0	0	13
Injured	14	10	8	12	2	8	6	5	18	12	95
Type of Facility											
Grain Elevator	5	2	2	5	8	4	4	4	2	2	38
Feed Mill	1	4	1	0	2	4	1	1	2	0	16
Flour Mill	0	0	2	0	0	0	0	0	0	1	3
Other: Corn Milling, Dry	0	0	0	1	0	1	0	0	2	2	6
Corn Milling, Wet	0	0	0	0	0	0	1	1	0	1	3
Rice Mill	0	0	0	0	0	0	1	0	2	0	3
Other	1	2	0	1	2	2	1	1	2	3	15

Source: Dr. Kingsly Ambrose, Purdue University

Dust Explosion Effects




Recommendations

1-Implement Effective Dust Control Systems
2-Eliminate Ignition Sources
3-Maintain Proper Ventilation and Explosion Vents
4-Monitor and Control Environmental Conditions
5-Design Silo Structures for Explosion Resistance
6-Control Dust Dispersion During Operations
7-Implement Real-Time Dust Monitoring
8-Regularly Inspect Ventilation and Filtration Systems