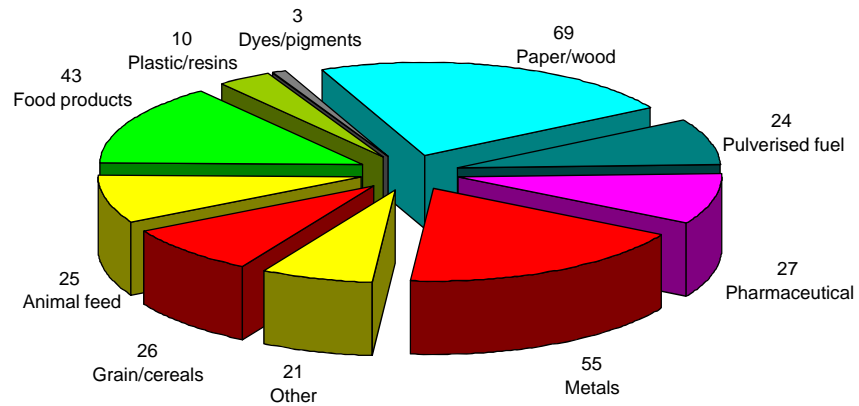


UK Explosions by industry



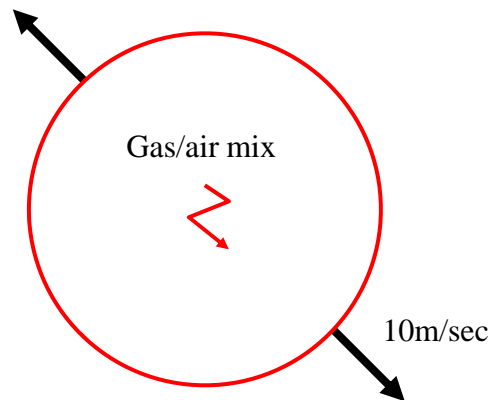
Source: HSE 10 year period

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Dust explosion testing for Industry

What is an explosion?

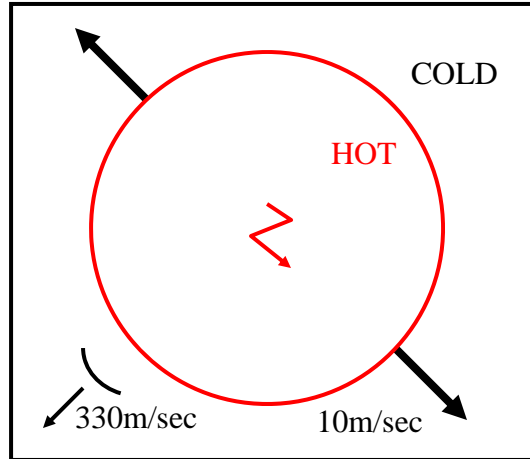
Unconfined explosion



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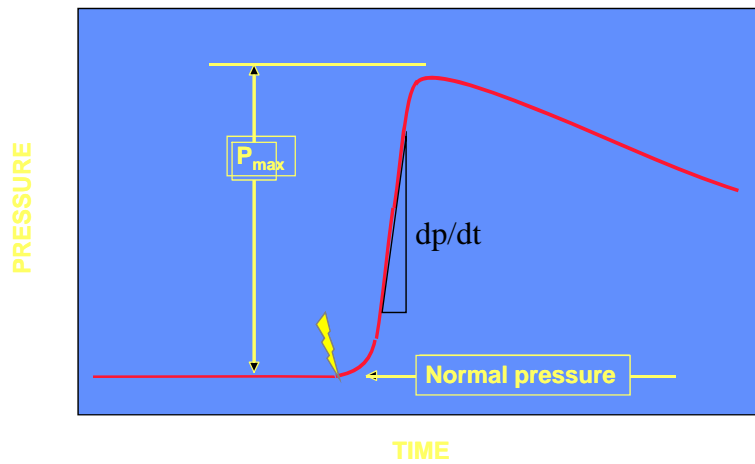
Confined Explosion



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Explosion Pressure Curve



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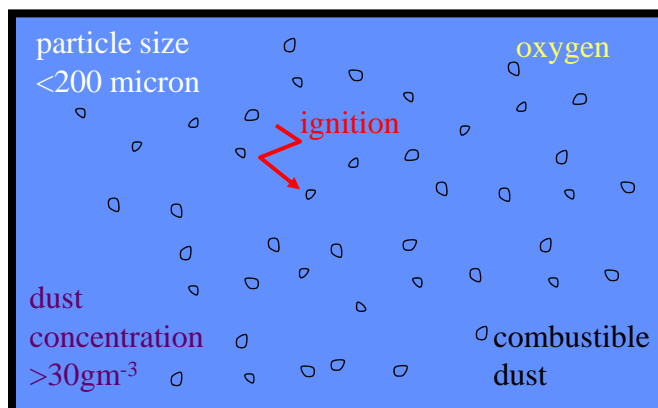
What explodes?

- Flammable gases
 - E.g. natural gas, hydrogen
- Flammable liquids (as vapours)
 - E.g. petrol, toluene
- Combustible dusts
 - E.g. coal, flour, sewage sludge
- Liquid mists
 - E.g. cooking oil, engine oil

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Conditions for a dust explosion



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Primary explosion



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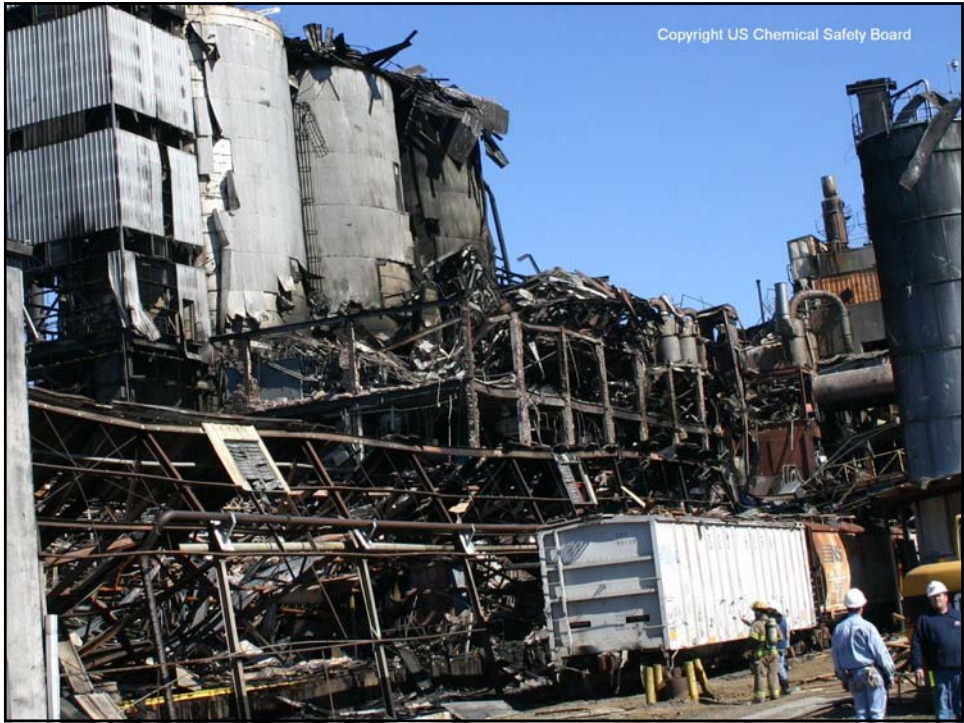
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Secondary explosion



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Housekeeping



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Dust explosion testing for Industry

Standard tests - Classification

Determines whether the dust
explodes or not

Group A (explosible)

Group B (non-explosible)

Hot coil ignition, 10kV electric
spark, 800°C hot surface &
pressure rise in test vessel



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Standard tests – Minimum Ignition Temperature

Lowest temperature of a hot surface which will cause a dust cloud to ignite and propagate flame.

The test apparatus and method follow BS EN 50281-2-1:1999.

For dryers or similar equipment.



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Standard tests – Layer Ignition Temperature

Lowest temperature at which a layer of dust of specific thickness (usually 5mm) ignites on a heated surface.

The test apparatus and method follow BS EN 50281-2-1:1999.

Specify appropriate temperature rating for electrical equipment.



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Standard tests – Minimum Explosible Concentration

Determines the lowest concentration of a dust that will allow combustion.

The test follows BS EN 14034-3:2006.

May be used as an explosion prevention method in areas where the concentration of the dust can be reliably controlled.



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Standard tests – Minimum Ignition Energy

Test measures the ease of ignition of a dust cloud by electrical and electrostatic discharges.

Follows BS EN 13821:2002.

Determines whether special precautions are necessary to prevent electrostatic discharge.



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Standard tests – Limiting Oxygen Concentration

Determines the minimum concentration of oxygen into which a dust cloud is dispersed that will sustain flame propagation.

Follows BS EN 14034-4:2004.

The test is required if inerting is the basis of safety

Different results for different inertants eg Steam, Nitrogen, Carbon Dioxide.



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Standard tests – Explosible Indices (K_{st} & P_{max})

Test measures the maximum explosion pressure and rate of pressure rise.

The test follows BS EN 14034-1:2004 & BS EN 14034-2:2006 .

P_{max} & K_{st} value is used to design explosion protection systems – venting & suppression.



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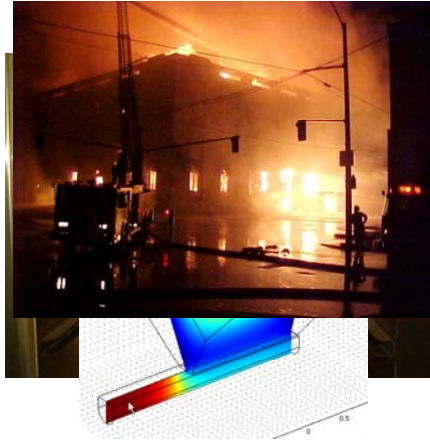
Standard tests – Self-Heating

Ascertain the risk from self-heating leading to spontaneous combustion

Screening test

Isothermal basket test to BS EN 15188:2007.

Finite element analysis software is used to computer model the self-heating process.



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Example explosibility data

	Mean particle size (micron)	Maximum explosion pressure (bar)	Kst (bar m/s)	St Class
Aluminium	10	11.8	455	3
Calcium	23	6.8	119	1
Epoxy powder	32	6.9	125	1
Lycopodium	27	6.5	135	1
Polyester	30	6.1	85	1
Polyethylene	14	5.9	134	1
Soya bean meal	70	5.7	26	1
Tinuvin 320	22	6.8	244	2
Wheat	22	6.1	65	1
Zinc	17	4.7	35	1

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Explosion Classification

Dust Explosion Class	Kst (bar m/sec)	Characteristics
St 0	0	No explosion
St 1	>0 <200	Weak explosion
St 2	>200 <300	Strong explosion
St 3	>300	Very strong explosion

Generic vs actual test data

- Example (sugar)
- $K_{st} = 138$ bar m/sec & $P_{max} = 8.5$ bar
- $K_{st} = 11$ bar m/sec & $P_{max} = 3.9$ bar
- $K_{st} = 205$ bar m/sec & $P_{max} = 9.1$ bar

Relying on data ... get it writing!

Data required for DSEAR/ATEX compliance

LOC (inerting)

Pmax Kst (venting, suppression or containment)

MIT (dryers etc)

LIT (electrical or mechanical equipment)

MIE (all plant)

Screening test (self-heating materials)

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Questions?

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