

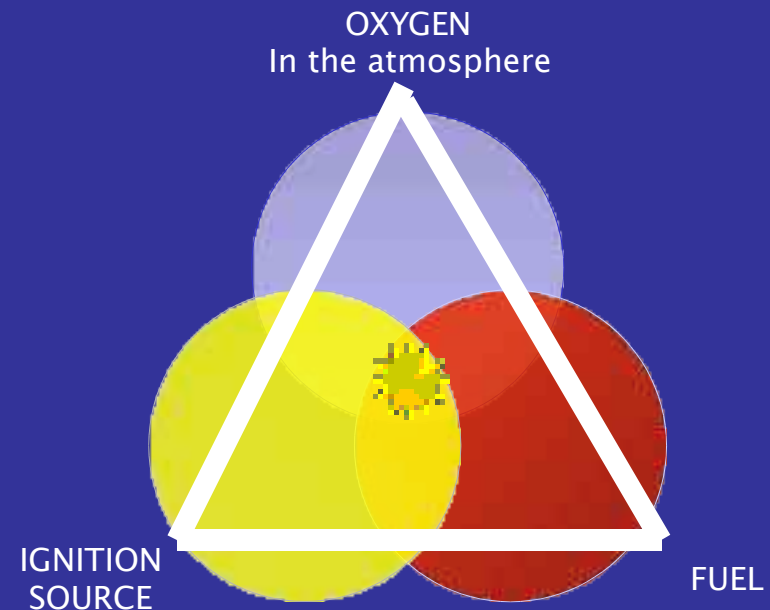
- *Dust Explosions*

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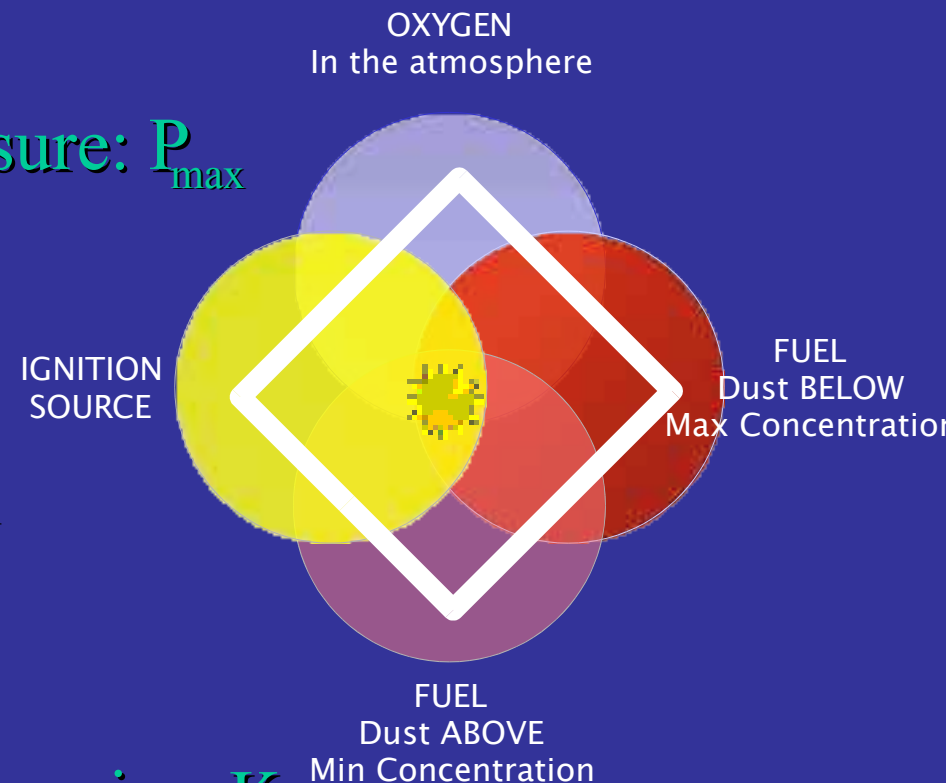
# Explosions

- *Explosions require combustion and to have combustion we must have the presence of:*
  - *Fuel*
  - *Oxygen*
  - *Ignition*



# *Dust Explosions*

- If the dust can't burn then it won't explode
- If the dust explodes then it also causes fires
- Must be in a confined space
- They have limited maximum pressure:  $P_{max}$
- Occur in the presence of
  - Oxygen (or reactive gas)
  - Ignition source
  - Fuel / Oxygen mix below a maximum concentration
  - Fuel / Oxygen mix above a minimum concentration
- They have a defined rate of pressure rise:  $K_{st}$



*Explosible dusts are classified according to the maximum pressure and rate of pressure rise*

- **A Class 1 Explosible Dust**
  - St 1
  - Typically (but not exclusively) 10 Bar.g maximum
  - $K_{st} < 200$  Bar.m/sec
- **A Class 2 Explosible Dust**
  - St 2
  - $K_{st} > 200$  Bar.m/sec
- **A Class 3 Explosible Dust**
  - St 3
  - $K_{st} > 300$  Bar.m/sec

# Regulation

- ★ *Health & Safety at Work Act*
- ★ *Provision and Use of Working Equipment Regulations*
- ★ *ATEX directive*
  - ★ *E.U. Directive for Explosible Atmospheres*
- ★ *DSEAR*
  - ★ *UK Regulation = Dangerous Substances and Explosive Atmospheres*
  - ★ *Must consider exothermic reactions = fires and their consequences*
  - ★ *Remember: SMOKE KILLS*
    - ★ *Don't assume people automatically escape from smoke*

# Understanding (exploding myths)

- ★ *Dust explosions have multiple sources of ignition*
  - ★ *This distinguishes them from gas and vapour explosions that have a single point source*
- ★ *The primary explosion is almost always smaller than the secondary explosions*
- ★ *Dust concentrations vary widely*
  - ★ *60 g/m<sup>3</sup> (“a dense fog”) is nothing more than a rule of thumb*
- ★ *A deflagration is an explosion that has a pressure wave below the speed of sound*
- ★ *A detonation is an explosion that has a pressure wave at (or above) the speed of sound*
  - ★ *They are BOTH explosions*
  - ★ *The distinction between a deflagration and detonation is entirely academic as far as the victim is concerned !*

# Avoidance measures

- PREVENTION
  - *Inert atmospheres*
    - » *Running condition*
    - » *Assisted inert atmospheres*
  - *Control over dust cloud formation*
    - » *Housekeeping*
    - » *Seeding with granules / inerts*
    - » *Dampening*
    - » *Keep the plant leak-tight / minimise flanges & leak-points*
  - *Plant controls*
    - » *Temperature control*
    - » *Process control interlocks*
  - *Location*
    - » *Build process plant outdoors (No building)*
  - *Eliminate ignition sources*
    - » *Slow rotation speeds*
    - » *Choice of materials*
    - » *Anti-static filter bags*
    - » *.... But some dusts are self-igniting ... so you can't eliminate them all*

# Avoidance measures

- PROTECTION

- Containment

- » Most dusts have a  $P_{max}$  of 10 Bar – design the vessel to withstand  $P_{max}$

- Relief venting

- » Minimum pressure for relief venting is around 350 mBar.g (with an activation setpoint of around 100 mBar.g)

- » Must relieve to safe area or use Q-pipe style – but beware of smoke

- » Venting of the building is required

- » DOESN'T PREVENT FIRES

- Explosion suppression

- » Minimum pressure for explosion suppression is around 350 mBar.g (with an activation setpoint of around 100 mBar.g)

- » Prone to misfire due to sensors working on minimum setpoint

- » Expensive

- » Produces a background pressure of its own when it fires off

- » DOESN'T (normally) PREVENT FIRES

- Location

- » Keep people away from the plant – Have the control room remote

- » Remote monitoring

- Inert atmosphere

- » Prevents BOTH fires AND Explosions

- » Must monitor the atmosphere with high reliability system

# Avoidance of propagation

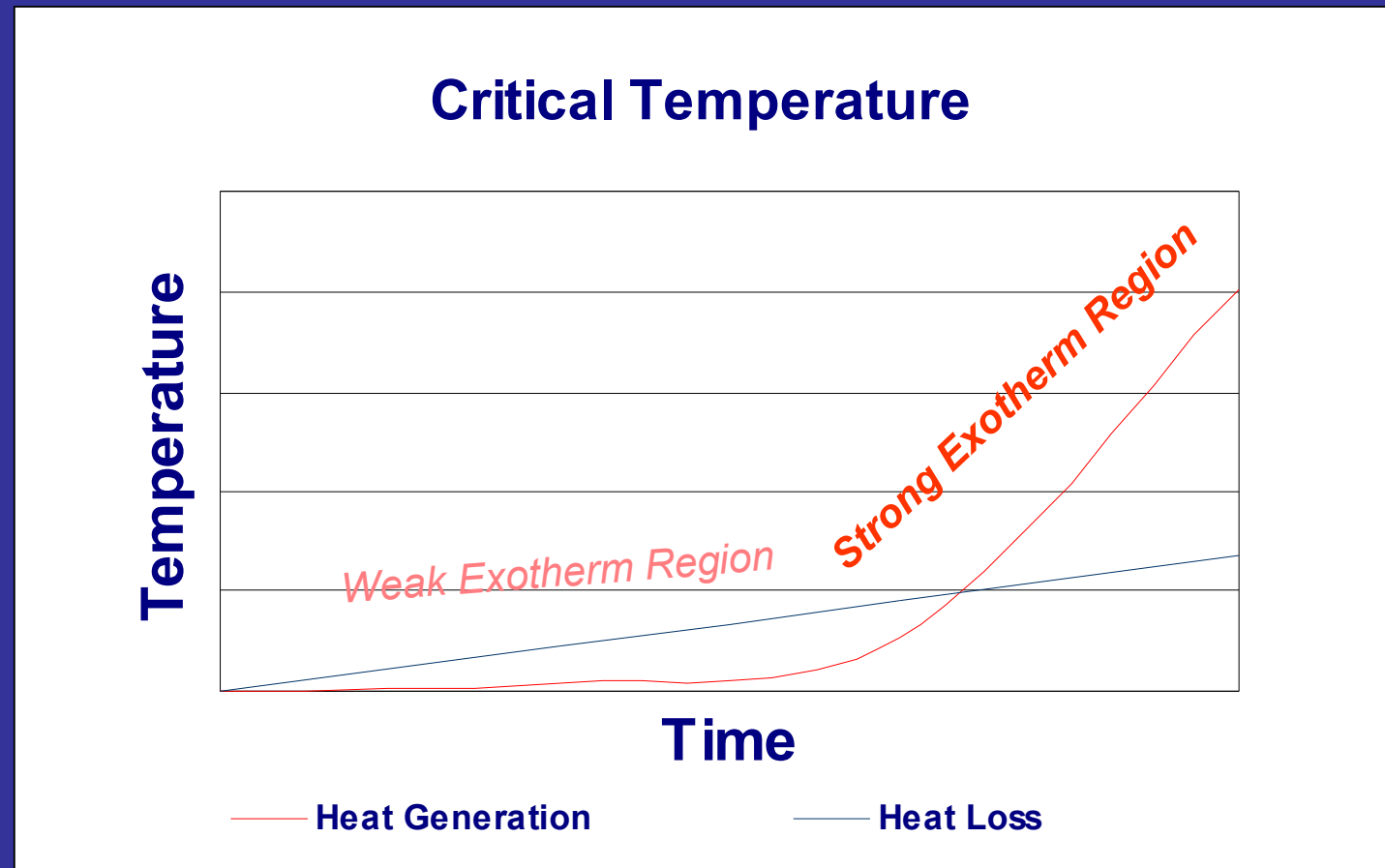
- PROPAGATION

- *Rotary valves*
  - » *Stops explosion spreading*
  - » *Doesn't stop the fire usually*
- *Choke plates in conveyors*
  - » *Stops explosion spreading*
  - » *Doesn't stop the fire usually*
- *Chemical barriers (suppressant)*
  - » *Can be design to stop both the explosion spreading and put out fires*

- INTERCONNECTED PLANT

- *EXPLOSION is of an order of magnitude greater due to pressure piling and enhanced ignition conditions*
  - » *Most standards recommend explosion suppression*
- *Slam-shut valve*
  - » *Must be able to protect all isolated volumes in which a dust explosion MIGHT occur.*

*For a dust to  
explode ....*



## Summary

- ★ *Dust explosions and fires must be considered under DSEAR*
- ★ *Primary dust explosions are small, secondary explosions are large*
- ★ *Minimise presence of dust clouds*
- ★ *Control the temperature – Avoid the strong exotherm region*
- ★ *Be sure inert atmospheres are present when required*
- ★ *Be sure protection measures are in place*