A CORUÑA | 2016 | OCTOBER | 12th - 14th

II CONGRESO INTERNACIONAL de SEGURIDAD INDUSTRIAL en PUERTOS

II INTERNATIONAL CONGRESS of SAFETY in PORTS

Puertos del Estado

Deputación DA CORUÑA

Ayuntamiento de A Coruña
Concello da Coruña

CESCI

EMAS

Puerto de A Coruña
Autoridad Portuaria de A Coruña

pixelling
ingeniería de seguridad

PRESENTACIÓN - INTRODUCTION

Henry Persson

- ***SP Technical Research Institute of Sweden, Fire Research***
- ***37 years of experience from research and testing related to fire brigades and industrial fire protection.***
- ***Main expertice in fire extinguishing media and fire fighting tactics***
- ***e.g. Tank fire fighting***
- ***Silo fire fighting***

Fire safety aspects during storage and handling of solid biofuels

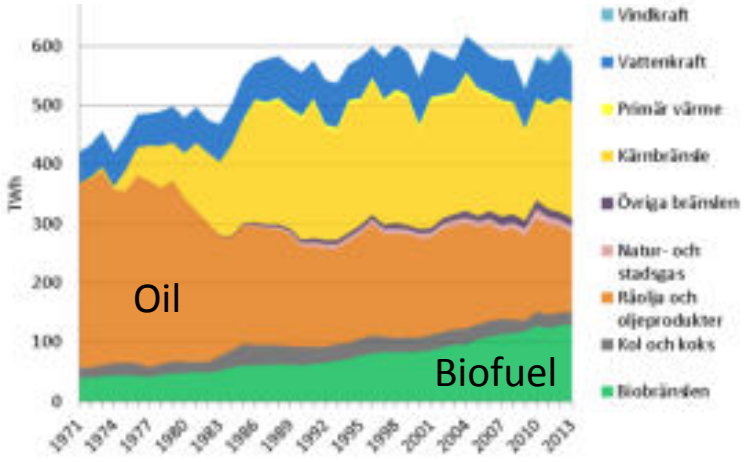
Henry Persson, SP Safety

More and larger storage facilities

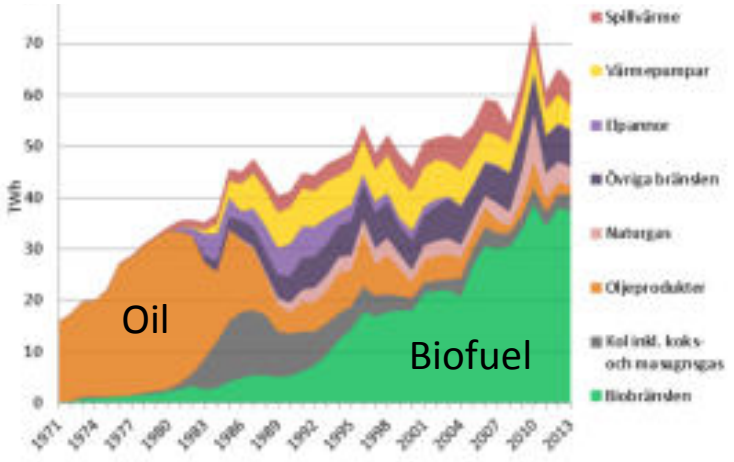
- Waste Directive (2008/98/EC) - seeks in particular to prevent waste generation and to promote reuse and recycling of waste.

- Decreased use of fossil fuels → use of biofuels/waste increases

Supplied energy in Sweden 1971-2013



Supplied energy in for district heating in Sweden 1971-2013

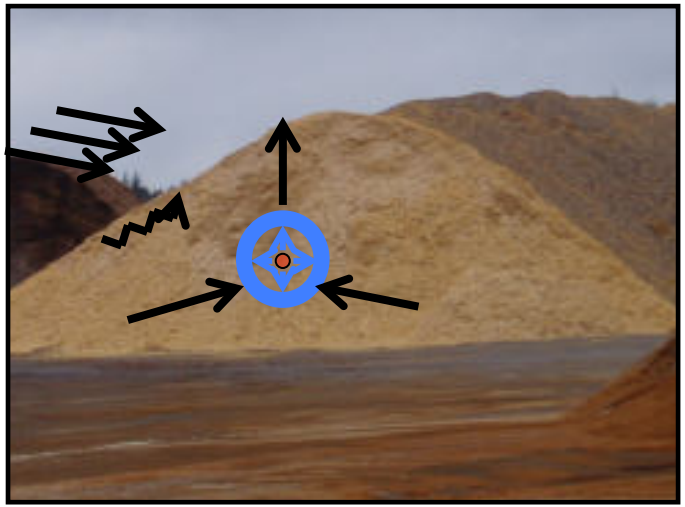


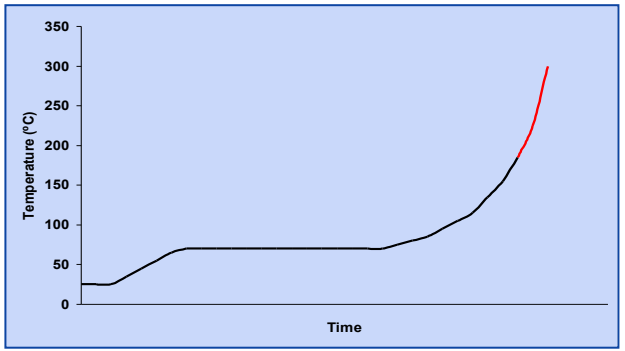
Production and storage of solid biofuels

Handling and storage of waste

Fuel storage problems in focus

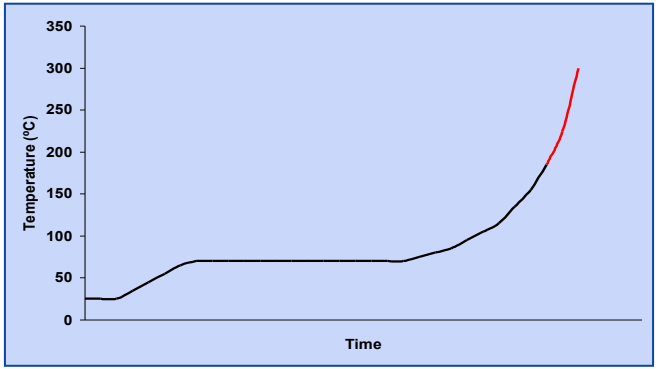
- Self-heating properties and risk for spontaneous ignition
- Explosions, fire development and risk for escalation
- Fire detection techniques
- Fire extinguishment tactics
- Emissions to air and water
- Improved guidelines



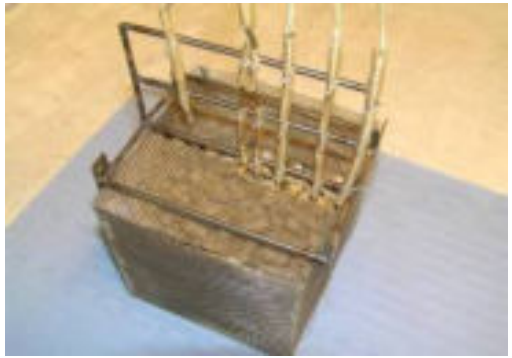


What causes self-heating?

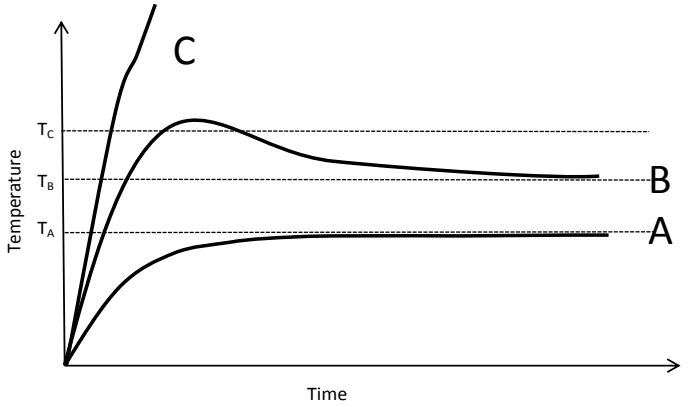
- Micro biological activity
- Physical processes
- Oxidation



Basket heating tests

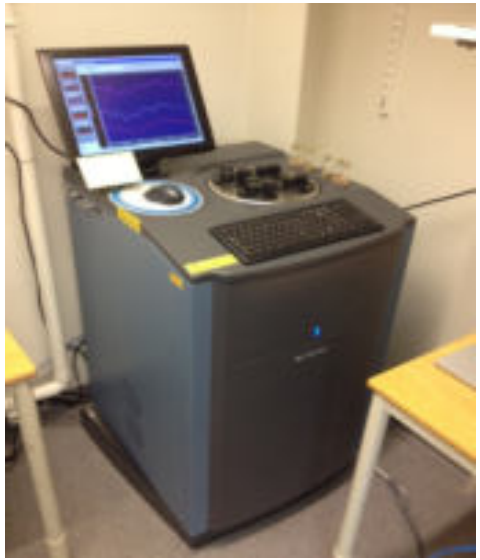


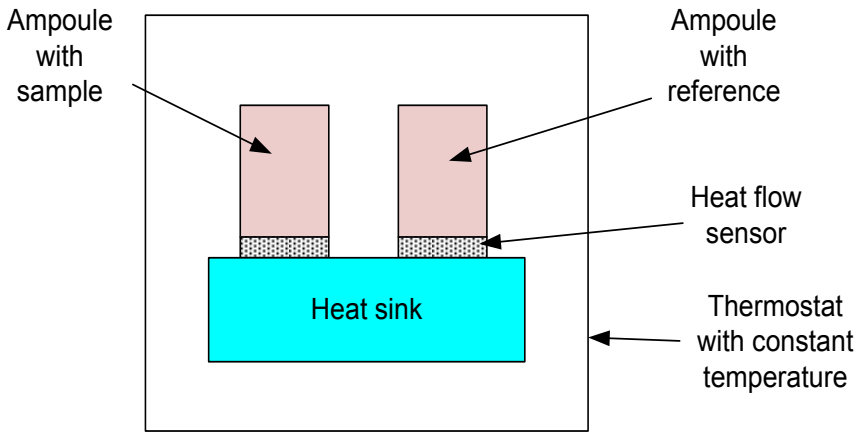
- Most common test for self-heating
- Material exposed to hot air in a heating chamber at various temperatures
- High test temperature, many tests
- Results: A) Sub-critical, B) Critical C) Supercritical



Isothermal calorimetry

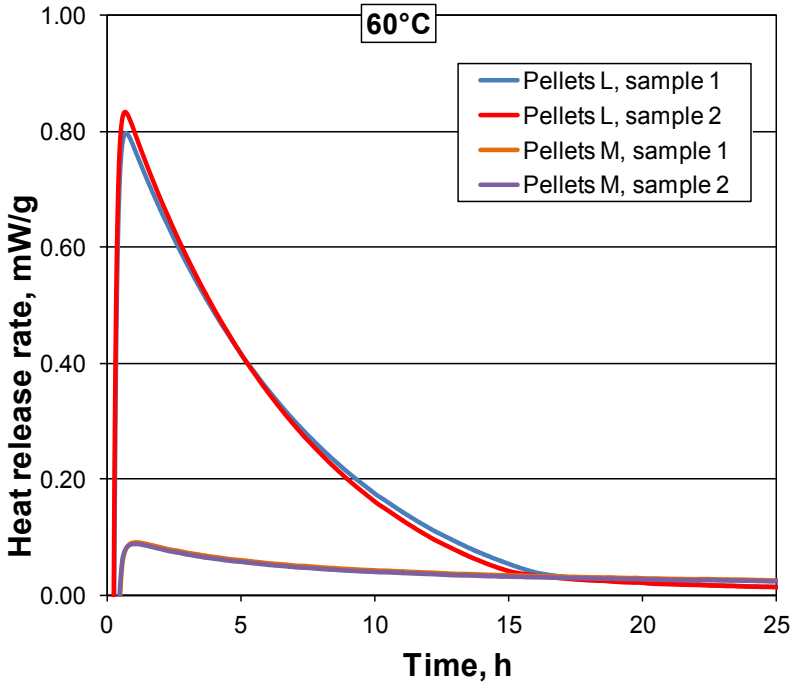
- Measures heat generation (e.g. mW/g)
- Tests at normal storage temperatures





Isothermal calorimetry – Example of results

Wood pellets



Batch no.	Composition	Comment	HRR_{max} (mW/g)
10.2	67 % spruce / 33 % fresh pine + some additional matured pine	Produced for 1 m^3 scale tests	1.37
9	40 % Pine / 60 % Spruce	-	0.91
6	80 % Spruce / 20 % Pine	-	0.77
12	50 % Pine / 50 % Spruce	-	0.69
5.2	100 % Pine	Produced for 1 m^3 scale tests	0.69
27	95 % Pine	5 % spruce bark as anti-ox.	0.38
25	100 % Pine	with anti-ox. PG	0.37
10	60 % Pine / 40 % Spruce	-	0.36
18	20 % Pine / 80 % Spruce	-	0.32
5	100 % Pine	-	0.29
14	100 % Pine	Lipid-free sawdust	0.26
23	100 % Pine	Ref. for anti-ox. pellets	0.23
20	100 % Pine	Torrefied	0.18
16	100 % Pine		0.16
29	Final flat storage trial in Denmark	Sampling right after production	0.16
28	Final flat storage trial in Denmark	1 week old at sampling	0.16
13	50 %Vine pruning / 50 % vine pomace		0.16
19	100 % Pine	Torrefied	0.15
15	100 % Pine		0.14
7	100 % Straw	Straight from the production	0.14
8	100 % Spruce		0.14
1	100 % Pine		0.11
26	75 % Spruce / 25 % fir + larch	From flat storage experiment	0.11
24	100 % Pine	With anti-ox. TBHQ	0.09
17	100 % Straw	From flat storage experiment	0.09
2	100 % Spruce	-	0.09
21	60 % Pine / 40 % Spruce	Sampled from fire	0.06
11	100 % Eucalyptus	Stored 1 year	0.05
22	100 % Eucalyptus	Fresh	0.05

1,37 mW/g

0,38 mW/g

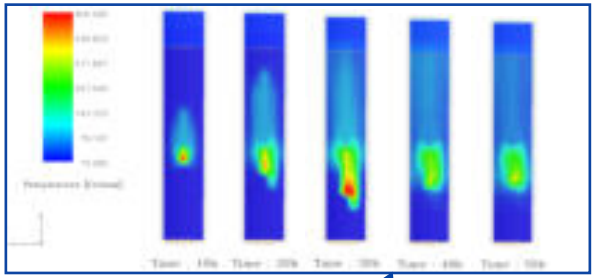
0,05 mW/g

Silo storage - fires often results in total loss

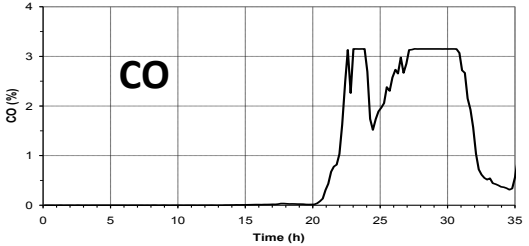
Background in 2003

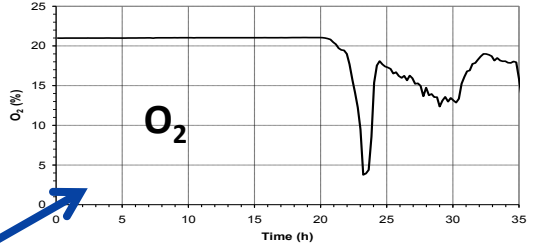
- Fire & Rescue Services limited experience
- Limited research available
- Very few guidelines
- No design data

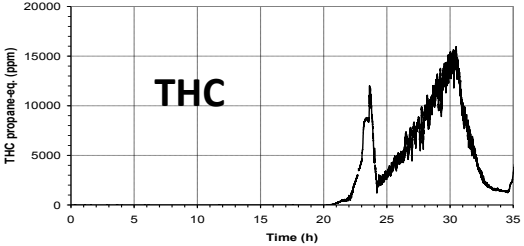
Silo fire tests in laboratory scale



- Temperature development inside the bulk material during fire and extinguishment
- Gas concentrations in silo headspace
- Extingusihing tests by injection of inert gas at silo bottom







Successful experience from real silo fires

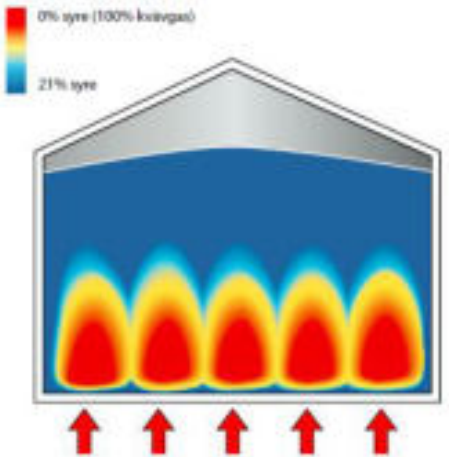
Wood pellets 2007
D=8 m, H=47 m

Coal 2009
D=10 m, H=13 m

Wood powder 2008
D=10 m, H=15 m

Experience on very large silos lacking!

Primary firefighting tactics



- Close openings and seal leakages to avoid access to oxygen.
- Injection of nitrogen at the silo bottom in gaseous form.
- The gas should be distributed over the silo cross section area.
- Design filling rate: 5-10 kg/m^2 h (cross section area)
  Total use: 5-15 kg/m^3 (gross volume)
- Start the discharge only when the fire is under control.

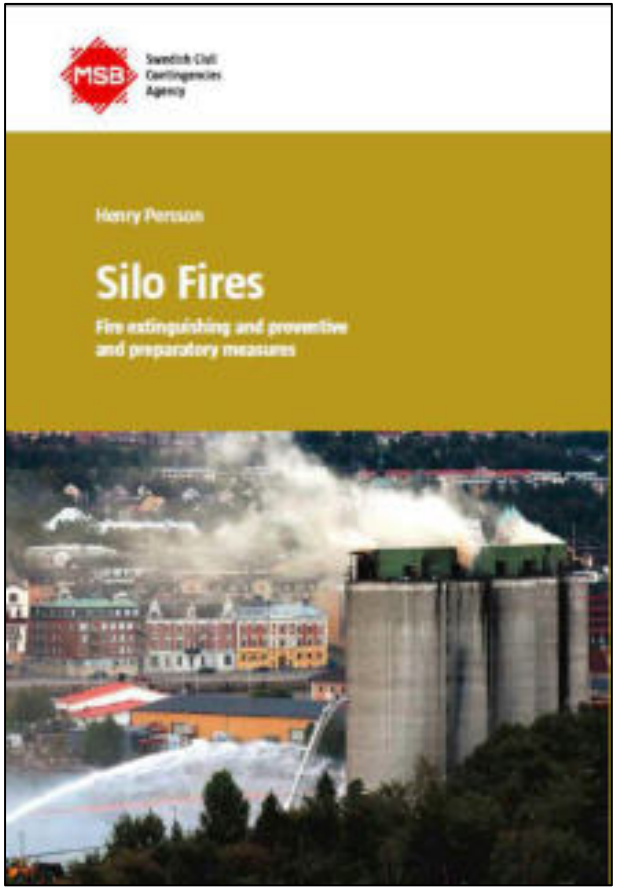
Primary firefighting tactics

- **Do not open the silo!**
  - Significant risk for gas- and dust explosions and fire escalation
- **Do not use water!**
  - Silos are not normally designed for the increased load.
  - Swelling might cause hangings/bridging inside silo or even cause rupture och the construction


Härnösand 2004


Hallingdal 2010


Laxå 2012



”Silo Fires - Fire extinguishing and preventive and preparatory measures”

Published by MSB (Swedish Civil Contingencies Agency)

Book available as pdf-file

Book and additional information at MSB web site (see links below)

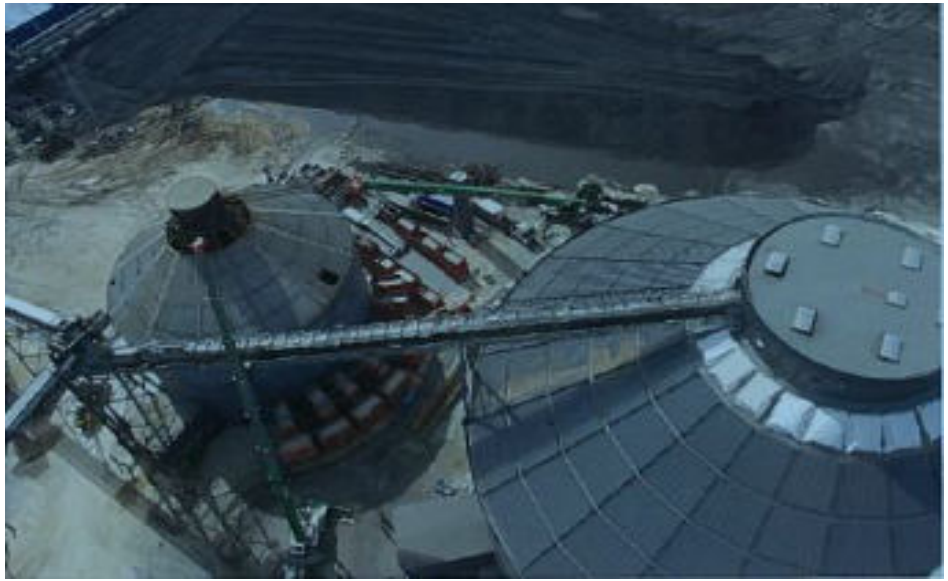
https://www.msb.se/sv/Produkter--tjanster/Publikationer/Publikationer-fran-MSB/Silo-fires-fire-extinguishing-and-preventive-and-preparatory-measures/

https://msb.se/sv/Insats--beredskap/Brand--raddning/Brand-i-silo/

Fires in flat storage

- 5000 ton of wood pellets
- Fire caused by self-heating
- Rapid fire development due to dischage of pellet bulk

Fires in conveyor systems



Silo fire in Denmark, aug 2012
45 000 and 100 000 m^3 silos involved

Fires in conveyor systems

ISO/TC238/WG7 – Safety of solid biofuels

Four standards under development

- ISO 20023 - Solid biofuels — Safety of solid biofuel pellets — Safe handling and storage of wood pellets in residential and other small-scale applications
- ISO 20024 - Solid biofuels — Safe handling and storage of solid biofuel pellets in commercial and industrial applications
- ISO 20048 - Solid biofuels — Determination of off-gassing and oxygen depletion
- ISO 20049 - Solid biofuels — Determination of self-heating

ISO/TC300 – Solid Recovered Fuels

WG 1 Terminology and quality assurance (secretariat by BSI)

WG 2 Specification and classes (secretariat by SIS)

WG 3 Sampling and sample reduction (secretariat by NEN)

WG 4 Physical/Mechanical tests (secretariat by DIN)

WG 5 Chemical tests and determination of biomass content (secretariat by UNI)

WG 6 Safety of solid recovered fuels (secretariat by SIS)

Thank you for your attention!

Questions?

Fire safety aspects during storage and handling of solid biofuels

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