Emerging risks from fires and explosions in solid biofuels - some evidence from Denmark

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Emerging risks from fires and explosions in solid biofuels - some evidence from Denmark

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Key arguments of this presentation

› Trend: convert coal fired thermal power plants to solid biomass fuel to reduce carbon dioxide emissions (renewable energy source, CO₂ neutral)
› Solid biomass fuel (wood pellets) is not only greener and more expensive than coal, it is also more dangerous (fire, explosion)
› Not classified as a dangerous substance (probably should) – not a "chemical hazard"
Wood pellet hazards

- Biomass pellets give off dust in quantities that present a serious dust explosion hazard.
- Compared to coal, the blast from the explosion is more severe and because pellets are sensitive to moisture they are handled in enclosures, which increase the dust explosion risk (both probability and severity).
- They easily ignite, from friction or sparks, and may even self-ignite if moist.
- Smoldering fires are difficult to detect and embers may migrate in the conveyor systems and develop into massive storage fires that cause extensive damage.

An emerging risk issue (ERI)?

- While wood dust accidents may have been grandfathered as tolerable risks, the intensification and complexities that come with the rapid scale-up and the handling of unprecedented quantities of solid biomass fuels call for increased attention.
- The number of serious accidents indicate that biomass pellets represent an emerging risk for which proper control strategies have yet to be developed.
Hazards of wood pellets

In 2012, the minister for climate change, Martin Lidegaard, hailed the "broadest, greenest, and most long-term energy agreement that has ever been reached in Denmark". The audacious plan would elevate Denmark as "the global leader in the transition to green energy".

The ambition is to have 50% of electricity consumption supplied by wind power, and to have more than 35% of final energy consumption supplied from renewable energy sources.
Substitution of coal for solid biomass fuel in thermal power plants - costs

- A socio-economic analysis estimates a benefit cost ratio of 0.4, i.e. that benefits amount to only 0.40 cent for each Euro spent
- The net present value for the entire conversion is estimated at minus 5.4 million Euros per MW converted effect
- Total negative net present value of 15.5 billion Euros for the anticipated Danish biomass conversion
- For scale and magnitude, this figure corresponds to about 12 percent of Denmark's 2012 gross national product.

Global production, wood pellets

Global consumption, wood pellets (increasing)


Global transport, wood pellets

Pelletizing for handling, convenience

Wood pellets

**Harvest feedstock**
- cut, haul

**Pelletizing**
- dry
- grind to dust
- press pellet

**Transport / storage**
- pellets

**Combustion**
- grind back to dust
- dust fired fluid bed units

Main differences: production, handling, storage

Wood pellets

**Harvest**
- extraction, manual work hazards (forest workers)

**Pellet manufacturing**
- fire
- dust explosion
- missile hazard

**Transport**
- dust explosion,
- self ignition
- carbon monoxide

**Storage**
- fire
- dust explosion,

**Combustion**
- fire
- dust explosion,

Coal

**Mining**
- extraction, manual work hazards (coal mine workers)

**Transport**

**Storage**
- nuisance smouldering fire

**Combustion**
- fire
- dust explosion
Wood pellet producer in Denmark

Wood chips → Mill → Pelletizer → Product shipment

Source: Company’s environmental permit

2010 explosion incident - wood pellet producer in Denmark

Wood chips → Hammer mill → Pelletizer → Ship product

Source: Company’s environmental permit
Shaft with cardan joints

Source: local DK workplace authority
Explosion?

Diffusion flame vs. pre-mixed flame
Dust, primary explosion makes dust airborne, powerful secondary explosion

1) Dust settles on flat surfaces
2) Some "event" disturbs the settled dust into a cloud
3) Dust cloud is ignited

Explosion - Imperial Sugar Company, USA, 2008, with 14 killed and 36 injured

› (sugar is not a dangerous substance)

› There have been two deadly sawmill explosion in Canada this year alone. One of the explosions was powerful enough to blow debris 400 metres away from the sawmill, and shake buildings and rattle windows several kilometres away (Vancouver Sun 2012)

› (wood dust is not a dangerous substance)
2002 explosion incident
- wood pellet producer in Denmark

Wood chips → Mill → Pelletizer → Ship product

Foreign bodies end up in hammer mill, pelletizer

- inherent generation of friction, sparks
- **routinely**, fires, explosions in hammer mills, pelletizers
- In case of fire, how to handle and what to do with contents (dust)?
> The fragmented information available indicate that, the Canadian British Columbia forestry industry had a fatality count of 43 in 2005, well over its annual average of 20.

> The injury count is not stated.

> Because of a large number of incidents and insurance claims from Canadian pellet mills, two insurers have left the pellet sector. The few insurers who remain, have implemented astronomical rates, restrictive terms and provide less capacity. (PMM 2011)

> Canadian insurance companies have recently told the pellet industry that its performance must improve or else pellet plants will no longer be insurable.
Solid biofuels - an emerging risk?

Numerous incidents at port facilities
> some reports of workers overcome by carbon monoxide emitted by pellets

Fires Denmark, UK, The Netherlands (?)
February 2012, Tilbury Power Station (UK), fire in 4,000 tons wood pellets, 3½ months of repairs

Structural issues

- Wood dust is not classified as a dangerous substance
- Accident investigations are kept internal and lessons learnt are not shared widely. This is a familiar and age old problem across industries and there are no indications that this will change without regulatory intervention
- While wood dust accidents may have been grandfathered as tolerable risks, the intensification and complexities that come with the rapid scale-up and the handling of unprecedented quantities of solid biomass fuels call for increased attention
Emerging risk issues (ERIs)

› The number of serious accidents indicates that biomass pellets represent an emerging risk issue (ERI) for which proper control strategies have yet to be developed.

› Some evidence of media-shifting - that the 'resolution' of a problem within the environmental domain creates a new problem in the workplace safety domain.

› Seems that minimal consideration has been given to this in environmental LCA studies, or in the audacious (and costly) plan to elevate Denmark as "the global leader in the transition to green energy".

Thank you for your attention!