SAFETY AGAINST FIRE AND EXPLOSION

IN DRY CARGO HANDLING

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Catastrophic fires and explosions have happened when transferring or storing flammable liquids and gases, and there is, at most ports, a high level of awareness, training and technical precaution against such incidents. But how many people know that there is also a high risk of explosion and fire associated with many dry cargoes? More worryingly, how many ports have the same level of training and awareness amongst workers in how to prevent such incidents with dry cargoes?

Biomass is one of the fastest growing bulk shipping sectors, fuelled mainly by wood pellets coming in to Europe to replace some of the coal used by existing power stations. Obviously as a fuel it is combustible; the same can be said for coal, but animal feed, grain, sugar and other organic material can behave in the same way.

DUST DANGERS

A big practical problem with organic dry cargoes is dust; often food, feed and biomass dust is far more dangerous than coal. Pellets or grain at typical moisture contents of 4% to 8% are dry to the touch, so dust particles don't bind to the surface like they do to coal. The dust particles are lighter, so they become airborne easier, travel further, and settle over a wider area compared to coal.

Furthermore, organic dust often contains mould spores, which are hazardous to health and can lead to "Farmer's Lung" (also known as alveolitis), the most common industrial disease in the agricultural industry. If the dust settles anywhere damp, the mould will multiply and release more spores. Settling on anything electrical, it causes heat to build up, and can start to smoulder and initiate a fire (this happened on a lamp at Tilbury Power Station in February, 2013, leading to a fire causing $50M of repairs and lost production). Airborne in a cloud, the dust is explosive and can be set off by hot surfaces or sparks.

Minimising and controlling dust has to be top priority, first by designing the handling systems to reduce breakage of the particles, then by containment and ultimately some extraction where there is no other alternative. Do not try to use extraction as a substitute for good prevention and containment, extraction is the most expensive and least effective contributor to effective dust control.

KEEP IT CLEAN

Controlling explosion hazards is a must. Where dust can build up in enclosed spaces; silos, sheds, filter houses and so on, there is potential for an explosion, so you need to either keep the dust level down, or provide explosion venting. In Europe, "ATEX" is the watchword – it stipulates how you carry out a risk assessment and decide on the level of explosion hazard in each area of the plant ("zoning"), then the ATEX equipment ratings enable you to select equipment that is safe to use, according to the level of explosion hazard present in each area. It's a good system, and easy to use once you understand it.

The most important factor in keeping a plant safe is simply preventing dust from spreading through the facility, and cleaning up dust that settles. Catastrophic dust explosions that demolish facilities and kill people (YouTube search "Imperial Sugars" for an example) are usually secondary explosions caused by dust on the floor, beams, lights, cabinets and so forth, being brought up into the air by an initial event, and then leading to a fireball that rips through the whole place incinerating anyone in its way. Essentially, if there's enough dust to write your name in, it's time to get it cleaned up. Keeping housekeeping up to near food factory levels is quite literally, a matter of life and death for the operatives.

Mobile plant (e.g. shovels and dozers) used in sheds and cargo holds for trimming needs to be protected against producing ignition hazards, and overheating due to dust ingress. Usually this means conversion of the machine, costing more than the first purchase price. These machines also need to be kept clean – budget for an hour of cleaning in every three or four hours of use, and make sure the dust is kept out of the cab.

SELF-HEATING AND FIRE PROTECTION

In storage, many combustible cargoes can self-heat. We don't fully understand this process – but the main protection is to get the cargo in, turned around and out in a short enough time to stop them from getting to thermal runaway stage. Make sure you have proper stock rotation – in a silo, do you know if you will have "mass flow" (first-in-first-out) discharge or core flow (first-in-last-out)? If you're not sure, make sure you find out, because it's critical to the operation and the need for regular complete emptying to prevent fires.

Monitor temperatures and look out for smouldering material coming into a store, and use both CO trending (not an alarm level as you would for coal) and multi-gas detectors. In spite of this, you will have a fire one day in your store (it's a case of when not if) so be prepared with a comprehensive fire strategy. Do not just rely on local firefighters because experience shows that they usually do not know how to tackle a dry cargo blaze and will often make matters worse, not better. To avoid loss of the facility, be ready with the right plans and equipment to deal with it yourself in the right way so no-one is put at risk.

LOADING AND UNLOADING

Handle to minimise breakdown of the particles, as well as containing dust. Grab unloading is most particle-friendly, but causes most spillage – design of the grab discharge hopper with good containment and local extraction is critical. Continuous ship unloaders are more efficient, but can be more problematic – bucket wheel machines create clouds of dust, pneumatics cause much more breakdown of the particles – but there is no single right answer, the machine needs to be chosen carefully according to the operating context, as does the storage facility, flat store, dome or silos?.

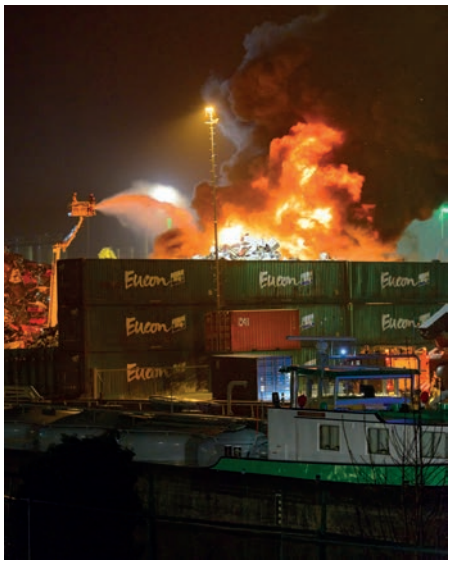
CONVEYING

Conveyors need to be designed to incorporate the latest "hood and spoon" chute technology – traditional transfer point designs will destroy the pellets and lead to massive dust problems – and implement the latest research in stilling chamber design. Then, with a small amount of extraction judiciously applied, dust problems will not exist. Conveyors must be protected against rain ingress and wind lift-off, but whether conveyors should be fully covered or open within a larger wind-proof gallery is a moot point.

Fully covered conveyors contain dust, but if they are not cleaned out regularly, they offer the perfect conditions to conduct a secondary dust explosion through the plant (Imperial Sugars, once more). Uncovered conveyors should not suffer excessive dust build-up, if the transfer point designs are done correctly and draughts are kept out of the galleries and transfer towers, but will still require regular cleaning.

TRAINING

The safety and efficiency of the operation depends on the experience and expertise of the designer and operators. However, bulk solids handling does not make it into the curriculum of most engineers and operators, so many people feel their way into the technology and this can lead to mistakes along the way. So the single most important factor is getting all the people trained up, from the procurement team so they know what they need to buy, through the designers and contractors so they can optimise the design, to the operators so they can work safely. For this reason, The Wolfson Centre for Bulk Solids Handling Technology has developed a suite of short courses for those interesting in handling dry cargoes. Getting all the people along the chain to know what they are up against is the single most important key to commercial success in the dry cargo business.



ABOUT THE AUTHOR

Mike Bradley is Professor in Particle and Bulk Technology and Director of the Wolfson Centre. He was awarded both his honours degree and PhD from Thames Polytechnic (now the University of Greenwich) and, as Manager and Director, provides technical leadership in all aspects of bulk solids handling. His particular areas of interest lie in pneumatic conveying, design of hoppers and silos, dust control, plant integration and maintenance of product quality. He is a member of Solids Handling and Processing Association (SHAPA) and Chair of their Technical Committee, Materials Handling Engineers Association (MHEA) and of the Institution of Mechanical Engineers Bulk Materials Handling Committee (IMechE).

ABOUT THE ORGANISATION

The Wolfson Centre for Bulk Solids Handling Technology is internationally recognised for its expertise in fields associated with bulk particulate handling and in the science and practical application of technologies to deliver improved process efficiencies. Our mission is to help industry to get powders and bulk materials to behave predictably through processes.

We have developed our portfolio of services over nearly four decades of interaction with industry, trade associations and professional bodies. We offer consultancy services to industry, conduct industrially focused research related to bulk solids handling issues and offer specialist short courses targeted at industry professionals

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