3

Fire

3.1 Explosion caused by fumigation

A bulk carrier had loaded yellow corn in all cargo holds up to the hatch coamings. After the loading was complete, fumigation technicians came on board and fumigated the cargo with fumitoxin pellets.

As per the cargo documentation, the fumigation pellets were required to be applied subsurface. In this instance the technicians poured the pellets from flasks while walking on the hatch coamings or hatch covers. This work took a little more than an hour and afterwards all the cargo hatches were closed and the vessel sailed.

A series of explosions

A couple of hours later an explosion occurred in one of the holds. The crew noted that the hatch covers had moved slightly and blue gray smoke was seen coming from under the edges. About an hour later another explosion occurred in a second hold, and a couple of minutes later an explosion occurred a third. There were explosions in the remaining holds shortly afterwards.

Cause

Fumitoxin pellets and similar fumigants are made up of around 55% aluminium phosphide which reacts with water to produce phosphine, an extremely toxic and effective fumigant. Phosphine gas will form an explosive mixture when mixed with air at a concentration exceeding around 1.8% to 2% by volume (the lower flammable limit). The concentration of phosphine in the air in each of the holds exceeded this lower flammable limit.

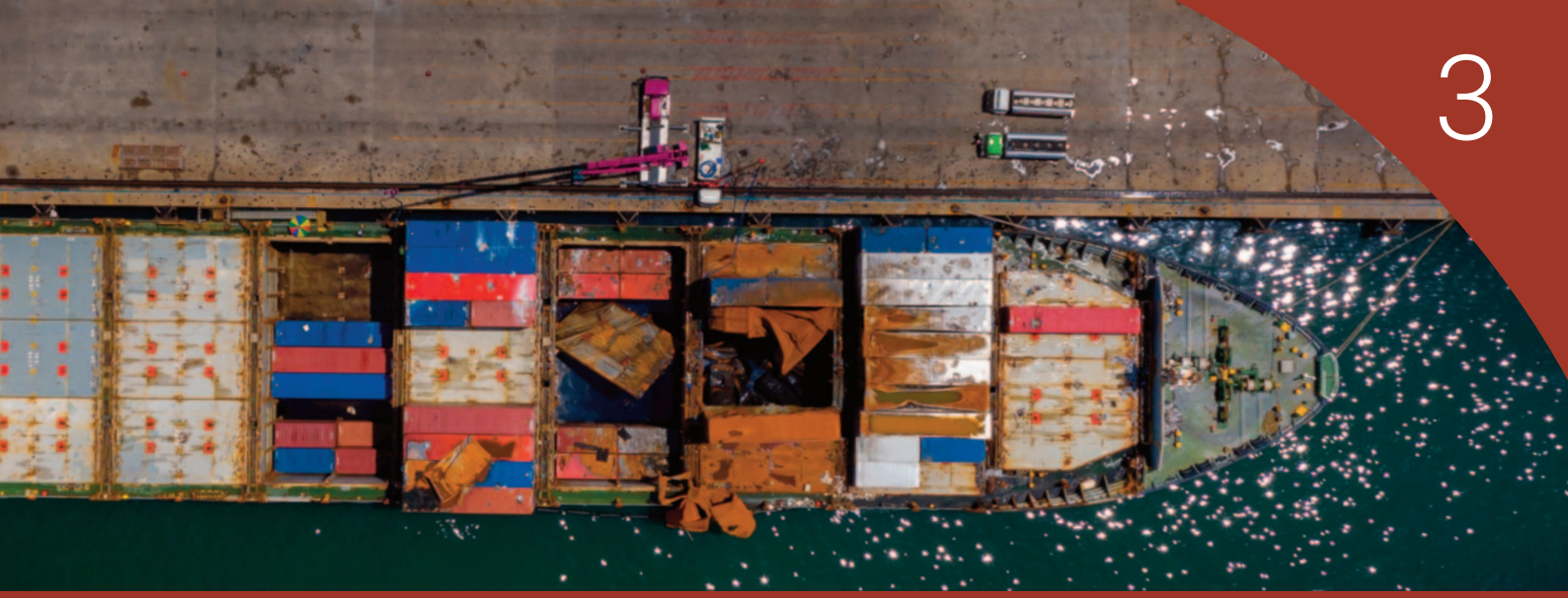
The fumigant pellets in each hold had not been distributed across the entire cargo surface, or applied to the subsurface, but had been applied by simply pouring the pellets on top of the cargo. This method of application had permitted the accumulation of the pellets in limited areas and promoted a relatively rapid reaction of the pellets with moisture, generating concentrations of phosphine gas above the lower flammable limit, which lead to the explosions.

What can we learn?

- The manager should provide training to the crew to ensure that the crew is aware of the requirements and procedures for the fumigation operation. The crew need to ensure that the fumigation pellets are distributed as per the cargo documents.

- Agricultural products in bulk may be fumigated in ships' holds to prevent insect infestation. Solid aluminium phosphide (or similar) is often used for fumigation. Aluminium phosphide reacts with water vapour (humidity) in air to produce phosphine, a toxic and flammable gas, which kills insects. Heat is also given off during the reaction. The solid fumigant may be applied in fabric 'socks' or as pellets on the surface, just before closing holds. Holds are then kept closed for a period before ventilating. People must keep out of holds that are being fumigated due to the toxic fumigant.

- If there is an excessive amount of fumigant in one place, or if the fumigant is in contact with liquid water e.g. from sweating or condensation, then the fumigant can react too quickly. This can evolve excessive heat and lead to ignition of cargo and/or packaging such as bags or paper placed over the top of the cargo. Under certain conditions the fumigant gas itself may ignite, producing an explosion. It is important that fumigant is applied according to the correct instructions. As holds are always un-ventilated for a time after fumigation, there may be a risk of excessive condensation, which can produce sweating or dripping. This can lead to cargo damage as well as the fire and explosion risks mentioned above. The weather conditions and cargo conditions, such as moisture content, therefore need to be considered properly before fumigation, which is often carried out by specialist companies.



3.2 Misdeclared container caused fire

It was early morning and from the bridge the Master saw a large cloud of smoke issuing from the forward part of the vessel. At the same time the fire detection system for cargo hold 2 sounded on the bridge. The Master described the smoke as being white at first and then greyish. The Chief Officer, however, described the smoke as being "dark grey, almost black".

The ventilation fans for the cargo holds were stopped. The fans for cargo hold 2 were not operating at that time but natural ventilation was being provided for the holds as the covers for the vents were open. Crew members closed the covers of the vents for cargo hold 2 and no crew member entered the cargo hold.

Discharge of CO_2

Meanwhile the Master navigated the ship to a nearby anchorage. After various checks had been performed, the Chief Engineer released the contents of 197 CO_2 cylinders into cargo hold 2. This discharge was the designated full complement of CO_2 required for the hold, and appeared to extinguish the fire. A couple of hours later smoke began to issue from the hold and a further 57 CO_2 cylinders were released into cargo hold 2. About six hours later smoke was observed issuing from cargo hold 2 and the Chief Engineer released a further 57 CO_2 cylinders.

Salvors boarded the vessel the following morning. Shortly before midnight, temperature checks were completed by the vessel's crew indicating that the temperature in cargo hold 2 was rising so five more CO_2 cylinders were released. In the morning another 15 CO_2 cylinders were released. The salvors entered cargo hold 1 and measured the temperature for the bulkhead to cargo hold 2 - it was 83°C. It was decided that cargo hold 2 should be filled with water from the fire hydrants. The water filled three container tiers up and after a couple of hours the salvors considered the fire to be extinguished.

Dangerous cargo

The container where the fire started was not declared as dangerous cargo but was actually loaded with calcium hypochlorite and had been misdeclared by the shipper. The charterer had loaded the container as per the rules of the IMDG code. As per the manifest, the container was allowed to be loaded in the cargo hold, but as the cargo was calcium hypochlorite it should not have been loaded below deck or in the position it was stowed in.

What can we learn?

Cargoes that fall into this category include calcium hypochlorite and other oxidising solids. They are often used for swimming pool sterilisation and fabric treatment (bleaching or washing). These materials do not oxidise but they can be relatively unstable chemicals that decompose slowly over time, evolving oxygen. This self-decomposition can evolve heat. A self-heating process can therefore happen in which the material towards the middle of a body of cargo becomes hotter, so the rate of decomposition and heating increases. This can lead to 'thermal runaway' with very rapid self-decomposition and evolution of heat and gases, sometimes including further oxygen. The effects of this in a hold can be similar to an explosion. The heat and oxygen produced can lead to fire spreading.

Potential causes of self-decomposition incidents include:

- Exposure to heat e.g. solar radiation (before or after loading), cargo lights and heated fuel tanks.
- Cargo formulation.
- Contamination of cargo at manufacture.
- Spillage and thus reaction between cargo and combustibles e.g. timber.
- Excess quantity of cargo in containers giving insufficient dissipation of heat Inadequate separation of packages in containers, also giving insufficient dissipation of heat.

3.3 Floodlights caused cargo fire on bulk carrier

A bulker had loaded sugar beet pellets in all three cargo holds with the operation taking 27 hours. When loading was completed the ventilation hatches and all other access points to the cargo holds were secured. In cargo hold 1 there were two metres of space between the cargo and the cargo hatch. In cargo holds 2 and 3 the cargo was almost up to the hatch coaming.

Smoke from cargo hold 2

Two days into the voyage the crew noticed smoke coming from cargo hold 2. Hot spots were discovered in hold 2 on the transverse hatch coaming, both forward and aft on the portside, and an additional hot spot was also discovered on hold 3 on the transverse hatch coaming, on the portside aft. All hot spots were located adjacent to recesses in the coamings for the cargo holds' floodlights.

The crew isolated the electrical power to the floodlights. Because of the increased temperature of the hot spots in hold 2, the Master released CO_2 into the hold. The CO_2 did not extinguish the fire but reduced its severity for a while. When the vessel arrived at the discharge port the cargo hatches were opened, and flames broke out from hold 2. At the same time a plume of smoke escaped from hold 3. The top layer of cargo in hold 2 had been burned.

Burn marks around floodlights

About 4 metres below the cargo surface the cargo was in good condition. It was discovered that the cargo in hold 3 had been damaged by condensation and tainted by smoke. There were clear burn marks around the floodlights and distinct burn marks by the coaming at the same locations where the hot spots had been discovered.

The floodlights were situated 1 metre below the cargo surface in holds 2 and 3 and there was black, burned cargo covering the floodlights. There were two floodlights fitted in cargo hold 1, port and starboard and four floodlights fitted in both cargo holds 2 and 3. All the floodlights were installed in recesses in the hatch coaming. The floodlights were protected by round bars preventing crane hooks, grabs etc from hitting them, but these bars do not prevent cargo like sugar beet pellets from covering the lights. The floodlights were controlled from the bridge on a panel with four key-switches. These switches were marked 1, 2, 3 and 4 respectively. No drawings or legends were attached clarifying which areas these key-switches served.

What can we learn?

- The subsequent investigation revealed that the cargo floodlights were not connected according to the approved 'as built' circuit diagrams delivered with the vessel. It was not clear on board which lights were controlled by which keyswitch.
- The fire was caused because a number of cargo lights were operating while cargo covered them, so the lights ignited the cargo. There was a lack of information on board about how the light circuits were connected and how the light system should be operated. There was also a lack of records concerning use of the lights.
- Many bulk carrier/general cargo holds have fixed cargo lights. Halogen-type lights can easily ignite combustible cargoes such as grain, animal feed, wood chips, pulp and paper if they are too close to the light.
- Cargo lights in holds need to be properly isolated before cargo is loaded. This is best done by removing fuses or other physical links in the electrical circuits so that the lights cannot be switched on by mistake. In container ships the lights need to be properly placed so that they do not overheat cargo or other combustibles and thus cause damage or fire. Lights in car carriers and ferries are usually fluorescent, which are unlikely to cause ignition. Nonetheless it makes sense to leave lights switched off when they are not needed, particularly in cargo areas where combustibles are present.

3.4 Hot work caused container fire

A container vessel was awaiting instructions for when to enter the port. During the wait the Chief Officer made the decision to carry out repairs to the cell guides in one of the cargo holds. The engine fitter and an AB began to prepare the welding job for the cell guides.

Container fire

Before the welding commenced a risk assessment and hot work permit were completed. As per the hot work permit, fire extinguishers were in place and one AB was the designated fire watch. The Chief Officer approved the job and was also present. Some time into the job, the engine fitter began to smell burned rubber, and on investigation saw that a container had caught fire. In the vicinity were a couple of oxygen and acetylene bottles which the engine fitter moved to safety. The Chief Officer ordered everyone to evacuate the cargo hold and informed the bridge that a container had caught fire. The general alarm was sounded and a fire team assembled and began boundary cooling.

The heavy smoke and high temperature made it impossible for the fire team to approach the fire so the Master decided to release the CO_2 system into the cargo hold, which extinguished the fire. The container that had caught fire was an open top container covered by a tarpaulin and containing cloths, tyres, wooden plates and machinery.

What can we learn?

- Many cargoes, including a wide range of bulk cargoes and general cargoes can be ignited by cigarettes and/or hot work. Smoking and hot work therefore need to be properly controlled. Control of smoking can be difficult where stevedores are working on board and hot work permits need to be properly considered, not just a 'tick box' exercise. Once a fire has started, some bulk cargoes will smoulder for long periods even after closing and sealing holds and using CO_2 to maintain a low oxygen concentration in the ullage space. This extended smouldering is often due to residual oxygen absorbed into the cargo and air/oxygen in voids in the cargo e.g. between pellets. In cases of extended smouldering the only option may be to discharge part or all of the cargo.

Glossary of common industry abbreviations

Term	Meaning
AB	Able seaman
AIS	Automatic identification system
ARPA	Automatic radar plotting aid
COLREGS	International Regulations for Preventing Collisions at Sea
COSWP	Code of Safe Working Practices for Merchant Seafarers
CPA	Closest point of approach
CSM	Cargo securing manual
ECDIS	Electronic chart display information system
ETA	Estimated time of arrival
GM	Metacentric height
GPS	Global positioning system
IHO	International Hydrographic Organization
IMDG Code	International Maritime Dangerous Goods Code
IMO	International Maritime Organization
IMSBC Code	International Maritime Solid Bulk Cargoes Code
ISM	International Safety Management Code
JRCC	Joint rescue coordination centre
MOU	Memorandum of understanding
NM	Nautical miles
OOW	Officer on watch
PA	Public address system
PMS	Planned maintenance system
SMS	Safety management system
SSAS	Ship security alert system
SSP	Ship security plan
STS	Ship-to-ship (transfer)
TML	Transportable moisture limit
UHF	Ultra high frequency (radio)
VDR	Voyage data recorder
VHF	Very high frequency (radio)
VTS	Vessel traffic serice

Head Office Gothenburg
Visiting address:
Gullbergs Strandgata 6, 411 04 Gothenburg

Postal address:
P.O. Box 171, 401 22 Gothenburg, Sweden
Tel: +46 31 638 400 | E-mail: swedish.club@swedishclub.com

Emergency: +46 31 151 328

For more information about The Swedish Club Casebook please contact:

Lars A. Malm
Director, Strategic Business Development & Client Relations

Telephone: +46 31 638 427
E-mail: lars.malm@swedishclub.com

Ellinor Borén
Claims & Loss Prevention Controller

Telephone: +46 31 638 449
E-mail: ellinor.boren@swedishclub.com

Joakim Enström
Loss Prevention Officer

Telephone: +46 31 638 445
E-mail: joakim.enstrom@swedishclub.com

Lorraine M. Hager
Loss Prevention & Marketing Advisor

Telephone: +46 31 638 492
E-mail: lorraine.hager@swedishclub.com

Peter Stålberg
Senior Technical Advisor

Telephone: +46 31 638 458
E-mail: peter.stalberg@swedishclub.com