



## 1.17 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 led 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.