Hydrogen sulfide
Methane
Sump
Maintenance
Fermentation
Victims
Organisation
Instructions

Fatal accident due to asphyxia by H2S
February 15th , 2001
Baupte – [Manche]
France

THE INSTALLATIONS IN QUESTION

The site

The establishment at Baupte employs approximately 350 people. It is specialized in the production of natural food additives such as gelling agents pr stabilisers, algae-based products through extraction (carraghenane) or by bio-fermentation (xanthane).
It is governed by a Prefectoral order of September 22, 1997 completed February 20, 2000.
The operator employs a peat bog of approximately 600 ha on this site, authorised by a Prefectoral order of July 4, 1974 for a period of 30 years. The peat extracted is used in the production of soil amendments.

The installations concerned

In the algae-based extraction process, the insoluble fractions, not used in the finished product, are recovered by filtration on a filtering soil (perlite) then through pressing. Approximately 15,000 m3 of filter cake per year is collected in this manner, which represents approximately 4,500 t/year of dry extract (≈ 30%).

The filter cakes derived from this operation are sent by trailer to a hermetic storage area to undergo lixiviation (removal of the sat) then composting.
After several turning operations (aeration of the storage heap) and after 18 to 24 months, the composted product used completely used for soil amendment purposes (with the peat) or to make horse riding trails.

Until 1999, the filter cakes were stored on a non-hermetic storage area. In order to reduce the environmental impact of this storage facility, since 1999 the area consists of a central paved portion of 3,000 m² and a peripheral portion made of compacted earth measuring 2 x 1,825 m². It is now possible to recover the drainage runoff.

The entire area is isolated from the subgrade by a geotextile membrane then by a geomembrane and is equipped with a drainage network and a degassing vent system. The latter system consists of a honeycomb structure placed underneath the lower geomembrane.

The drainage water is recovered in two sumps, one of which is equipped with a "cellar drainage pump" which conveys the leachates to the site's effluent processing station. This pump is controlled by a level floater.

THE ACCIDENT, ITS BEHAVIOUR AND CONSEQUENCES

The accident:

On February 15, 2001, two company employees performed maintenance on a sump pump used to recover drainage runoff from the filter cake: according to the site Director, owing to the design of the drainage system, the hose connecting the pump discharge to the line going to the treatment plant comes disconnected relatively frequently.

In this case, the following operation is performed:

- ✓ the sump is drained using a motor-driven pump,
- ✓ the pump is removed from the sump using a chain,
- ✓ the hose is reconnected,
- ✓ the pump is placed back in the bottom of the sump and the flange is replaced.

This is the type of intervention, which had already been performed 5 to 8 times since the storage facility was reworked in 1999, that the two companies perform.
At around 3.15 pm, the sump drainage operation was completed and the first operator entered the sump. At 3.35 pm, a witness noticed the second operator on the outside.
At 5.15, when it was noted that the employees were not back yet, the alarm was given.

The Consequences:

At 6.30 pm, the two employees were found dead in the bottom of the sump.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

Dangerous materials released	☐ ☐ ☐ ☐ ☐ ☐
Human and social consequences	■ ■ ■ ☐ ☐ ☐
Environemental consequences	☐ ☐ ☐ ☐ ☐ ☐
Economic consequences	☐ ☐ ☐ ☐ ☐ ☐

The parameters that comprise these indices and the corresponding rating method are indicated in the appendix hereto and are available at the following address: http://www.aria.ecologie.gouv.fr

The "human and social consequences" index is 3 owing to the death of two employees (parameter H3).

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The filter cakes consist of sulphur-containing organic materials which, through anaerobic fermentation, release hydrogen sulphide and methane. This release is inescapable and cannot be avoided.

According to the operator, the very rainy climatic conditions in the weeks prior to the accident did not allow the heaps to be manipulated. The anaerobic fermentation was thus promoted. These conditions of strong humidity significantly increased the production of H2S.

The hermetic character of the storage zone, built to recover the drainage runoff, actually confined the gases in the drainage network located underneath the geomembrane.
An organisation requisitioned by the District Attorney, conducted atmospheric measurements by chromatography in a mobile laboratory, just a few days after the accident.

The results of the measurements taken in the sump are as follows:

- ✓ sump totally full: NTR,
- ✓ sump drained to the level of the pipe bringing the drainage runoff: 222 ppm of H2S. (Note: when the pump was stopped, the concentration of hydrogen sulphide in the sump went from 222 to 6 ppm in approximately 20 minutes).
- ✓ Sump completely drained: 550 ppm of H2S. (In the bottom of the sump, the concentration of hydrogen sulphide reached 2,270 ppm).
- ✓ Average methane content: 300 ppm (0.03%).
- ✓ Oxygen concentration: approximately 20%.
- ✓ Carbon dioxide concentration: 0.1 to 0.2%.

Results of the measurements in a degassing vent:

- ✓ H2S: 6,570 ppm,
- ✓ O2: 1.1%,
- ✓ CO2: 28%;
- ✓ CH4: between 40 and 80%.

According to the material safety data sheet, the hydrogen sulphide is, at ambient temperature and atmospheric pressure, "a colourless gas, heavier than air (d = 1.19), having a characteristic fetid smell (rotten egg)… ". This odour, detectable at very low concentrations (0.02 to 0.1 ppm) can be attenuated and even disappear at strong concentrations (the sense of smell is lost at concentrations above 100 ppm).
This gas is deadly in just a few minutes at concentrations above 1,000 ppm and causes a rapid loss of consciousness, then death without immediate medical assistance above 500 ppm.

Hydrogen sulphide is thus the cause of the death of the two operators. The operator had not identified this toxic hazard. As a result, the design of the installation and the maintenance procedure were inappropriate.

ACTION TAKEN

Given the concentrations of H2S and CH4 measured and the considering the hazards that they represent (toxicity, explosiveness), on February 26, 2001 the DRIRE proposed a draft order indicating emergency measures (signed March 5, 2001 by the Prefect département) aimed at considering the storage facility as a controlled zone and the area surrounding the sumps and the degassing vent as dangerous zones, and by laying out provisions to be taken in case of intervention (limited access, prior atmospheric measurements, …).

The operator has foreseen to modify the pump's discharge line to avoid having to enter the sump. This modification, however, cannot be made until the judicial authorities in charge of the inquiry have granted authorisation.

Beyond these measures, the longer term technological changes must be considered to minimise the risks due to the inevitable formation of these gases, against the probable causes identified.
In this respect, the operator was asked to study and submit to the inspectorate possible provisions to optimise the management of the filter cake stock (quantity produced, storage time, heap aeration frequency, …) and to avoid possible zones of gas accumulation.

In addition, it was requested that a danger study be updated bearing on all of the company's activities.