

Case 4

Two crew members died by inhaling hydrogen sulfide gas generated inside a slop tank

Outline: At around 11:27, June 28, 2011, while the Vessel boarded by the master, the chief engineer (C/E), the chief officer (C/O), the first engineer (1/E) and the first officer (1/O) was sailing along Nagoya Port North Passage after completing the unloading of sodium hydrosulfide at a shipper's pier in Nagoya Port, C/O, 1/E and 1/O fell down on the starboard side of the forecastle deck, and C/E became half conscious at the stern. All of the four crew members were engaged in tank cleaning.

C/O and 1/E died while 1/O and C/E were injured.

The Vessel



Type: Chemical tanker
Gross tonnage: 499 tons
L × B × D : 64.95 m × 10.00 m × 4.50 m

* Company A owning the Vessel was in charge of operating the Vessel, and was practically managing the Vessel's tank cleaning.

Events Leading to the Accident

Three days before the accident occurred

After completing the unloading of acrylic acid entirely at a pier in Yokkaichi Port, the Vessel left the pier and was **collecting in the slop tank (starboard, port) (*1) acrylic acid washing water generated during tank cleaning.**

*1: A tank for collecting washing water generated during tank cleaning

Around 11:10 on the day of the accident

After completing the unloading of acrylic acid entirely at a pier in Nagoya Port, the Vessel departed for Wakayama Shimotsu Port in Wakayama Prefecture for cargo loading.

While the Vessel was sailing in Nagoya Port, C/O started cleaning No.2 cargo tank (starboard, port) while operating a fresh water washing pump with C/E, 1/E and 1/O.

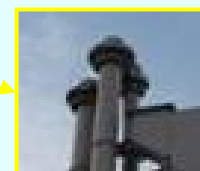
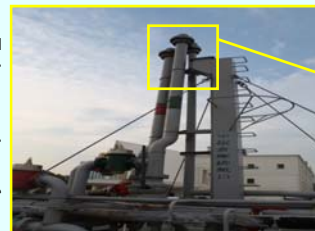
When the Vessel completed cleaning No.2 cargo tank (starboard, port), C/E **transferred sodium hydrosulfide washing water** inside the tank **to the slop tank (starboard, port)** by operating the cargo pump.

Around 11:26

Inside the slop tank, sodium hydrosulfide washing water and acrylic acid washing water caused a chemical reaction, and generated hydrogen sulfide gas, which spouted out of the discharge port of the slop tank's exhaust pipe while making a sound.

→ **hydrogen sulfide gas spouted**

Exhaust pipe of the slop tank



Discharge port of the slop tank's exhaust pipe

Manhole hatch covers of the slop tank



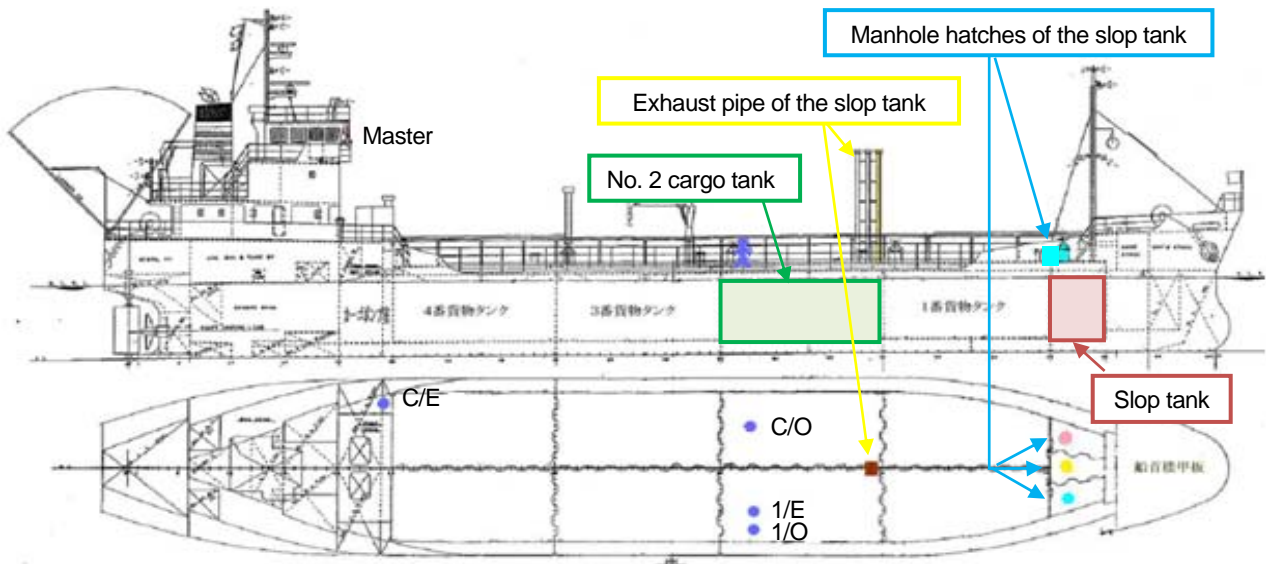
In the middle of evacuating to the starboard side of the forecastle deck on the windward, C/O, 1/E and 1/O opened each of the manhole hatch covers of the slop tank (starboard, port) in order to stop hydrogen sulfide gas from spouting out of the discharge port of the slop tank's exhaust pipe.

→ **hydrogen sulfide gas spouted**

At around 11:27, C/O, 1/E and 1/O fell down on the starboard side of the forecastle deck, and C/E became half conscious in the dining room for a while.

C/O, 1/E and 1/O were rescued and taken to hospital by the staff of Nagoya Coast Guard Office who came for relief, and **C/O and 1/E were confirmed dead. 1/O was hospitalized due to hydrogen sulfide intoxication, and C/E was also hospitalized due to hydrogen sulfide intoxication and chemical pneumonia.**

【Location of the slop tank and other facilities, and positioning of the crew when the accident occurred】

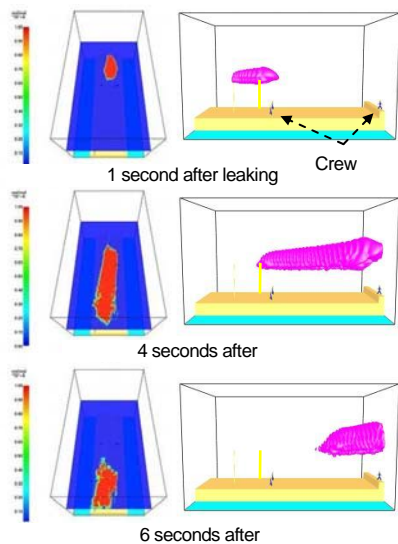
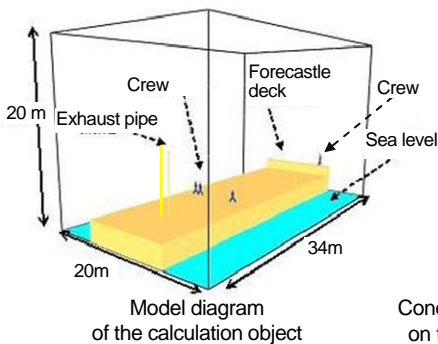


Research on How the Crew Were Affected by the Hydrogen Sulfide Gas Which Spouted out of the Discharge Port of the Slop Tank's Exhaust Pipe

The Board entrusted National Maritime Research Institute with a research on the effect on the crew of the hydrogen sulfide gas which spouted out of the discharge port of the slop tank's exhaust pipe. The result of the research is summarized as follows.

【Calculation condition (excerpt)】

- Crew stationing: from the discharge port of the slop tank's exhaust pipe, about 7.5 m astern (C/O, 1/E, 1/O) and about 27.5 m astern (C/E)
- Height of the discharge port of the slop tank's exhaust pipe: 6.5 m
- Relative wind direction: 5° starboard bow
- Relative wind speed: 7.4 m/s



Concentration distribution on the horizontal section Isosurface changes over time

【Research result and analysis】 (excerpt)

Effect of hydrogen sulfide gas which spouted out of the discharge port of the slop tank's exhaust pipe

- ▶ For C/O, 1/E and 1/O, it is proper to consider that the accident was caused by a different reason, and it is considered probable that they inhaled hydrogen sulfide gas which spouted out of each of the slop tank (starboard, port) manhole hatches.
- ▶ For C/E, it cannot be denied completely that part of hydrogen sulfide gas which spouted out of the discharge port of the slop tank's exhaust pipe reached C/E, and it is considered probable that C/E inhaled hydrogen sulfide gas which spouted out of the discharge port and each of the manhole hatches of the slop tank (starboard, port).

Probable Cause 1

It is considered probable that the accident occurred because C/O, 1/E and 1/O who were engaged in tank cleaning inhaled hydrogen sulfide gas which spouted out of each of the opened manhole hatches of the slop tank (starboard, port), and C/E inhaled hydrogen sulfide gas which spouted out of the discharge port of the exhaust pipe and each of the opened manhole hatches of the slop tank (starboard, port), when hydrogen sulfide gas was generated by a chemical reaction caused by mixing sodium hydrosulfide washing water and acrylic acid washing water, soon after the sodium hydrosulfide washing water inside No.2 cargo tank (starboard, port) was transferred to the slop tank (starboard, port) in which acrylic acid washing water was collected when completing the cleaning of No.2 cargo tank (starboard, port) which completed the unloading of sodium hydrosulfide washing water, while the Vessel was engaged in tank cleaning while sailing in Nagoya Port.

Analysis of Safety Management of the Vessel

While being unaware of the danger of tank washing water when mixed, Company A neither mentioned about transfer work of tank washing water in the tank cleaning procedure manual, nor instructed the crew on the danger of tank washing water when mixed and the proper use of a slop tank.

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With respect to the Vessel, tank washing water was collected in the slop tank (starboard, port) and two different types of washing water or more were mixed in the tank on a regular basis.

* “Ship Inspection Regulations” in a notice by Director-General, Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) specifies as follows.

Requirements pertaining to a slop tank shall be as follows.

- (4) In case of loading two different types of material or more at the same time which may cause dangerous interaction, tank washing water and bilge water containing such material shall not be loaded in the same slop tank. Accordingly, the number of slop tanks shall be the same as those materials which are to cause dangerous interaction and to be loaded at the same time.

The crew of the Vessel did not know that tank washing water could cause a chemical reaction when mixed and generate a dangerous material, and were unaware of the details of the procedures for handling dangerous goods, either.

Probable Cause 2

According to the findings that Company A was unaware of the danger of tank washing water when mixed, and neither mentioned about transfer work of tank washing water in the tank cleaning procedure manual, nor instructed the crew on the danger of tank washing water when mixed and the proper use of a slop tank, it is considered probable that the Vessel transferred sodium hydrosulfide washing water inside No.2 cargo tank (starboard, port) to the slop tank (starboard, port) in which acrylic acid washing water was collected because the crew of the Vessel did not know that tank washing water could cause a chemical reaction when mixed and generate a dangerous material, and were unaware of the details of the procedures for handling dangerous goods, either.

In Order to Prevent Recurrence

On August 4, 2011, for fear of occurrence of a similar accident, the Japan Transport Safety Board provided information for Maritime Bureau, MLIT about the outline and factual data of the accident, with a view to alerting chemical tanker operators and owners.

On September 26, 2011, in response to this information provision, Maritime Bureau, MLIT (Safety/Environment Policy Division, Safety Management and Seafarers Labour Division and Inspection and Measurement Division) issued to the Japan Federation of Coastal Shipping Associations a notice with the following instructions, with a view to alerting them to the danger in the handling of tank washing water on board a chemical tanker.

When keeping different types of cargo washing water in a slop tank, proper management and operation is required, bearing in mind a possibility that washing water, when mixed, may generate a material dangerous to the human body.

For this reason, chemical tanker operators and owners under the Federation shall be fully reminded of the following and the need for ensuring proper management and operation with respect to the keeping of washing water.

- Property management of washing water shall be implemented properly in order to apprehend correctly “what kind of material is included in the washing water kept in a slop tank”
- In order to enable assessing the risk of a toxic substance generated, information related to the reactivity of onboard materials shall be provided for chemical tankers in the form of “procedures for handling dangerous goods” or “material safety data sheet (MSDS)”.
- Procedural information like “procedures for handling dangerous goods” or “material safety data sheet (MSDS)” shall be used to check “if there is a danger that a toxic substance may be generated when mixing another type of washing water with the already collected washing water”.
- When it is possible to discharge washing water in the sea, it shall be done so frequently.
- In the event that a reaction of some sort has occurred inside a tank, attention shall be paid to the existence of any danger to the human body.

In order to prevent occurrence of a similar accident, it should be ensured that coastal shipping operators, owners and masters should disseminate the following instructions to the crew so that these instructions should be observed by them.

(1) Method of handling tank washing water and assessing the risks associated with it

In order to prevent mixing different types of tank washing water likely to cause a dangerous chemical reaction while recognizing that tank washing water includes cargo residue on board and bears similar properties as cargoes, it is necessary to identify in which case mixing tank washing waters is dangerous, such as by making a chemical interaction chart for dangerous types of cargo when mixed while referring to procedures for handling dangerous goods or material safety data sheet (MSDS). This should be fully disseminated to the crew. It is also necessary to fully disseminate the method of tank washing water treatment and slop tank usage to the crew in the form of a manual in order to ensure that they observe such procedures at all times.

(2) Observance of evacuation procedures

In case a toxic substance like hydrogen sulfide gas is generated by chemical reaction while transporting tank washing water without checking the condition inside a slop tank, the manhole hatch covers of the slop tank should not be opened, and crew members staying near the discharge port of the slop tank’s exhaust pipe should evacuate to the windward side of the discharge port of the exhaust pipe while those staying near the accommodation space should evacuate without delay to the closed accommodation sections.