罕見硫化氫中毒事件

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- 蘇澳漁船不明氣體中毒事件
- 廢液回收(硝酸鎳加硫化鈉)致硫化氫中毒事件

事發摘要

- 發生地點：宜蘭南方澳港口
- 事故類型：不明氣體中毒
- 事故摘要：民國103年2月2日(年初三)上午八時，宜蘭蘇澳籍漁船「新景福268號」(捕撈鯖魚為主)，休息4天後進行漁船準備出海前的魚艙排空廢水及清洗作業，漁工們先以馬達抽取船艙內積水，接著由漁工下船艙以人工清理。A君先行進入深約三公尺的槽內清理殘存的廢水並以清水清洗魚艙，但進入魚艙內立即覺得暈眩無力，隨即昏迷而趴倒艙內，其餘八名船員(1台籍、1中國籍、7印尼籍漁工)見狀，先後爬下魚艙欲救援其同事後，出現嘔吐、頭暈、昏沉等症狀。友船漁工也加入搶救。

- 宜蘭縣消防局獲報後，派遣多個分隊前往救援，分送羅東聖母、羅東博愛、與蘇澳榮民醫院。
- 傷亡人員: 1位24歲印尼漁工OO死亡，兩位(20多歲印尼漁工及38歲中國籍漁工)插管進加護病房，三位住院，另有8人就醫後出院；共14人疑似吸入不明氣體而身體不適。

事發當時

- 2月2日9:30am PCC接獲通報高度懷疑魚艙廢水擱置數天後，在高溫下產生有臭味的硫化氫氣體，造成人員中毒。

環保署毒災應變隊獲報後，2月3日派員偵測船艙內不明氣體，但未找到氣體洩漏點，也未發現氨氣、低濃度揮發性有機化合物等有毒氣體 (並未檢測硫化氫) 。

冷凝管，用於低溫保鮮

約三公尺深 (3*0.6*0.7m)；艙底約3*2*2.5m

事發當時船艙; 氣體偵測，未發現硫化氫

與北檢所一同現場訪視2/6

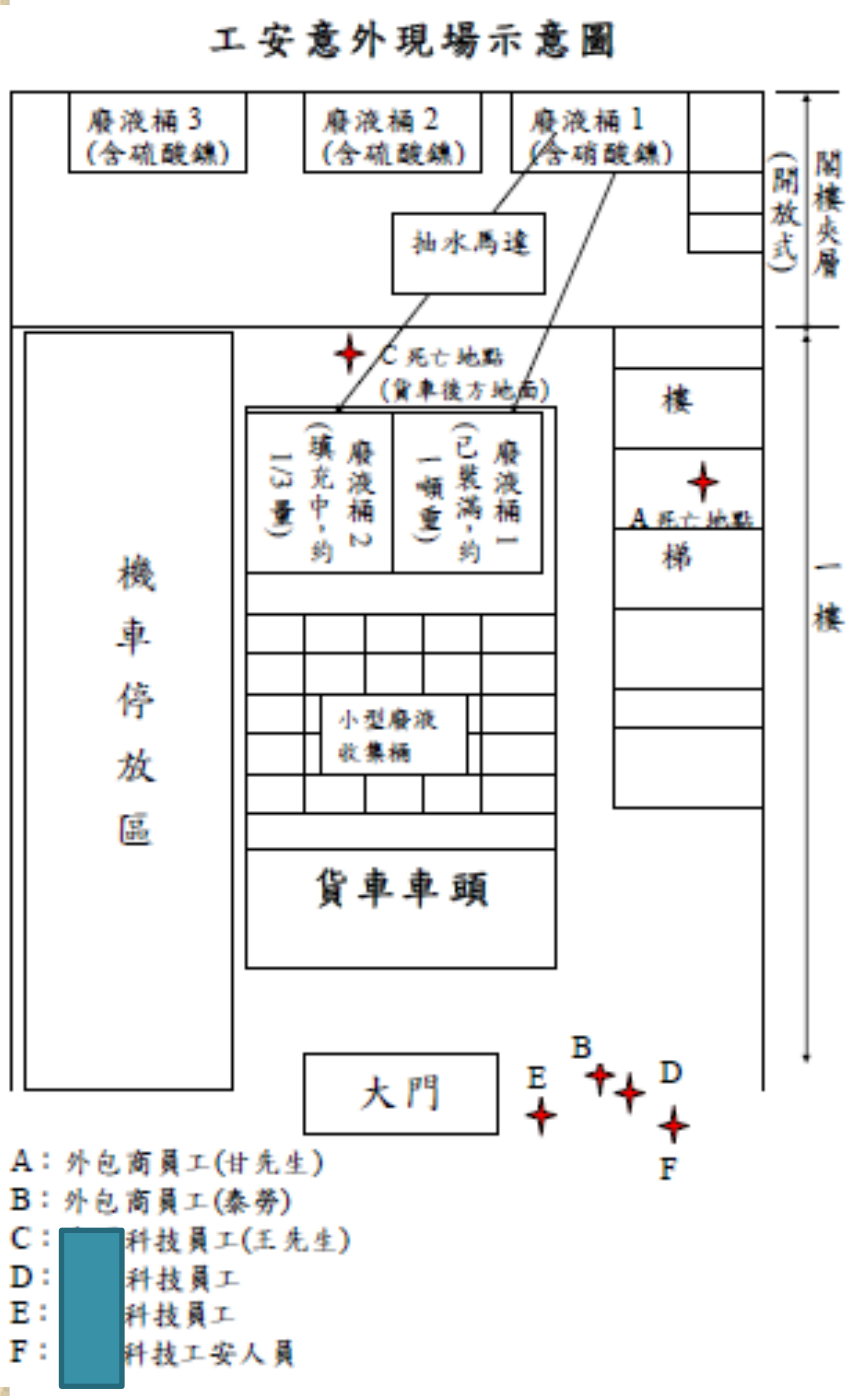
病人訪談

- 訪問最後兩位靠近船艙的印尼籍船員。
- 當天作業程序和以前一樣
- 當時靠近就感覺暈眩，想吐的不舒服，感覺有怪味，但沒有很刺激的感覺。出院後仍覺得有些全身無力。
- 死亡的病患臉呈黑色，眼睛發紅。

回收廢液突冒毒氣瞬間奪兩命及四傷

事故摘要：

- 96年某日下午，ㄇㄇ公司到台北縣〇〇科技公司回收清洗電路板廢液時，疑因化學廢液混合產生有臭味的毒性氣體，28歲的司機A倒地不起，34歲的泰勞B 下樓呼救時昏倒。科技公司的三名員工(30歲的C、37歲的D、及27歲的E)趕來搶救，也但先後中毒。32歲的F在救援時，對C進行口對口人工呼吸後，亦產生呼吸不適症狀而自行就醫。在前述6人，A及C在送醫前即已死亡(OHCA)。



- 現場氣體分析:
  - H_2S: 420 ppm
  - SO_2: 12 ppm
- 廢液收集桶內上方測得硫化氫濃度高達200,000 ppm以上(根據勞委會北檢所資料)
- 硫化鈉 + 硝酸 →硝酸鈉 + 硫化氫

DISCUSSION

- Hydrogen sulfide poisoning is primarily a clinical diagnosis.
- Environmental monitoring is the best likely source for real-time analytical confirmation.
- Controversy remains on the best treatment options.

可能暴露硫化氫之職業

下水道作業	橡皮及塑膠製造	牲畜屠宰處理
污水處理廠	合成纖維製造	動物油脂處理
污水槽清潔	造紙業	魚產品處理
隧道工程	皮革鞣皮工業	垃圾掩埋場作業
地下管路維修	製毯作業	瀝青貯存作業
掘井/清井作業	染料製造	發酵作業
沉箱工作	重水處理	釀酒業
電纜埋設及濠溝作業	石油製造及精煉	煤礦汽化工作
電纜絞結	製絲業或紡織業	天然氣製造及處理
硫磺溫泉水槽清洗	硫化物產品(如硫酸、二硫化碳)製造	銅、鉛、金礦等礦物之硫化
鍋爐作業	碳酸鋇製造	化學實驗室作業

Immediate "knockdown" agents

Methane	Acetylene
Propane	Argon
Nitrogen	Helium
Nitrous oxide	Nitrogen dioxide
Carbon monoxide	Carbon dioxide
Carbon disulfide	Carbonyl sulfide
Organophosphate	Hydrogen cyanide
Sodium azide	Hydrogen sulfide

Case files of the University of Cincinnati fellowship in medical toxicology:2 patients with acute lethal occupational exposure to H2S. J Med Toxicol 2007; 3: 73-81

表3　工作環境中硫化氫含量對人體所造成之影響[27]

濃度(ppm)	對人體之影響
0.025	嗅覺敏銳者可感覺對於特有氣味之刺激(嗅覺之下限濃度)
0.2	任何人均可感覺到有臭氣味道
3-5	可感覺中等程度之臭氣不舒服
10	容許濃度(眼睛黏膜受到刺激之限度)
20-30	嗅覺疲勞，無法在感覺到高於此濃度之臭味(刺激肺之最低濃度)
50	對眼睛影響：結膜炎、癢、痛、覺得有砂進入眼裡、目眩、充血、腫脹、角膜混濁、角膜破裂與剝離、視野模糊與歪曲、痛楚隨著光度增加而增加
100-200	吸入 2-15 分鐘嗅覺神經麻痺，反而減輕刺鼻之不舒服感，如連續暴露 8-48 小時會因支氣管炎、肺炎、肺水腫之窒息而死
250-300	呼吸道黏膜有灼熱之痛感，如暴露在 1 小時內尚不致有生命危險
350-400	暴露在 1 小時即有生命危險
600	暴露 30 分鐘即有生命危險
700	對腦神經影響：短時間呼吸加速，會立即引起呼吸麻痺
800-900	意識喪失、呼吸停止、死亡
1,000	昏倒、呼吸停止、死亡
5,000	立即死亡

可造成立即性呼吸停止

侷限空間安全工作計畫指引. 勞研所2001

Table: Bacterial spoilage compounds (Church, 1998)

Specific spoilage bacteria	Spoilage compounds
Shewanella putrifaciens	TMA, H_2S, CH_3SH, $(CH_3)_2S$, HX
Photobacterium phosphoreum	TMA, HX
Pseudomonas spp.	Ketones, aldehydes, esters, non-H_2S sulphides
Vibrionacaea	TMA, H_2S
Aerobic spoilers	NH_3, acetic, butyric and propionic acid

TMA: Trimethylamine; H_2S: Hydrogen sulphide; CH_3SH: Methylmercarptan; $(CH_3)_2S$: Dimethylsulphide; HX: Hypoxanthine; NH_3: Ammonia

Gas analyses in holds of industrial-fishing cutters immediately after opening hatches in port

		Cutter no.													
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*TLV*
Temperature of cargo (°C)		20	18	20	19	20	25	22	18	17	21	16	18	18	
CO_2 (vol%)	(G)	<1	<1	1[1]	2[1]	31[1]	34[1]	40[1]	23[1]	19[1]	14[1]	13[1]	30[1]	—	0·5
CO_2 (vol%)	(D)	—	3[1]	1[1]	2[1]	50[1]	32[1]	60[1]	>20[1]	11[1]	>20[1]	>20[1]	—	19[1]	0·5
O_2 (vol%)	(D)	20	>20	>20	18	5[2]	5[2]	<5[2]	18	17[2]	—	7[2]	7[2]	3[2]	18
H_2S (ppm)	(D)	100[1]	25[1]	100[1]	300[1]	>2000[1]	>2000[1]	2000[1]	3	10	100[1]	100[1]	—	240[1]	10
NH_3 (ppm)	(D)	0	—	—	<1	700[1]	>700[1]	>700[1]	0	0	>700[1]	1000[1]	7000[1]	4000[1]	50
$(CH_3)_3N$ (ppm)	(G)	3	7	32	74	1535	2160	1420	—	71	195	70	510	—	—
$(C_2H_5)_2NH$ (ppm)	(G)	0	0	0	63[1]	0	0	132[1]	—	22	306[1]	940[1]	573[1]	—	25
$C_4H_9NH_2$ (ppm)	(G)	<1	6[1]	30[1]	64[1]	71[1]	58[1]	35[1]	—	7[1]	4[1]	17[1]	7[1]	—	5

The cutters ranged between 50 and 171 tons gross. The cargo was haddock in all cases, except in No. 6, which carried herring; cutter No. 1 carried both. The preservation method was icing in Nos. 1 and 2, formaldehyde in Nos. 3-7, 9, and 11, and both icing and formaldehyde in Nos. 8, 10, 12, and 13. The cutters had been at sea for 2-9 days (mostly 4–7 days) and had been waiting for up to 44 hours in port before leasing.

G = analysis by gas chromatography.

D = analysis by Dräger gas detector.

[1]Exceeding TLV (Threshold Limit Value, Amer. Conf. Government. Indust. Hyg., 1969).

[2]Below minimum oxygen content, according to TLV.

Fatal poisoning and other health hazards connected with industrial fishing. Br J Ind Med 1972;29:307-16.

Fatal methane and cyanide poisoning as a result of handling industrial fish: a case report and review of the literature.

J Clin Pathol 2000;53:794-5.

Abstract

- The potential health hazards of handling industrial fish are well documented. Wet fish in storage consume oxygen and produce poisonous gases as they spoil. In addition to oxygen depletion, various noxious agents have been demonstrated in association with spoilage including carbon dioxide, sulphur dioxide, and ammonia. A fatal case of methane and cyanide poisoning among a group of deep sea trawler men is described. Subsequent independent investigation as a result of this case led to the discovery of cyanides as a further potential noxious agent. This is thus the first case in which cyanide poisoning has been recognized as a potentially fatal complication of handling spoiled fish. The previous literature is reviewed and the implications of the current case are discussed.

TABLE 1. *Production of HCN by Pseudomonas aeruginosa grown in the presence of various amino acids*

Amino acid added[a]	HCN produced (μmol/ml of culture)	Amino acid added[a]	HCN produced (μmol/ml of culture)
No addition[b]	0.221	Arg	0.198
Gly	1.091	Asn	0.088
Ala	0.294	Gln	0.225
Val	0.392	Trp	0.142
Thr	0.981	Phe	0.666
Ser	0.266	Pro	0.206
Ile	0.348	His	0.150
Leu	0.343	Cys	0.032

[a] All amino acids are in a final concentration of 12.5 mM.

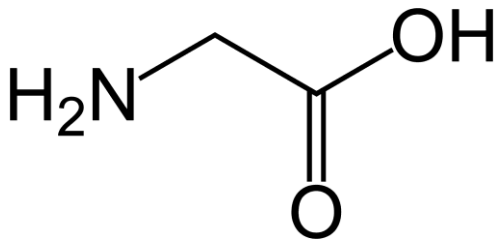
[b] Complete medium minus glycine.

Glycine metabolism by Pseudomonas aeruginosa: hydrogen cyanide biosynthesis. J Bacteriol 1977; 130: 826–31.

Production of cyanide

- Cyanogenic bacteria generate cyanide from glycine.

$$NH_2CH_2COOH + O_2 \rightarrow HCN + CO_2 + 2H_2O$$



Knock down victims

- Search for clues such as a victim's activity (working at manure pit)
- Suggestive clinical signs
- Therapeutic trial

When to suspect Hydrogen sulfide poisoning

- Rotten eggs odor
- Rescue from enclosed space
- Person rapidly loss consciousness (Knocked down)
- Collapse of a previous healthy worker at work site
- Multiple victims with sudden death syndrome

Thanks for your attention

衛生福利部暨臺北榮民總醫院

毒藥物諮詢中心

- **24小時諮詢專線電話：**

  02-28717121