EIGA Safety Newsletter

Prepared by the Safety Advisory Group SAG NL N° 78/03/E

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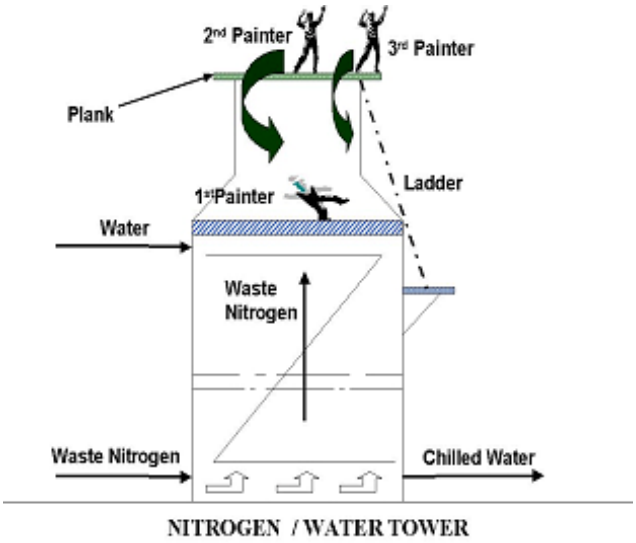
Most cases of asphyxiation take place in confined spaces, such as process vessels, cold boxes, totally enclosed working areas and pits. However, asphyxiation can occur in the open air as demonstrated by a number of accidents reported to EIGA. The purpose of this Newsletter is to draw to the attention of operators working with industrial gases the dangers of asphyxiation when working in the open air.

1. Asphyxiation fatalities on a construction site

During the commissioning phase of a new air separation unit (ASU), prior to the mechanical completion of the plant, three subcontract employees were killed while working on a waste nitrogen tower.



NITROGEN / WATER TOWER

Figure 1

1.1. Accident circumstances:

- Three painters from a subcontractor were working to complete external painting works on a waste nitrogen / water tower while the plant was being started up
- To complete the painting of the top tower section a wooden plank was put across the exhaust section to atmosphere.
- One painter climbed on the plank, was overcome by the surrounding nitrogen stream and fell inside the tower.
- The two other painters rushed from the ladder to the plank to rescue their colleague.
- Both collapsed into the tower as well.
- The three painters died before they could be rescued.

1.2. Learning Points:

- Safe systems of work are required at all times.
- Specific hazard controls are required during plant start up
- Need of clear definition of responsibilities between all parties involved in construction / commissioning phases

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- Hazards to be identified and communicated to contractors and sub-contractors workers
- Use of identification / warning signs against asphyxiation hazards or potential hazards from equipment in operation
- Need of appropriate training

2. Asphyxiation near-miss accident in the open air

2.1. Incident circumstances:

The project consisted of installing equipment to enable the diversion of the out flow from a nitrogen tower (see figure 2). The work was carried out on a platform 10 metres above ground, the equipment being lowered by crane onto the top of the nitrogen vent. Two contractors were working on the platform together with a supervisor who was in radio contact with the crane operator. A work permit was prepared, the operators were trained and wearing portable oxygen monitors.

The sequence of events as the equipment was lowered into place was as follows:

- One of the workers lost consciousness and the second worker who went to assist his colleague also collapsed;
- As the equipment was lowered into position the nitrogen was diverted onto the platform, (see figure 3);
- The oxygen monitors showed the lack of oxygen;
- The supervisor realised what was happening and instructed the crane operator to raise the equipment;
- The oxygen concentration quickly returned to normal and the workers recovered without any permanent effects.

2.2. Learning Points:

- Safe systems of work are required at all times;
- Appropriate training for the operators to increase the sensitivity to works in elevated situation together with a risk of asphyxiation;
- Prepare an efficient emergency plan;
- Unless the N_2 emission can be stopped, operate with a self-contained breathing system in the risk areas;
- Use personal oxygen monitors as identified by risk assessments when planning the work.

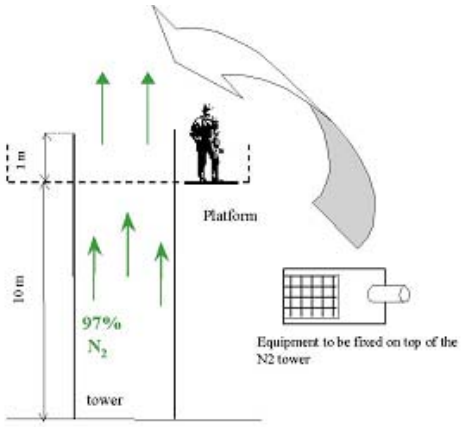

Figure 2

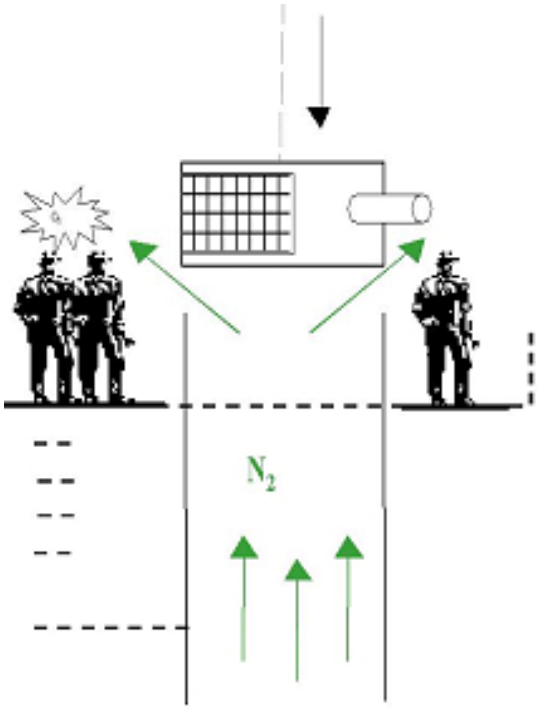

Figure 3

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Figure 4: The tower after completion of the work

3. Contractor affected by CO_2 in open air

3.1 Accident circumstances:

An electrical contractor was working in an open area fitting a cable ducting when he developed breathing difficulties and turned blue in the face (see fig. 5). He stood up and staggered backwards. His colleagues took him to the control room where he slowly recovered. He was taken to hospital where he made a full recovery and was released after a few hours.

Weather conditions were blustery and the work was being carried out in the open air in a freely ventilated area. However, a catch pot drain was permanently cracked open to give a continuous vent of CO_2 and the work involved the electrician's face being within 0.5 metres of the outlet. Measurement subsequent to the incident indicated an oxygen concentration of 15.8% close to the drain. This oxygen concentration means that the CO_2 constituted about 25% of the air – a level which can be fatal.

Information on the hazardous effects of CO_2 is given in Appendix B of IGC Doc. 66/99 – 'Refrigerated CO_2 storage at users' premises'.

3.2 Learning Points

- Unlike other common asphyxiant gases, CO_2 has toxic and damaging effects on the body at high concentrations. When the CO_2 concentration exceeds 10% in air, a fatal risk exists even though the resulting oxygen concentration at 19% would otherwise be considered relatively safe. For this reason, where CO_2 exposure is likely, it is always necessary to use a CO_2 monitor to get a true measure of the risk.
- The managers on site were aware of the continuous venting of CO_2, but given that these vents were in the open, they were not perceived as a hazard.
- During the planning prior to issuing the permit, there was not a realisation that the electrician would be placing his head dangerously close to the vent.
- The contractor was not familiar with the plant or the product, so he did not realise he was at risk.
- The practice of venting CO_2 in this way is to be reviewed.
- A card advising personnel of the hazards of CO_2 is to be issued.
- If the vents are retained, they will be closed off prior to any work being undertaken in the vicinity.

Figure 5 The site of the incident; with the vent red ringed

4. Recommendations for safe open air work on operational and construction sites

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When working near the vicinity of vent pipe discharges the following factors shall be considered in evaluating the hazardous zone in the general vicinity of vent pipe discharges. This assessment must be carried out as part of the risk assessment when issuing a work permit.

- The vent type, height, and orientation relative to surrounding equipment, scaffolding, work areas, personnel access areas and prevailing wind direction.
- Vent use frequency:
  - Continuous
  - Intermittent in normal operation
  - Commissioning/startup/shutdown
  - Performance testing
  - Emergency pressure relief
- Hazards associated with vented gas:
  - Asphyxiation (nitrogen and argon)
  - Oxidant (oxygen)
  - Cold and low visibility (cryogenic gases and liquids)
  - Hot gases (e.g. compressor inter-stage relief/discharge gas vents)
  - Noise – damage to hearing
  - Shock from sudden venting, particularly hazardous when working at heights
- The possibility of operation of manual and automatic vent valves during the period of work covered by the work permit.
- Consequences of failure of upstream equipment (e.g. control valves failing open).
- Possibility of ingress of vented gas into temporary equipment and structures, such as air compressor intakes, buildings, and air conditioning/ventilation systems.
- The degree of hazard posed by falling ice from the vent-tip.
- The need for warning signs posted on paths, roads, at the base of ladders or access points:

  Caution!
  Possible asphyxiating atmosphere beyond this point

  A similar sign shall be utilized for high oxygen content situations.
- Where scaffolding is installed for a period before work is due to commence, consideration should be given to the possibility of oxygen from venting operations being absorbed into wooden scaffold planks, etc.
- The possibility of wind blowing into the vent tip of a low velocity vent which is venting such as to cause a hazardous atmosphere behind the vent tip.

5. References

IGC Doc. 40/02 "Work Permit Systems"
IGC Doc. 44/00 "Hazards of Inert Gases"
IGC Doc. 66/99 "Refrigerated storage of CO_2 at users' premises"
SAG NL 77/03 "Campaign against asphyxiation"

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