Handling Ammonia Refrigerant in the Workplace

by: Roshan Sebastian

On October 17, 2017, an ammonia leak was detected in the refrigeration mechanical room attached to an ice-hockey rink in the City of Fernie in British Columbia, Canada. Three fatalities were reported inside the refrigeration mechanical room due to ammonia exposure. An investigation of the incident by the Technical Safety BC regulators concluded that the leak was due to corrosion in the chiller system that caused a rapid release of ammonia into the enclosed room. This leak led to concentrations exceeding 20,000ppm, and reports from the neighboring community[1] of an ammonia odor. According to the National Institute for Occupational Safety and Health (NIOSH), an ammonia concentration of 300ppm is considered Immediately Dangerous to Life and Health (IDLH)[2]. The surrounding areas were evacuated, and a week-long state of emergency was implemented.

One type of operation that has sharpened focus on the use of ammonia is grocery store refrigeration, which typically uses a class of chemicals called hydrofluorocarbons (HFC). Recent climate legislation from the United States congress, the American Innovation and Manufacturing Act of 2020, calls for phasing out the production and consumption of HFCs by 2035 in line with the commitment to the 2018 Montreal Protocol. HFCs, commonly used in cooling and refrigeration systems, are greenhouse gases considered significantly more potent than carbon dioxide. The fact that their global warming potential is suspected to be a thousand times greater than carbon dioxide implies that a kilogram of HFC has the same impact on climate change as a ton of carbon dioxide[3]. This has increased emphasis on the use of ammonia as a refrigerant due to its minimal contribution to ozone depletion and global warming when released to the atmosphere.

While ammonia has tangible benefits in its potential use as a refrigerant, it poses safety concerns to be considered as refrigeration systems transition to ammonia use:

- Metallurgy specifications need to be considered in system design as ammonia reacts rapidly with common materials such as copper, brass, zinc, and other alloys in the presence of moisture, which can pose significant corrosion concerns. This can be avoided by designing ammonia systems using aluminum, stainless steel, and carbon steel.
- Explosion testing performed by BakerRisk has indicated that ammonia does not readily undergo outdoor vapor cloud explosions[4]. However, ammonia refrigeration systems are typically indoor processes with limited ventilation as the objective is to maintain cold temperatures. This creates the potential for significant flammable concentration build-up that could result in indoor vapor

1 https://www.technicalsafetybc.ca/sites/default/files/2018-07/FaultTrees/TSBC_257671_InvestigationReport_v14_online.pdf
2 https://www.cdc.gov/niosh/npg/npgd0028.html
3 https://www.nrdc.org/experts/anjali-jaiswal/climate-action-global-transition-away-hfcs-moving-forw
4 https://www.bakerrisk.com/br-published-paper/ammonia-and-hydrogen-vapor-cloud-explosion-testing/

cloud explosions. Such an indoor explosion was found to have occurred in a food manufacturing plant employing ammonia as a refrigerant in Elk Grove Village, Illinois in 2017[5].

- While lighter than air, ammonia releases will typically aerosolize and react with the moisture in the air to form an ammonia-water vapor hydrate that is heavier than air and can stay close to the ground. This poses a significant toxic hazard for use of ammonia as it can result in extended toxic exposure to personnel.

The incident in Fernie, British Columbia resulted in a renewed focus on ammonia safety in refrigeration systems within Canada. This has led to regulatory requirements around such systems by agencies in Ontario and in British Columbia. Similarly, such systems in the United States may be covered under the OSHA Process Safety Management (PSM) and the EPA Risk Management Plan (RMP) guidelines to minimize hazards from ammonia use. However, for most refrigeration systems, the ammonia charge is low enough to not be covered under the PSM and RMP guidelines. For such systems, the International Institute of Ammonia Refrigeration (IIAR) has come out with guidelines under its Ammonia Refrigeration Management (ARM) program that helps those facilities with low ammonia charge to safely manage their systems[6].

In addition to being an excellent candidate for commercial refrigeration systems, ammonia is a carbon free fuel that is often at the forefront of discussions as a viable, promising candidate for alternative energy solutions to building a sustainable world. Its production, storage, and transportation are less complicated than several of the alternatives, and it has a wide-range of potential applications such as:

- a fuel for combustion engines,
- a hydrogen carrier[7],
- a fertilizer/feedstock, and
- a cleaning agent

In summary, if your facility is undertaking a project to utilize ammonia as a refrigerant, the hazards associated with ammonia should be reviewed and a holistic risk assessment considered to ensure that the risk is deemed to be within an acceptable range. While this article focuses on ammonia as a refrigerant, similar considerations should also be given to other materials commonly considered as refrigerants, such as propane, propylene, and carbon dioxide.

Ammonia hazards are real and BakerRisk has a long history of working with facilities that handle ammonia to evaluate, manage, and address the hazards to ensure risk is minimized. For more information, contact us at ContactUs@BakerRisk.com.

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[5] https://www.chicagotribune.com/news/breaking/ct-elk-grove-village-explosion-20170707-story.html
https://www.youtube.com/watch?v=QWCiqoLb-VU

[6] https://www.iiar.org/iiar/itemdetail?iproductcode=01boo-en0500
https://www.iiar.org/IIAR/ItemDetail?iProductCode=01BOO-EN0302&Category=BOOK

[7] https://www.nutrien.com/what-we-do/stories/collaboration-key-our-blue-and-green-ammonia-journey