Hazards of Anhydrous Ammonia

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After reading the article by Steve Law in the Portland Tribune, November 29, 2018, page A6, I was puzzled by the description of hazards of anhydrous ammonia attributed to the U.S. Centers for Disease Control. So I sent the following email to the Silver Chemists of the American Chemical Society Portland Local Section.

“An article in the Portland Tribune about ammonia storage tanks at the Rivergate terminal in North Portland says that upon release ammonia forms a heavier than air cloud. The Center for Disease Control website says

When handled improperly, anhydrous ammonia can be immediately dangerous to life or health. As liquid anhydrous ammonia is released from its container into the air, it expands rapidly, forming a large cloud that acts like a heavier-than-air gas for a period of time.

Is this correct? Ammonia has a lower molecular weight than nitrogen and oxygen. If correct, why does ammonia act like a heavier-than-air gas?”

I received nine responses, including two from people who had worked at industrial facilities that distributed anhydrous ammonia. Edited versions of three of the most thorough replies follow.

Respondent 1

Ammonia has a density of about 0.9 kg/m3 and is thus less dense than air (1.2 kg/m3) at **STP**.

However, ammonia as used in industry is not at STP, but instead compressed and usually at or near liquid which has a density of almost 700 kg/m3

During an accidental, sudden release, the higher density liquid or low temperature gas will flow much like water away from its source near the ground as it warms and is further dispersed as a gas.

Respondent 2

I found a firefighter training manual with several pictures of liquid ammonia release:

https://www.transcaer.com/docs/AATour/Transcaer_Ammonia_Training_Student_Handout_rev04.pdf

There is initially a white cloud which can go either up or down depending on weather

conditions — damp and cold conditions favor downward flow. Released ammonia would become rapidly hydrated in humid air and its cooling effect would tend to condense water droplets. (pg 15: “Ammonia loves water and will become a heavier than air gas cloud when mixed with water vapor”). So I suspect the ‘aerosol’ cloud is actually a mist of ammonia in water. Droplets of pure ammonia would evaporate very rapidly at 1 bar pressure.

Respondent 3

For several years early in my career I was responsible for distribution throughout the northwest, mostly by tanker trucks delivering to fertilizer facilities. While we had no significant releases, any leaks could be counted on to vaporize and rise quickly. Of course, we still provided full safety equipment and training to the customers and visited often. Ammonia safety may be a well-known technology, but you can't let your guard down.

There are hundreds of communities in the northwest with liquid ammonia storage. It would be a disservice to the users of such an important compound to spread scare tactics. Training, inspections and good maintenance are always important. The only concern that I would have would be that somehow in this age of regulation and enforcement accompanied by investigative reporting, disasters seem to be more common than ever.

Anyone who would like to help assure ammonia safety should get involved in the AIChE program that has been in place for more than 64 years and is still going strong in their successful efforts to make this vital compound safely available.
https://www.aiche.org/conferences/annual-safety-ammonia-plants-and-related-facilities-symposium/2019