

# The Potential Impact Analysis of Ammonia Gas Leakage On Refrigeration System Using Aloha Software (Case Study At PT. Cahaya Gunung Foods)

*by* Haryono S Huboyo

---

**Submission date:** 13-Dec-2020 09:33PM (UTC+0700)

**Submission ID:** 1473687527

**File name:** The\_Potential\_Impact\_Analysis\_of\_Ammonia\_Gas\_Leakage.pdf (174.39K)

**Word count:** 1702

**Character count:** 9070

# The Potential Impact Analysis of Ammonia Gas Leakage On Refrigeration System Using Aloha Software (Case Study At PT. Cahaya Gunung Foods)

R Purnama<sup>1</sup>, S Syafrudin<sup>2</sup> and H S Huboyo<sup>2</sup>

<sup>1</sup> Master Degree of Environmental Engineering, Engineering Faculty, Diponegoro University

<sup>2</sup> Department of Environmental Engineering, Engineering Faculty, Diponegoro University

rezi.pur@gmail.com

**Abstract.** A refrigeration system uses Ammonia Anhydrous in the liquid phase and the gas phase. The refrigeration system has the potential for gas leakage, which poses a risk to worker safety as well as environmental pollution to water bodies and air pollution. This risk might have an impact on employees in the factory area and could extend to the surrounding community. This study is intended to be able to analyze the risk of pollution accurately before installing the refrigeration installation. In this study, the analysis method that will be used is the statistical method and the use of mathematical models supported by Aloha software. The distribution of pollutants from ammonia gas leakage is influenced by several factors, including the capacity of the refrigeration system, meteorological conditions, and land use. The use of Aloha software in the prediction of zones affected by the spread of toxic substances in the atmosphere can calculate and predict the area affected by leakage events. With modelling done, will get a map of concentration and impacted area. The direction and magnitude of the impact of pollution will be known immediately, and the potential losses that may arise will be minimized.

## 1. Introduction

Ammonia Anhydrous is a type of refrigerant that is energy efficient and environmentally friendly because it does not harm the ozone layer. In the cooling system, Ammonia will be used in the liquid phase and the gas phase. The using Ammonia in the refrigeration system must have been equipped with a leak prevention system to minimize risks to occupational safety and environmental pollution in water bodies and air pollution. One of the efforts made to reduce risk to the environment is to keep the cooling installation area away from the community. Under normal conditions, the risk will be minimal because all protection systems work well. However, if a leak occurs, it will potentially lead to an



1  
Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](#). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

emergency **that** must evacuate the surrounding community. Besides, the risk of land damage will also require rehabilitation measures.

The current condition is that PT. Cahaya Gunung Foods still has problems in dealing with the threat of danger, especially to the ammonia storage system, namely. There are still factors that cause leakage of the ammonia storage tank system that is not yet known. Efforts to improve techniques are needed to minimize the risk of leakage incidents. Not all stakeholders understand the risks & emergency response procedures. Considering the high risk, accurate pollution risk analysis is needed before installing the refrigeration installation. Many risk analysis methods, including statistical methods and the use of mathematical models supported by software that can calculate and predict the area affected by leakage events. By risk modelling in this study, a hazard model that is the concentration of ammonia concentration will be obtained and can be taken into consideration for the preparation of risk models for planning preparedness and emergency response development programs.

## **2. Risk of ammonia release**

### *2.1. Ammonia characteristic*

Ammonia has a normal boiling point of  $-33^{\circ}\text{C}$  at atmospheric pressure. To facilitate handling, Ammonia is stored in a tank in liquid conditions. Ammonia is a chemical included in the category of hazardous and toxic materials, is corrosive and causes burns [1]. Which can cause irritation and injury to delicate tissues such as the nose, trachea, lung- lung and other body parts exposed [2]. Irritation can occur in the eyes, skin, nose and upper respiratory tract. Chronic exposure can cause a decrease in lung function. Acute exposure can cause the eyes to become inflamed to blindness and cause muscle spasms and affect the nervous system [1].

### *2.2. Impact of ammonia exposure on humans.*

That non-ionized Ammonia diffuses more easily into body tissues than ammonium ions ( $\text{NH}_4$ ). Ammonia penetration power is quite durable. It has a burning effect (caustic effect) on body tissues. Still, at lower concentrations, Ammonia increases "irritation", because Ammonia is very soluble in water, so wet body surfaces that come in contact with Ammonia will be irritated or burnt whose severity is determined by the alkaline nature of the Ammonia itself. The 1% ammonia solution in water makes the water pH 11.7 and the parts of the body that are most likely to have contact and impact are [3]:

- Respiratory organ
- Eyes
- Skin
- Mouth and respiratory tract

### *2.3. Air pollution by Ammonia.*

The quality of the ambient air will determine the negative impact of air pollution on the health of employees, the community and its environment. Theories to get a prediction about pollution both in quality and quality are carried out, such as:

#### a. Black Box Model (Qualitative)

Distributed pollutants (ammonia vapour) are considered homogeneous and flow upward to form an air column.

#### b. Gaussian Model (Quantitative)

That the dispersion of contaminants spread in all directions with varying concentrations, given the very complex atmospheric conditions. The Gaussian model can be used to estimate the amount of pollutant (gas) concentration. In a fixed position and emission as well as from a moving emission source.

#### 2.4. Water pollution by water containing Ammonia

If Ammonia enters the water then measured total Ammonia (NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>), free Ammonia cannot be ionized, while ammonium (NH<sub>4</sub><sup>+</sup>) can be ionized. At pH 7 or less, most of the Ammonia will undergo ionization, on the contrary at a pH of more than 7 ammonia is not ionized and is toxic to organisms. This toxicity will increase if there is a decrease in dissolved O<sub>2</sub> levels, pH and temperature. Fish cannot tolerate too much free Ammonia, because it can interfere with the process of binding O<sub>2</sub> by the blood which can ultimately lead to "Suffocation". Ammonia is free, cannot be measured directly.

#### 2.5. The ammonia storage system in a tank

The basic principle of storing Ammonia in tanks is to keep it in the liquid condition when storing, by keeping the inner tank pressure close to the atmosphere at a temperature of -33°C. While stored in the tank, the ammonia condition is maintained in equilibrium, namely the heat entering and being above its equilibrium, the heat will be used to vaporize the existing Ammonia, which is called the evaporation process. Furthermore, the steam formed in the tank through the compressor unit is compressed and condensed continuously at a certain speed. This will suppress the rise in pressure in the tank, which is harmful. This compressor unit that suppresses and condenses ammonia vapour is called a refrigeration system.

#### 2.6. Aloha Software

The statistical, mathematical model is represented by ALOHA 5.4.3 (Areal Locations of Hazardous Atmospheres) [1], an atmospheric dispersion modelling program used for evaluating the impact of chemical accidents. This program is non-commercial and is freely available on the internet. Some input data has been partially adjusted through a typical situation of the release of hazardous substances or classes of atmospheric stability by Pasquill-Gifford. This program can be used to model dispersions, poisons, or toxic gas explosions. To calculate the dispersion of toxic gases, this program uses two models: Gaussian and heavy gas. The heavy gas model is used when the molar mass of a hazardous substance is higher than the substance (gas) that fills the surrounding atmosphere (air) or when the temperature of the hazardous substance is lower than the ambient temperature. For all other situations, a Gaussian model is used. ALOHA 5.4.3 selects a model that suits itself, or the model can be selected manually by the investigator. Modelling results are expressed as iso lines of hazardous substance concentrations that limit 2D map areas and determine harmful zone boundaries according to the researcher's input. The statistical model is based on the application of turbulent diffusion mathematical theory. Diffusion of pollutants from point sources is explained by a simple "diffusion equation" that can be solved analytically. Turbulent diffusion follows the normal (Gaussian) distribution. Calculation procedures are less time-consuming and expensive, but results for estimating sources of emissions, faulty terrain and low flow rates are not reliable. At zero flow velocity, the diffusion equation has no solution.

### 3. Conclusion

The paper discusses a case study of chemical release scenario refrigeration system. The article includes review population analysis inside as well as surrounding of the facility for quantitatively estimating the risk. Also, the dispersion modelling is helped by aloha software represent the simulated model of the toxic cloud concentration map. Developing a process plan that would be helpful for emergency response and restoration team during an unexpected incident. Also, this will prove to help determine the rate and direction of chemical release as well as the emergency plan required in to suppress any chances of danger. This modelling can be employed in any case where there is a chemical release and thus proves to be highly relevant and useful to prevent undesired events owing to loss of life and properties. This can be employed anytime, anywhere.

**References**

- [1] White E S 1971 A case of near fatal ammonia gas poisoning *J. Occupational Medicine* 13 pp 543-550
- [2] Asfahl C R 1999 Industrial safety and health management Prentice Hall Inc, New Jersey, USA
- [3] Susiyanto M 2007 Anticipation PT Pupuk Kaltim on leakage risk at Ammonia Anhydrous Storage Tank System Diponegoro University, Semarang pp 27

# The Potential Impact Analysis of Ammonia Gas Leakage On Refrigeration System Using Aloha Software (Case Study At PT. Cahaya Gunung Foods)

---

## ORIGINALITY REPORT

---

15%

SIMILARITY INDEX

14%

INTERNET SOURCES

7%

PUBLICATIONS

8%

STUDENT PAPERS

---

## PRIMARY SOURCES

---

1

Submitted to Universitas Diponegoro

Student Paper

8%

---

2

[www.irjet.net](http://www.irjet.net)

Internet Source

7%

---

Exclude quotes  On

Exclude matches  < 10 words

Exclude bibliography  On