Ensuring a safety workplace by the automation of the ammonia cooling system.

by Luis Felipe Cordoba
Fulbright – English for Graduate Studies Program 2020

Abstract

Ammonia presents high efficiency in freezing food products for preserving them for exportation; however, the use of this refrigerant implies a high risk to human life because it presents high concentrations of toxic gases that can produce deadly consequences to human beings. Smart relays present a flexible manner to automate industrial process; therefore, this poster aims to replace the manual and inefficient manner of controlling ammonia cooling system by using a smart relay that can control the levels of this refrigerant in the precooler and cooler section; resulting in considerable decrease workers' in exposure to this refrigerant.

Key words: ammonia, smart relay.

Introduction

Gerovitch (2003) comments that "Automation is the conversion of a work process, a procedure, or equipment to automatic rather than human operation or control" (p.122). Akash, et al (2020) concludes that automation has brought important advantages in industries, for example: improving productivity, reliability, and profitability. Smart relays are designed for small automated systems and can be tailored to be used in different industrial environments.

The United Nations Environment Programme (UNEP, 2016) reports that ammonia has historically been one of the foremost refrigerants for numerous sectors of industries. The high cooling efficiency, low cost, and environmental benefits are undoubtedly enough reasons to advocate for this fluid.

Despite the incredible thermodynamics' properties, this refrigerant presents an important disadvantage. Hawley (2020) indicates that the ammonia exhibits hazards as "corrosiveness, toxicity, and flammability" (p. 44) that can affect workers in case of one leak. The New York Department of Health (2004) states "exposure to high concentrations of ammonia in air causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death."(para. 8)

Assuring a safe workplace for workers is essential. Automating the cooling systems using a smart relay to mitigate employee's exposure guarantee a safe workplace.

Process

The cooling system is composed by the following elements:

- Compressor: It takes the ammonia in gaseous state and pressures it to the next stage.
- Condenser: A heat transfer process occurrs. In this stage the refrigerant changes from gas to liquid.
- Reservoir: It contains ammonia in liquid stage.
- Precooler and Cooler: This tank contains the maximum liquid ammonia. In this stage, ammonia pressure decreases.
- Pumps: It carries ammonia from the cooler to the evaporators.
- Evaporators: It takes ammonia from the cooler to the freezing rooms where the product is storage.

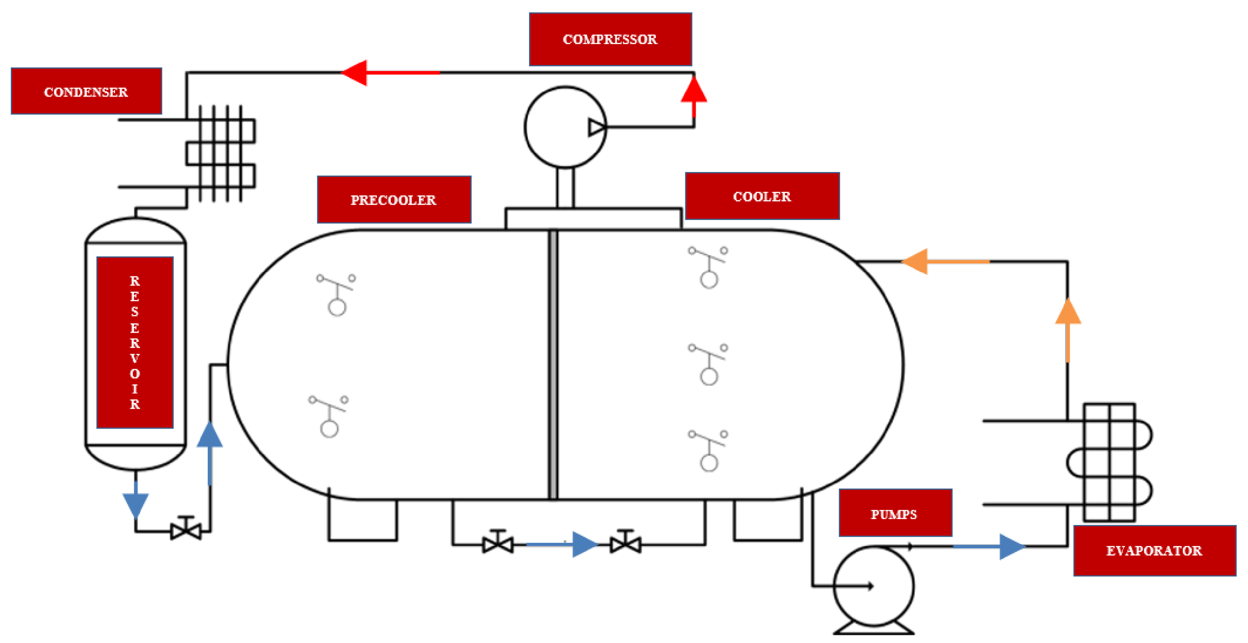

Figure 1. Ammonia Cooling Process Diagram.

Problem

Ammonia levels, specifically in the precooler and cooler stage, are controlled manually; therefore, this implies the presence of workers handling the valves to regulate the level of refrigerant.

The following image represents a consequence due to human contact to ammonia.

Figure 2. Ammonia Burn.
Source: EMS World Web Site

Proposed Solution

The automation of the system provides an engineered solution to address the problem. The smart relays present an excellent option because of the flexibility of adaptation to industrial process, friendly programming software, and low cost. The smart relay proposed is the SR3B261FU by Schneider with 16 inputs and 10 outputs.

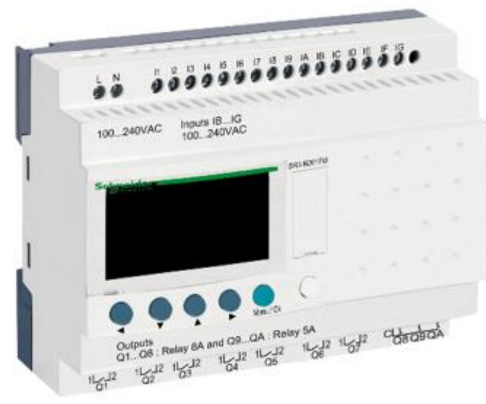

Figure 3. Smart Relay SR3B261FU
Source: Schneider Electric

Additionally, it is necessary to consider level sensors inside the tank, and the replacement of the manual valves to solenoid valves. The models proposed respectively are series PFGLP and ASCO RedHat, both capable to support corrosive fluids.

Figure 4. Level sensor and solenoid valve
Source: Altec and Asco manufactures.

The following diagram represents all the inputs and outputs necessary to automate ammonia systems.

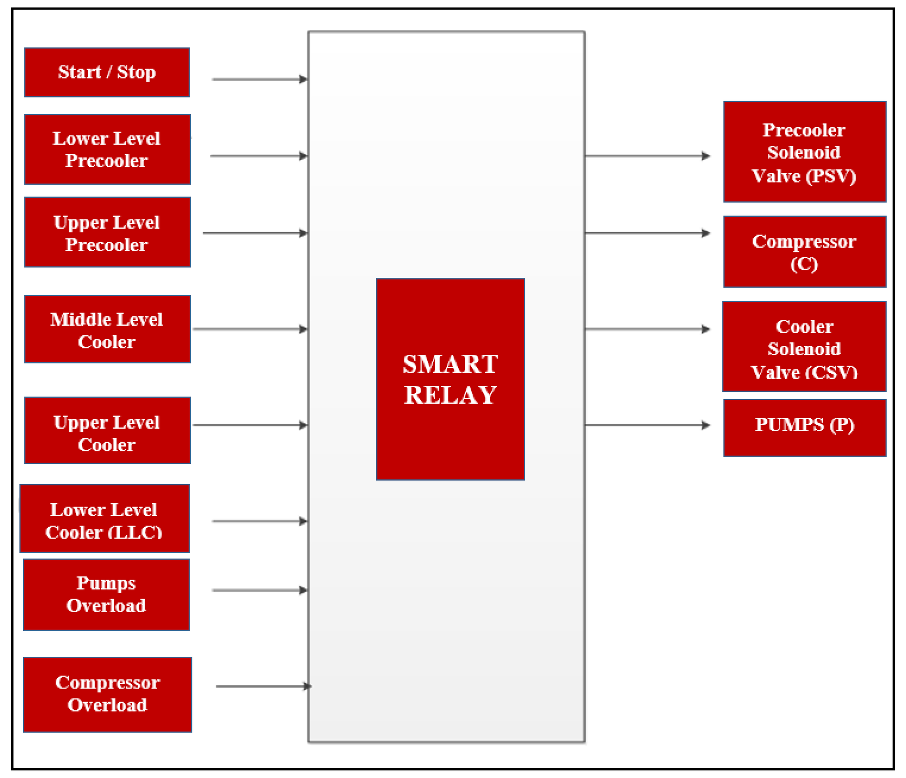

Figure 5. Inputs and Outputs of the process.

Proposed Solution

After inputs and outputs have been defined, the next stage is creating the programming logic that explains how our smart relay will behave according to the signals sent by the sensors. The next flow chart displays the proposed logic and programming interface.

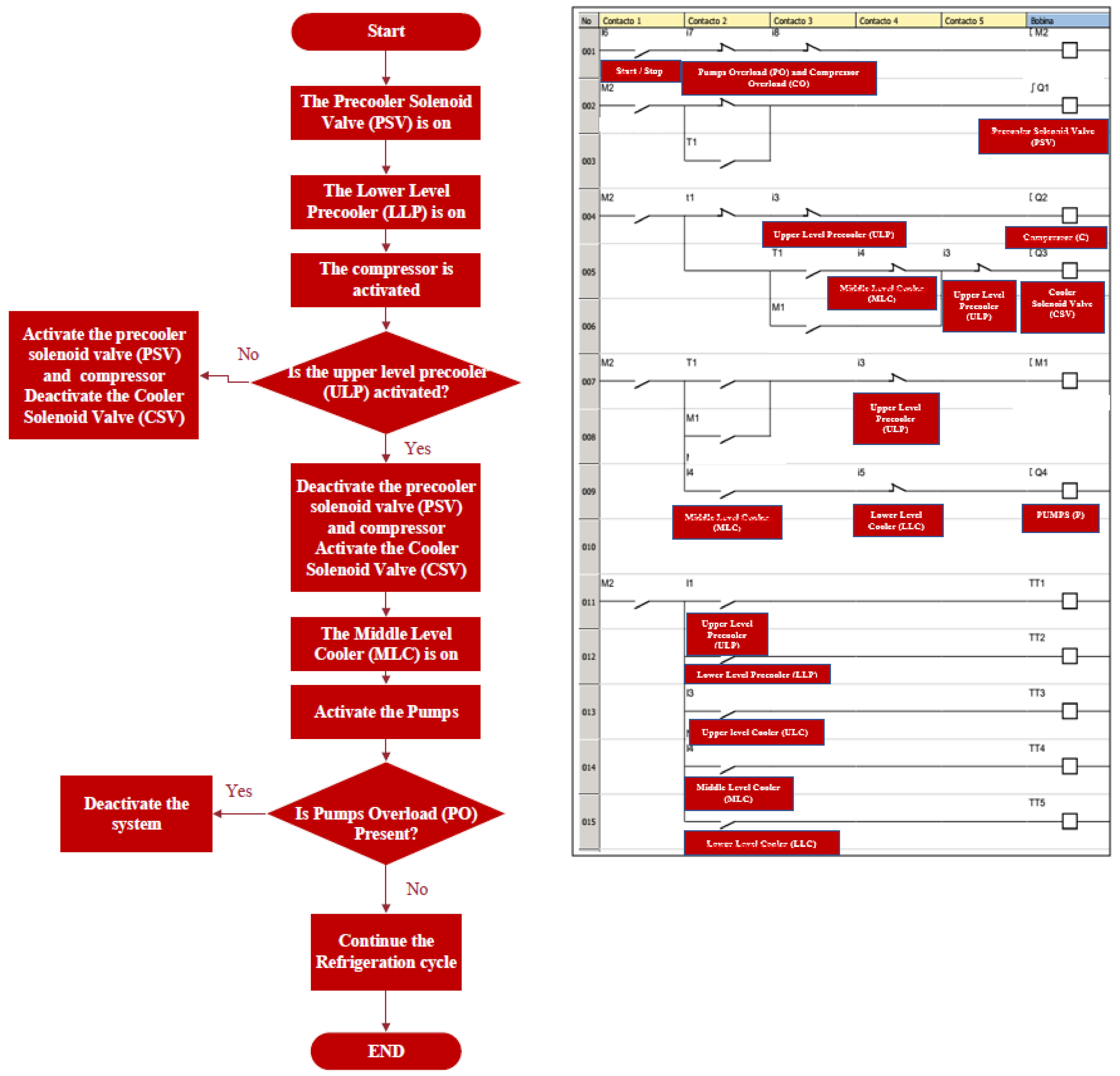

Figure 6. Programming logic flow chart and smart relay programming software

Conclusion

Due to the hazardous consequences that ammonia presents, the automation of the system using a smart relay offers an efficient way to diminish the worker´s exposure. The proposed solution can be adopted by other industries that work with corrosiveness and toxics substances in order to protect the worker´s health.

References

Akash, B., Devendra, S., Nidhi, B., Namrata , S., & Akshay , D. (2020). Real Time Monitoring and Control for Industrial Automation using PLC. *International Journal for Research in Applied Science & Engineering Technology*, 8.

EMS World. (2014, August). *EMS World*. From Chemical Burn Care: A Review of Best Practices. https://www.emsworld.com/article/11362795/chemical-burn-care-review-best-practices

Gerovitch, S. (2003, January). *Automation*. http://web.mit.edu/slava/homepage/articles/Gerovitch-Automation.pdf

Hawley, C. (2020). *Hazardous Materials Monitoring and Detection Devices.* Burlington, MA: Jones & Bartlett Learning.

New York State Department of Health. (2011, March). *The facts about ammonia*. From Department of Health. https://www.health.ny.gov/environmental/emergency/chemical_terrorism/ammonia_general.htm

United Nations Environment Programme (UNEP). (2016). *Lower-GWP Alternatives in Commercial and Transport Refrigeration: An expanded compilation of propane, CO2 ammonia and HFO case studies.* Nairobi.