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TITLE:

DYNAMIC PROCESS SAFETY ASSESSMENT BY MAPPING ALOHA SIMULATION INTO BOW-TIE ANALYSIS: APPLICATION TO DISTILLATION COLUMN IN PRODUCTION OF ACETIC ACID

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2023

ABSTRACT

The production of acetic acid has been found to have several key issues that could result in serious accidents if not addressed. The distillation column has been identified as the main point of concern. This project aims to analyse the hazards posed by chemicals passing through the heat exchanger by conducting risk analysis during the preliminary stage of chemical production site design. Two risk analysis methods will be used which is Bow tie analysis and Areal Locations of Hazardous Atmospheres (ALOHA) modelling software. Bow tie analysis provides insight into the root causes of accidents and potential consequences but lacks detail. The bow tie analysis also uses Inherent Safer Design (ISD) principles, such as minimizing, moderating, simplifying, and substituting, to create mitigative barriers. ALOHA modelling software provides a more detailed analysis of consequences, showing the extent of the threat zone. The results from the ALOHA modelling software indicate that the most hazardous chemical from the heat exchanger in the production of acetic acid is acetic acid itself. The threat zone is shown to include scenarios involving non-burning tanks and toxic vapor clouds. By utilizing both Bow tie analysis and ALOHA modelling software, the most effective risk assessment can be conducted and the current hazards can be reduced.

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CHAPTER ONE
BACKGROUND

1.1 Introduction

Safety is of paramount importance in the chemical industry due to the potential hazards posed by the chemicals and processes involved. The handling and storage of chemicals, as well as the operation of process equipment, can all present risks to employees, the public, and the environment. Therefore, it is essential that proper safety measures are implemented to minimize these risks and protect all stakeholders. There have been several incidents in chemical plants over the years, some of which have resulted in significant loss of life, injuries, and damage to the environment. These incidents highlight the need for strict safety protocols and procedures to be in place in chemical plants, as well as the importance of regular inspection and maintenance of equipment and the proper storage and handling of chemicals. Engineers play a crucial role in minimizing workplace incidents in chemical plants by designing and implementing safety systems and procedures that protect employees, the public, and the environment. Engineers have the technical expertise and understanding of chemical processes and equipment to identify potential hazards and implement controls to mitigate those hazards. They also can design and develop new technologies and processes that can improve safety in chemical plants. One of the keyways that engineers can minimize workplace incidents in chemical plants is through the design and implementation of process safety management systems. These systems involve identifying and assessing potential hazards associated with a chemical process and implementing controls to minimize the likelihood of an incident occurring. Engineers can use their knowledge of chemical processes and equipment to identify potential hazards, such as the potential for a chemical release or the risk of fire or explosion.

In this case study, ALOHA software will be implemented as the system of how to analyse hazard consequences in chemical plant. ALOHA (Areal Locations of Hazardous Atmospheres) is a software program developed by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) for use in emergency response and planning for hazardous chemical releases.

The software is used to predict the potential spread of toxic chemicals in the event of a release and help emergency responders and incident commanders make informed decisions about evacuation and other response actions. The software is based on advanced mathematical models that consider factors such as wind speed, wind direction, temperature, atmospheric stability, and the physical properties of the release material. These models are used to create detailed simulations of how a chemical release will move and spread through the air, allowing emergency responders and other officials to quickly assess the potential risks and take appropriate actions to protect the public. ALOHA can be used to model a wide range of different release scenarios, including accidental releases from industrial facilities and transportation accidents. It can also be used to model the effects of releases of different types of chemicals, including toxic gases, flammable liquids, and radioactive materials.

1.2 Literature Review

1.2.1 Main Chemical: Acetic acid

Acetic acid is a colourless liquid with a pungent, vinegary odour. As early as the third century BC, this substance was utilised in alchemy, frequently in the form of glacial (waterless or anhydrous) acetic acid. Even in our own home, acetic acid can be present in diluted form, or it might be a substance you handle at work (Helmenstine, 2018). In either event, it's critical to use caution when handling this potentially dangerous and corrosive acid by according to these safety recommendations from our MSDS experts(ScienceLab, 2006).

1.2.2 Hazard of Acetic Acid

Hazards of the Product:

This product is a corrosive and flammable liquid and vapor that can cause serious harm to the digestive and respiratory systems. Contact with the liquid or vapor can result in severe burns to the eyes and skin, and even lead to irreversible damage. Additionally, absorption through the skin can be harmful. When the temperature drops below 17°C (62°F), acetic acid can form a solid similar to ice (ScienceLab, 2006).

1.2.3 Main Equipment: Distillation column

A distillation column is a vital tool utilized in the process of separating a liquid