TITLE:
INTEGRATION OF BOW-TIE ANALYSIS AND ALOHA SOFTWARE FOR RISK AND CONSEQUENCES ANALYSIS EVALUATION FOR HEAT EXCHANGER DURING CHEMICAL PROCESS DEVELOPMENT AND DESIGN

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ABSTRACT

Providing a safe and healthy working conditions in the chemical processing industry is a crucial aspect for an employer to prioritise. However, several accidents have been recorded due to heat exchangers in the chemical processing sector over the past few decades, one of which was caused by a lack of containment and mostly ended in fire and explosion. Therefore, this study aims to analyze the risk and hazards present in a heat exchanger in the production of methanol route 2 in the preliminary stage and to propose a suitable mitigation measure for the identified hazard and measured risk by using Basic Over Web Tactical Imagery (Bow-Tie) Analysis and Areal Location of Hazardous Atmospheres (ALOHA). Bow-Tie Analysis only provides the analysis of risk. Meanwhile, ALOHA Software only provides a visual representation of the consequences. As a result, these two existing methods are then implemented at the same time in the process of safety analysis to develop an integrated process safety analysis that covers the evaluation of hazards and risks precisely. From the threat zone generated by ALOHA software, Carbon Monoxide has the largest area (red zone) of a high level of hazard ranging around 190 meters that are caused by the direct source. The scenario for the generated threat zone is the toxic area of the vapour cloud. To conclude, this study enhances and combines Bow-Tie analysis and ALOHA software to develop a more comprehensive risk and consequences analysis evaluation

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BACKGROUND

1.1 Introduction

Considering both humanitarian and financial factors, there is a general concern about the need to improve working conditions. A safe and healthy workplace is a crucial component of work quality. Additionally, a secure and healthy workplace is essential to a person's quality of life. Therefore, to provide a safe working condition of a workplace, it is crucial to act as early as possible. In furtherance, various of methods needed to be done to ensure a safe working environment of an industry. It comprises of

identifying the hazards to be assessed, risk assessment, risk control and advancing the process unit or stream assessed. Implementing these methods could lower the frequencies of any unwanted accident to occur as the engineer is aware of the possibilities and severity of the consequence beforehand. An evaluation or observation of accidents occurred due to an equipment in the chemical processing industry is important as it provides knowledge of the risk associated and the consequence it may come with. The engineer is able to predict the likelihood of the accidents occurred and analyse the main cause of the accidents to provide a more efficient and safer design of the equipment. The cause analysis of major accidents shows that some accidents could have been avoided if appropriate preventive measures were put in place. It is truly inevitable for chemical processing plants to operates without any presence of hazards, even the minor hazards. Working in a plant comes with a great risk and responsibilities but it takes a safety engineer to enhance the safety of the plant to diminish any hazards and risk. If an accident were to occur inside a plant, not only it will do a great damage to the plant, but it could also be fatal to the people around the area, costly to repair the damage that has been done and potentially leaves an impact to the environment. Needless to say, a proper and detailed planning and analysis of hazards and risk presence in a plant should be conducted by the engineer in the early process to temper the safeness of the plant.

To achieve to a low hazards and risk while operating a chemical processing plant, an analysis of risk presence in the plant should be conducted. An analysis method known as the Bow Tie Analysis provides a clear diagram of the threats, mitigative and preventive barrier, and the consequences of an event. It uses a graphical flow chart that connects every element to analyse the consequences of an event and the factor of the consequences. Inherent Safer Design (ISD) is implemented in the preventive barrier where it uses all the four elements of ISD -Minimize, Moderate, Simplify and Substitute. As a result, a potential solution to the threats is justified hence lowering the risk and the possibility of the event to occur. However, if the stated event were to occur, the mitigative barrier gives an insight of the actions that need to be done to avoid the situation from worsening. The analyzation of risk is not enough to fulfil the standard of providing a safe operating plant. Therefore, a consequence analysis by using Areal Locations of Hazardous Atmospheres (ALOHA) software is then implemented after Bow Tie Analysis to gives more support to the safety analysis. The ability of ALOHA to predict a chemical release and dispersion to an area by the usage of a visual called