Risk-Based Inspection for Ammonia Storage Unit by Using PRIMS: A Case Study

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Abstract: Risk-based inspection (RBI) is a method that applies risk analysis as its foundation. In this study, RBI methodology is applied on an ammonia storage unit in a specialized bioprocess facility. A liquid ammonia is stored in two pressure vessels. This study aims to determine the level of risk posed by the storage unit and decide the right inspection method and timeframe to conduct the inspection on the unit. The methodology used is based on PRIMS-RBI software with reference to American Petroleum Institute, API 581 Risk-based inspection methodology. This study is the first application of RBI for ammonia storage tank in bio-processing facilities in Malaysia. Based on the analysis performed, the most credible damage mechanism experienced by the unit is identified as internal and external wall thinning. Also, based on the analysis, the probability of failure of this unit is identified as "Low", and the consequences of failure is identified as "Catastrophic". Based on the risk analysis, the risk level of this unit is categorised as "Medium-High" level. This "medium-high risk" is caused by the property of the fluid stored in this device, which is toxic in nature and may potentially cause serious safety and health impact to the surrounding population.

1. Introduction

A series of major accidents involving fuel storage facilities, handling and production complexes have directed a worldwide attention on the importance to control the design and management of such facilities where potential for major accidents exists. In Malaysia, the Control of Industrial Major Accident Hazards (CIMAH) Regulation was promulgated on 1st February 1996 under Occupational Health and Safety Act No. 514 of 1994 to control, manage and regulate such activities. Ammonia has been identified as hazardous substances, under CIMAH Regulations 1996, and due to its hazardous classification, ammonia storage demands the utmost attention a high safety requirement. Damage to ammonia storage equipment and the release of ammonia gas and liquid, affects not only the operations of other assets but also safety of workers and surrounding communities, because such events could result in serious injuries and led to potential death of workers and surrounding inhabitants [1].

At the same time, ammonia storage facilities require an effective and appropriate maintenance strategy to sustain its functional operations and to ensure it will not cause a disastrous accidents and disaster. In this study, risk-based inspection using PRIMS methodology is applied to ammonia storage facilities to identify components, likelihood to fail and its consequences. The result of the study will help the industry in identifying the risk of the installation and to allow prudent allocation and assignment of resources to inspect and maintain integrity of equipment based on equipment identified risk level.

Plant reliability is an important performance indicator for processing plant [2]. The amount of maintenance resources, which includes inspection activities, that is allocated to equipment involved in the processes have direct effects to the overall plant operational and integrity performance. Allocating the same level of resources to inspect, maintain and ensuring each piece of equipment's integrity, is not cost effective. Furthermore, it can lead to oversight of equipment categorized as high-risk. Although the number of high-risk equipment in an operating plant usually exists in lower percentages than low risk equipment, an oversight in the implementation of needed inspection and maintenance of these high-risk equipment may cause a catastrophic event when it involves toxic materials. Thus, it is important to perform risk-based assessment of such installation so that the risk is known, and the correct resources could be allocated to ensure the integrity of the equipment, the safety of the people and the protection of the environment.

The existence of large quantities of hazardous substances in storage, introduce risk for the population and the surrounding area including the environment. Any spills of hazardous substances, especially exceeding the threshold limit, into the soil can lead to expensive cleaning and decontamination processes. Leakage of oil, toxic gas or hazardous chemicals from storage tanks could lead to a disastrous situation of fire outbreak, tank explosion, or toxic gas release. Many reports have shown the risk and consequences with storage tanks upon major disaster [3-5]. With regards to risk associated with storage of hazardous substances, it is important to assess the risk potentially caused by the leakage of ammonia from a storage facility, because of the potential serious consequences it can caused on the affected areas [6].