RISK MANAGEMENT IN NGBC PLANT USING HAZARD IDENTIFICATION RISK ASSESSMENT AND RISK CONTROL (HIRARC) AT PT XYZ

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Abstract

PT XYZ is a company that produces fiber as the main product with capacity of 220.000 tons per year. In this fiber production process, PT. XYZ uses several types of chemicals. One of them is carbon disulfide which is produced by the Natural Gas Based Carbon (NGBC) plant. Based on accident data from 2015 to 2021 at the NGBC plant, there were no work accidents that occurred in fatalities. PT XYZ wants to continue to improve working conditions by managing the hazards that exist in the work location. This goal is also in line with the company's vision to become an excellent company in safety and health, good for the planet and people, and exceed compliance to global and local regulations. This research was conducted using the Hazard Identification, Risk Assessment and Risk Control (HIRARC) method. HIRARC is a method that aiming to identify hazard, assess and control risk. From the

process implementing hazard identification, there are 7 risks categorized as medium risk, 17 risks categorized as high risk and 3 risks categorized as extreme risk. The basic causes of the risk come from lack of awareness, lack of discipline, lack of interlock in some systems, insufficient rest breaks, repetitive awkward postures, and poor housekeeping.

Keywords: Accident, HIRARC, Risk Management, Safety and Health,

Introduction

Due to intense competition in producing quality products or services, many industries take advantage of the development of equipment and processes to support their business lines. This development is often followed by problems such as work accidents, occupational diseases and negative impacts on the environment. This is because no activities in industries are risk-free. Based on data from the West Java Department of Labor, only a few companies in West Java have managed to achieve zero accident. It is recorded that out of 50 thousand companies in West Java, only 20% have succeeded in achieving zero accident [1-4].

In 2020 there were 35,291 cases of work accidents that occurred in West Java. The majority of these mishaps were caused by human error. For this reason, companies must have awareness about the importance of occupational safety and health management. This is in accordance with Government Regulation of the Republic of Indonesia No. 50 of 2012 about the Implementation of Occupational Safety and Health Management Systems. This safety and health management system called as SMK3 in Indonesia. SMK3 aims to increase the effectiveness of planned, measurable, structured and integrated occupational safety and health protection. With the implementation of SMK3 it is hoped that the workplace will be safe, comfortable and efficient to encourage business productivity[5, 6].

PT. XYZ is a company located in Purwakarta, West Java. PT. XYZ has been a producer of staple fibers that are processed through a viscose solution obtained from a mixture of various chemicals. Every year PT. XYZ is capable of producing up to 220,000 tons of fibers per year. In this fiber production process, PT. XYZ uses several types of chemicals. One of them is carbon disulfide which is produced by the Natural Gas Based Carbon (NGBC) plant[7].

Based on accident data from 2015 to 2021 at the NGBC plant, there were no work accidents that occurred in fatality. Fatality is an employee death resulting from a work-related incident or exposure; in general, from an accident or an illness caused by or related to a workplace hazard. Even so, the management wants to continue to improve working conditions by managing the hazards that exist in the work location. This is given that the nature of CS2 is flammable and has the risk of causing an explosion. This goal is also in line with the company's vision to become an excellent company in Safety and Health, good for planet and people, and exceed compliance to global and local regulations[8-11].

To identify potential hazards, this research uses the HIRARC method. In its application, this research will be adapted to the work safety system at PT XYZ which refers to the Occupational Health and Safety Assessment Series (OHSAS) 18001 standard regarding work management systems and occupational safety and health (SMK3) in managing K3 through a management system approach, as well as measuring Occupational Health and Safety performance in the industrial world. With this research, it is hoped that the prevention and reduction of work accidents can be done so that the company's goal of creating zero accidents can be achieved [12-16].

Literature Review

According to the Government Regulation of the Republic of [6] all companies are required to record all important elements of the Occupational Health and Safety Management System (SMK3) and those related to these elements. Documentation of the Occupational Safety and Health Management System such as policies, procedures, work instructions to be communicated to ensure that all related elements receive the same information about what is required for Occupational Safety and Health Management. Actions such as risk assessments, control plans, meetings, inspections, accident and incident investigations, health monitoring, company maintenance, review, and evaluation of activities need to be recorded and documented because they are an important source of information for the effectiveness of the Occupational Health and Safety Management System. In addition, the documentation is used for monitoring and evaluation of the implementation of SMK3 in the company[17-19].

Risk management has many standards that have been used. Many countries even have their own risk management standards to apply in their country. However, in essence, this standardization is used as a basis for understanding the concept of risk management implementation. Examples of risk management standards that are still in use today are British Standards, Canadian Standards, COSO Enterprise Risk Management, and Australia/New Zealand Standards [20] is widely used by various standards and applied in many countries because it is considered more relevant.[9, 21] advantages over other standards. One of the advantages is that AS/NZS 4360:2004 uses a systematic approach to manage risk and achieve the safety goals of an organization. In addition, this standard offers great flexibility since it can be applied to all types of organizations..

Risk Control is process to remove or reduce a hazard in such a way that it does not pose a risk to workers who must enter an area or work on equipment during scheduled work. The effectiveness of controls should be checked and observed regularly. The results of the risk assessment will be used as the basis for controlling risks in each work area. Risk control is carried out based on the risk control hierarchy in [17] and is given in the form of input/suggestions for companies to improve the existing Occupational Health and Safety Management System.

Methods

This research was conducted using HIRARC method. HIRARC or Hazard Identification Risk Assessment and Risk Control is a method that aims to identify, analyze hazards and risk control techniques used to review systematic processes or operations in a system[22]. This method has an important component to assessment to recognize of existing hazards, evaluate the probability or chance of occurrence, and recommend relevant controls [7]

[22] states that probability is the chance of something happening, whether defined, measured, or estimated objectively or subjectively or in terms of general descriptors (such as rare, unlikely, likely, almost certain), frequencies or (mathematical) probabilities. In this research, the assessment of probability in NGBC Plant was based on employee experience, analysis, or measurement. Probability can be assessed using a scale as shown in Table 1.

Table 1

Probability Scale

Range	Criteria	Descriptions
1	Rare	May occur only under special conditions/about once a year.
2	Unlikely	It may occur under certain conditions, but unlikely.
3	Possible	May occur under certain conditions
4	Likely	May occur in almost all conditions
5	Almost Certainly	Can occur in all conditions.

Source**:** AS/NZS 4360:2004

Severity is outcome from an occasion like severity of injury or health of people, or damage to property, or insult to environment, or any combination of those caused by the event. In general, severity can be divided into five categories based upon an increasing level of severity to an individual's health, the environment, or to property [20, 21]. Severity can be assessed using a scale as shown in Table 2.

Table 2

Severity Scale

Range	Criteria	Descriptions
1	Insignificant	No loss, little material loss
2	Minor	Minor injuries require P2K3 treatment can be handled directly at the scene, moderate material loss
3	Moderate	Missing workdays, requiring medical treatment, material loss is quite large
4	Major	Injuries result in disability or loss of function body in total big material loss
5	Catastrophic	Causing a huge material disaster

Risk assessment is a process for identifying, quantifying, and controlling hazards and risks. This assessment can be calculated by multiplying the level of Probability and Severity values. The higher the result, the greater risk for an activity. This method helps balance the weight of severity and probability as shown in Table 3.

Table 3

Risk Assessment Matrix Level

AS/NZS 4360 : 2004		SEVERITY					
		Insignificant	Minor	Moderate	Major	Extreme	
PROBALITY	Almost Certainly	Moderate	High	High	Extreme	Extreme	5
	Likely	Moderate	Moderate	High	High	Extreme	4
	Possible	Low	Moderate	High	High	High	3
	Unlikely	Low	Low	Moderate	Moderate	High	2
	Rare	Low	Low	Moderate	Moderate	High	1
		1	2	3	4	5	

Source**:** **[8, 23]**AS/NZS 4360:2004

Result and Discussions

At the NGBC Plant, most of the control of carbon disulfide production is carried out from the control room. Activities that need to be carried out in the field are filling out logsheets every two hours, operating manual valves according to instructions from the control room operators, taking samples at the beginning of each shift, changing over equipment every morning, and operating boiler with a steam capacity of 20 tons.

Currently operational production process has a safety control through a safety interlock system. This safety interlock system built in to provide automatic actions to correct if abnormality happen. Because of this the number of potential hazards have been reduced. The remaining hazard coming from chemical properties of used chemical, operator activities, and unsafe condition at NGBC Plant.

HIRARC method is carried out by identifying hazards in each operational activity at the NGBC Plant. The potential hazards found are then analyzed and continued with risk level assessed. The results of this analysis and assessment are then used as the basis for risk control. After the implementation of the risk level, the next stage will be carried out afterwards with the following results:

Table 4

Hazard Identification in NGBC Plant

No	Activities	Risk	Probability (P)	Severity (S)	Scores (PxS)	Risk Rating
1	Production Control from Control Room	Back Pain	4	2	8	Medium
		Mental Exertion	4	3	12	High
		Kidney Problem	4	4	16	High
2	Check Sulfur Hydraulic Seal	Splash with Sulfur Liquid	3	2	6	Medium
		Fall down from a high (2 M)	3	3	9	High
		Contact with hot Surface	3	3	9	High
		Exposure Toxic gas (SO2, H2S)	4	3	12	High
3	Take Condensate water sample from Boiler	Splash by hot water	4	3	12	High
		Contact with Hot Surface	4	3	12	High
4	Take CS2 sample	Splash by CS2 liquid	4	2	8	Medium
		Toxic gas exposure (CS2, H2S)	5	3	15	High
5	Periodic logsheet filling	Exposed by CS2, NG, H2S, SO2 beyond PEL	5	5	25	Extreme
		Contact with Liquid Sulfur	3	2	6	Medium
		Struck by object	2	3	6	Medium
		Fall	2	3	6	Medium
		Splash by liquid sulfur	3	2	6	Medium
		Splash by Steam Condensate	4	3	12	High
6	Boiler Operation	Steam drum explode	3	5	15	High
		Main Steampipe explode	3	5	15	High
		Hearing loss at the time steam venting and safety valve open	4	4	16	High

		Exposed heat and steam leak valve when open and close manual steam valve	4	4	16	High
		Falling down from height when control/inspect above the steam boiler drum	4	5	20	Extreme
7	NaOH Filling	NaOH Overflow	3	3	9	High
		Fall from high (2.5 M)	3	4	12	High
		Eyes and Skin irritation	3	4	12	High
8	Change Over Rotate Equipment	Toxic gas exposure (CS2, H2S)	5	4	20	Extreme
		Got Electric Shock	3	4	12	High

Based on the hazard identification process that has been carried out there are 7 risks that are categorized as medium, 17 risks that are categorized as high and 3 risks that are categorized as extreme. The main hazards were identified as chemical, physical and ergonomic hazards. This type of hazard requires control measures and risk reduction before the work begins[24]. In this research, risk control is implemented by looking for the basic cause of risk and application of the hierarchy of hazard control such as elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE) as shown in Table 5.

Table 5

Risk Control Recommendation

No	Activities	Risk	Basic Cause	Risk Control
1	Production Control from Control Room	Back Pain	Employee Age	Improve work policies and procedures
		Mental Exertion	Insufficient rest breaks	Short Break Scheduling
		Kidney Problem	Repetitive Awkward Postures	Implement 5S System
2	Check Sulfur Hydraulic Seal	Splash with Sulfur Liqiud	Lack of Awareness	Improve work policies and procedures
		Fall down from a high (2 M)	Poor Housekeeping	Training and Supervision
		Contact with hot Surface	Lack of discipline	Refreshment training
		Exposure Toxic gas (SO2, H2S)		Using Proper PPE
3	Take Condensate water sample from Boiler	Splash by hot water	Lack of Awareness	Improve work policies and procedures
		Contact with Hot Surface	Lack of discipline	Using Proper PPE
4	Take CS2 sample	Splash by CS2 liquid	Lack of Awareness	Improve work policies and procedures
		Toxic gas exposure (CS2, H2S)	Lack of discipline	Using Proper PPE

5	Periodic logsheet filling	Exposed by CS2,NG,H2S,SO2	Lack of Awareness	Improve work policies and procedures
		Contact with Liquid Sulfur	Lack of discipline	Supervision
		Struck by object	Poor houskeeping	Refreshment training
		Fall	Old Piping System	Implement 5S System
		Splash by liquid sulfur		Using Proper PPE
		Splash by Steam Condensate		
6	Boiler Operation	Steam drum explode	Lack of Awareness	Improve work policies and procedures
		Main Steam pipe explode	Lack of discipline	Supervision
		Hearing loss at the time steam venting and safety valve open	Poor houskeeping	Refreshment training
		Exposed heat and steam leak valve when open and close manual steam valve	Old Piping System	Implement 5S System
		Falling down from height when control/inspect above the steam boiler drum		Using Proper PPE
7	NaOH Filling	NaOH Overflow	Lack of interlock system	Improve work policies and procedures
		Fall from high (2.5 M)	Corrosive Platform	Refreshment training
		Eyes and Skin irritation	Lack of discipline	Using Proper PPE
8	Change Over Rotate Equipment	Toxic gas exposure (CS2, H2S)	Lack of Awareness	Improve work policies and procedures
		Got Electric Shock	Lack of discipline	Using Proper PPE

Conclusions

Based on the results of the data and analysis that has been carried out, the following conclusions can be obtained from the process of implementing hazard identification. There are 7 risks that are categorized as medium, 17 risks that are categorized as high and 3 risks that are categorized as extreme. Based on hazard identification and risk assessment using the HIRARC method, activities that have an extreme risk in NGBC plant are periodic logsheet filling, boiler operation and change over-rotate equipment. Activities that have a high risk in NGBC plant are production control from control room, check sulfur hydraulic seal, take condensate sample from boiler and carbon disulfide sample from carbon disulfide drain point. The basic cause of the risk comes from lack of awareness, lack of discipline, lack of interlock in some systems, insufficient rest breaks, repetitive awkward postures and poor housekeeping.

This research proposed several suggestions to enhance occupational safety and health condition in NGBC Plant. As a primary step to prevent accidents, PT XYZ should prioritize the safety factors by improving work policies and procedures. Regulation like short break is also needed to avoid mental exertion that comes from shift systems and high-pressure condition. To keep awareness and discipline on a good level there is a need to schedule refreshment training. This can be accompanied by 5S system implementation to avoid poor housekeeping, eliminate waste and optimize efficiencies. Risk assessment should be prepared by experienced and competent personnel so the assessment results become more accurate. In controlling the risks, safety officers should take preventive and corrective actions against the workers who do not comply with the work safety requirements.

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