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Fire Risk Analysis in the Activity of Unloading Flammable Chemicals from Ship to Storage Tank

Arief Bagus Arjuna

Universitas Al-Khairiyah, Jl. H. Enggus Arja No. 01 Citangkil, Kota Cilegon

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Abstract: The application of automation technology in industry is growing rapidly, especially in the chemical industry. The more advanced the level of industrial development in a country or region, the greater the number and types of industries. By integrating technological, machine, and human resources, it provides major changes to the industrial sector to get priority for development because it can make a significant contribution to the national economy. Several chemical industries have developed, including the petrochemical industry, agrochemicals, and so on. The chemical industry produces various chemical products to meet the needs of the Indonesian people. In human life, it is inseparable from the use of chemicals produced by the chemical industry. The increase in the number of chemical industries will also increase the potential for danger and risk. The danger of fire is one of the potentials that can have a major impact and even the risk of death and serious burns to humans. In addition to the risk to humans, fire also damages company assets and pollutes the environment. Therefore, the author conducted a study in one of the chemical industries in the city of Cilegon which has great potential for danger and high risk. This potential fire hazard is triggered by the activity of unloading flammable chemicals from ships to storage tanks. The purpose of this study is to identify hazards and assess risks in the activity of unloading flammable chemicals from ships to storage tanks. This study uses the Hazard Identification, Risk Assessment and Control (HIRAC) method. The results of this study are to determine the level of fire risk in the activity of unloading flammable chemicals from ships to storage tanks and to prepare prevention and mitigation strategies

Key words: fire, chemical, risk assessment

I. Introduction

The chemical industry in Indonesia is growing rapidly by implementing automation technology. The increase in production volume is in line with the increasing needs of customers and the market. With the increasing number of chemical factories built, the potential for danger and risk of accidents will also increase. The greatest potential hazard in the chemical industry is fire. According to Ramli (2010), a fire is an uncontrolled fire, unwanted or beyond human ability and desire that can cause material, life, or environmental losses. In addition to the potential for fire hazards, there are still other potential hazards in the form of leaks of toxic chemical gases or vapors, explosions due to flammable gases or liquids, fires due to electrostatics, and so on.

Law of the Republic of Indonesia Number 1 of 1970 concerning Occupational Safety states that through laws and regulations, work safety requirements are determined to prevent, reduce, and extinguish fires. According to the International Labor Organization (2018), the common causes of major fires in the workplace have three basic requirements, namely: 1) the presence of fuel or flammable materials, 2) the presence of a source of ignition, 3) the presence of oxygen in the air to support combustion. Cases of industrial fires abroad can be seen in Table 1.

Table 1. Cases of Industrial Fires

No	Date	City/Country	Number of Fatalities
1	March 2, 1960	Busan/South Korea	68
2	November 18, 1968	Glasgow/England	24
3	June 26, 1971	Czechowice/Poland	37
4	September 3, 1991	Hamlet/United States	25
5	May 3, 1993	Kader/Thailand	188
6	November 20, 1993	Zhili/China	81
7	September 21, 1997	Jinjiang/China	32
8	April 22, 2000	Qingzhou/China	38
9	June 30,2000	Guangdong/China	36
10	June 26, 2000	Agra/India	42

Source: ILO (2018)

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The fire cases in table 1 are a serious concern for company management and workers. The government is required to carry out routine supervision and inspections of chemical industries that have great potential hazards. Several cities in Indonesia that have chemical industries include Gresik, Cilegon, Bontang, and so on. Previously, the author had written an article on fire risk analysis in chemical warehouse activities. Therefore, the author developed other potential hazards in activities in the chemical industry by conducting a fire risk analysis in the unloading of flammable chemicals from ships to storage tanks. In overcoming the problem of fire in the chemical industry, the author provides suggestions including that companies that store or produce flammable chemicals must report the type and quantity of chemicals to relevant government agencies, companies are required to implement the Occupational Safety and Health Management System (SMK3), companies must conduct a fire risk analysis. The author uses the Hazard Identification, Risk Assessment and Control (HIRAC) method based on the Occupational Health and Safety Assessment Series (OHSAS) 2018.

Theoretical Basis

Fire is a chemical reaction process and oxidation event of three elements, namely materials, oxygen, and heat that can cause material losses or even human death (National Fire Protection Association, 2002). The storage criteria for flammable chemicals according to the quantity threshold value are regulated in the Decree of the Minister of Manpower and Transmigration Number 187 of 1999 concerning Control of Chemicals in the Workplace. Meanwhile, the classification of the level of potential fire hazard is regulated in the Decree of the Minister of Manpower and Transmigration Number 186 of 1999 concerning Fire Fighting Units in the Workplace. Hazard is anything including situations or actions that have the potential to cause accidents or injuries to humans, damage or other disturbances (OHSAS 18001). Risk is a combination of the possibility of a hazardous event or exposure with the severity of the injury or health disorder caused by the event or exposure (OHSAS 18001). Risk assessment is an effort to calculate the magnitude of a risk and determine whether the risk is acceptable or not (Ramli, 2010). Qualitative method is the possibility or likelihood given a range between a risk that rarely occurs to a risk that can occur at any time (AS/NZS 4360). Severity is between an event that does not cause injury or minor losses and the most severe event that can cause death or major damage to company assets. The likelihood criteria consist of (1) very rare, (2) has occurred in three years, (3) has occurred once a year, (4) often occurs at any time throughout the year more than once. The severity criteria consist of (1) does not have a significant impact on humans or assets with losses of less than two million rupiah, (2) causes minor injuries and has no significant impact on the company with losses of more than two million rupiah, (3) has a significant impact and causes serious injuries with losses of 10 - 50 million rupiah, (4) the impact is very serious, can cause loss of life, severe damage and can disrupt the company's business operations with losses of more than 50 million rupiah. In Table 2, the values 1 - 4 are interpreted as low risk, 5 - 8 are moderate risk, 9 - 12 are high risk, and 13 - 16 are extreme. The risk rating consisting of likelihood and severity can be seen in Table 2.

Table 2 Risk Rating (Likelihood and Severity)

Likelihood	**Severity**		
	1	**2**	**3**
	4		
1	1	2	3
	4		
2	2	4	6
	8		
3	3	6	9
	12		
4	4	8	12
	16		

Source: Ramli (2010)

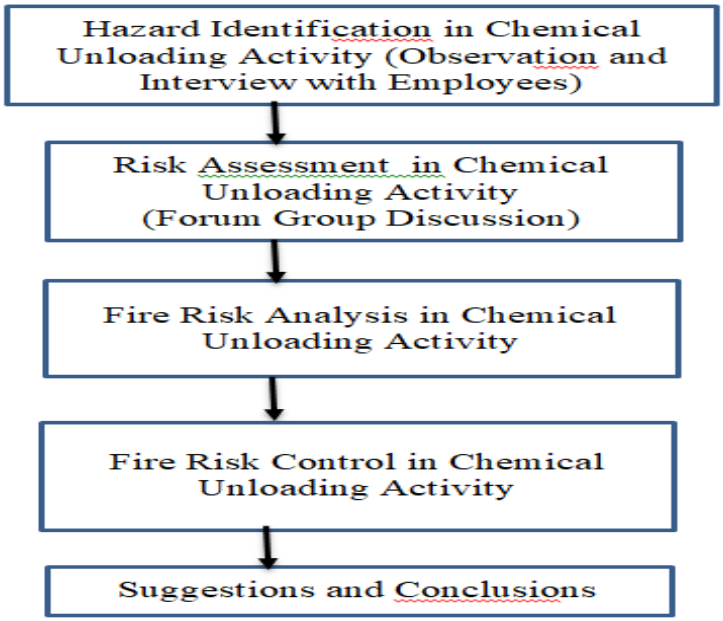
The results of previous studies indicate the need to conduct hazard identification and risk assessment in industries that have the potential for fire hazards. In previous studies conducted fire hazard assessments, analysis of technical implementation of fire prevention and control in factories, application of fire protection systems, human resource preparedness, promotion of Occupational Safety and Health, implementation of fire equipment readiness (Muhammad Masood Rafi, Syed Wasiuddin, Salman Hameed Siddiqui. 2012, Rini Puspita Dewi. 2012, Luthfan Firdani, Ekawati, Bina Kurniawan. 2014, Zia Wadud, Fuad Yasin Huda, Nizam Uddin Ahmed. 2014, Eko Yudhi Prasetyo, Syahrul Meizar Nasri. 2014, Meli Azrini, Hanifa Maher, Denny, Laksmono Widagdo. 2015, Ifan Zanuar Ashary, Bina Kurniawan, Baju Widjasena. 2015, Yi Li et all. 2015, Resti Ayu Lestari, Katharina Oginawati. 2016, Aristy Yulanda Ambarani, Abdul Rohim Tualeka. 2016, Laila Fitriana, Suroto, Bina Kurniawan. 2017, Bagas Satrio Priambudi, Bina Kurniawan, Badju Widjasena. 2017, Rigen Adi Kowara, Tri Martiana. 2017, Kristiana Kuntoro, Daru Lestyanto, Ekawati. 2020, Apriliyanti Supit, Woodford B. S. Joseph, Odi R. Pinontoan. 2021, Irfan Rahmanto, Muhammad Ihsan Hamdy. 2022, Mirah Alamiyyah, Ajeng Febrianti Rahayu, Septa Indra Puspikawati. 2022, Arief Bagus Arjuna,

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XI, November 2024

M. Juju Adhiwikarta, M. Zuhdi Prasetyo Nugroho. 2022, Putri Ayu Ananda, Friska Ayu. 2023, Novrikasari et all. 2023, Rahmad Inca Liperda, Rifqi Rahmadanti. 2023, Michelle Delaliarte, Joji Davila Linaugo, Dennis Villasor Madrigal. 2024)

II. Methodology

The compilation of descriptive methodology with qualitative research and conducting observations and interviews in the field in analyzing the risk of fire in the unloading of flammable chemicals from ships to storage tanks using the Hazard Identification, Risk Assessment and Control methods. In conducting hazard identification and risk assessment, activity data and competent human resources are required. In risk assessment, a forum group discussion is needed to align perceptions with employees (operators, supervisors, managers) in the company consisting of the safety department, jetty terminal operations department, and maintenance department to explore data as shown in Figure 1.



Gambar 1. Framework of Thought

III. Result and Discussion

In the identification of hazards in the activity of unloading flammable chemicals from ships to storage tanks by conducting observations and interviews in the field, the data used for risk assessment were obtained as shown in Table 3.

Table 3. Potential Hazards and Risk Assessments in the Activity of Unloading Flammable Chemicals from Ships to Storage Tanks

No	Activity	Potential Hazard	Risk
1	Ship crashes when docking at the jetty	Fire	Death
2	Jetty operator climbs onto the ship using a ladder	Falling into the sea	Death
3	Take samples of flammable chemicals in the ship's tank	Irritation	Health Disoders
4	Blow the pipeline from the jetty to the storage tank	Noise	Health Disoders
5	Install hoses from the ship to the storage tank pipeline	Caught in work tools	Injury
6	Transfer flammable chemicals from the ship to the storage tank	Fire	Death
7	Disconnect the pipeline hose	Irritation	Health Disoders
8	Blow the remaining flammable chemicals in the pipeline to the storage tank	Fire	Death
9	Pigging pipeline from jetty to storage tank	Fire	Death
10	Remove the pigging tool	Irritation	Health Problem

Source: Forum Group Discussion (2023)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XI, November 2024

The hazard identification data above is used to conduct risk analysis and align perceptions when conducting forum group discussions with human resources in related sections. Risk analysis data is used to determine severity and probability as well as the multiplication value between severity and probability.

Table 4. Potential Hazards and Risk Assessments in the Activity of Unloading Flammable Chemicals from Ships to Storage Tanks

No	Activity	Severity	Likelihood	Risk Assessmentt	Risk Level
1	Ship crashes when docking at the jetty	4	3	12	High
2	Jetty operator climbs onto the ship using a ladder	4	2	8	Medium
3	Take samples of flammable chemicals in the ship's tank	2	3	6	High
4	Blow the pipeline from the jetty to the storage tank	2	3	6	High
5	Install hoses from the ship to the storage tank pipeline	2	3	6	Low
6	Transfer flammable chemicals from the ship to the storage tank	4	3	12	High
7	Disconnect the pipeline hose	2	3	6	Low
8	Blow the remaining flammable chemicals in the pipeline to the storage tank	4	3	12	High
9	Pigging pipeline from jetty to storage tank	4	3	12	High
10	Remove the pigging tool	2	2	4	Low

Source: Forum Group Discussion (2023)

Risk assessment data and risk levels will determine the fire risk control strategy in the activity of unloading flammable chemicals from ships to storage tanks by preparing: (1) standard operating procedures, (2) work instructions, (3) checklists, (4) grounding systems, (5) bounding systems, (6) workforce competencies, (7) training for operators/supervisors. The risk control strategy in this activity must be carried out consistently and responsibly.

IV. Conclusion

Every activity in the chemical industry certainly has potential hazards and risks, including unloading flammable chemicals from ships to storage tanks. Before carrying out these activities, hazard identification and risk assessment must be carried out. The potential for fire hazards is always present in these activities, while the risk assessment is based on the calculation between severity and probability which will be used to determine the risk value and risk level. In efforts to prevent and control fires, a strategy is needed by top management, both in terms of providing supporting equipment for the chemical unloading process, fire extinguishing equipment, and human resource competencies. In addition, the implementation of the Occupational Safety and Health Management System must be carried out by industries that have the potential for fire hazards.

Acknowledgements

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