

Comparative Analysis and Case Study on Domestic and Foreign Chemical Accidents and Implications

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Abstract— As the chemical industry develops globally, the risks imposed on human and environmental safety are increasing. In recent decades, accidents of harmful chemicals have become a major global problem and regarding chemical control, developed countries have reorganized national laws and policies such as conventions, evaluations and guidelines while they went through small and large chemical accidents.

In the case of Korea, as the country is small and the chemical industry is also developing, the incidence of chemical accidents is increasing, residents in nearby residential areas are exposed to very vulnerable conditions to chemical accidents. Especially when looking at cases of chemical accidents in the last 10 years, there has been a steady increase in casualties and property damage and accordingly, laws related to chemical substances and specialized agencies are emerging, however it is considered to be insufficient compared to other developed countries. Therefore, this study aims to draw up lessons and implications and suggest alternatives accordingly by analyzing cases of domestic and foreign accidents on chemical accidents. Also, it tries to discuss ways to prevent chemical accidents and actively respond to them.

Keywords— Chemical Accident, Chemical Substances, Specialized Agency.

I. INTRODUCTION

In Korea, there are many places where residential areas and industrial complexes are close each other due to the expansion of disorderly urbanization compared to the small size of the country. As such over-development and industrialization progress, the amount of chemicals used is increasing so that it is a trend that chemical accidents are also frequently happening.

Korea's chemical industry is growing to the top level which is 3.4% of the global chemical market and it accounts for 16.7% of Korea's manufacturing GDP. Therefore, it can be said that the chemical plays an important role in the national economy. However, as currently, there is insufficient chemical management and lack of information, it is a situation that as the amount of chemical handling increases, the risks and incidence of chemical accidents such as leaks, explosions, fires, etc. are increasing. Particularly, some chemicals that are highly toxic

require information about the correct chemical to prevent diffusion in an early stage because the rate of diffusion is very fast when a chemical accident occurs. By analysing past accident cases and reviewing causes of accidents, the degree of damages, countermeasures, etc. similar chemical accidents that may occur in the future can be prevented.

Therefore, this study aims to investigate the current status of domestic and overseas chemical accidents, draw implications for chemical accidents through case studies and discuss mitigation plans.

II. ANALYSIS ON CHEMICAL ACCIDENT IN KOREA

2.1 Status of chemical handling

As of 2010, the volume of chemical substances manufactured, imported and used by chemical companies had increased by 4.6% per year compared to 2002.

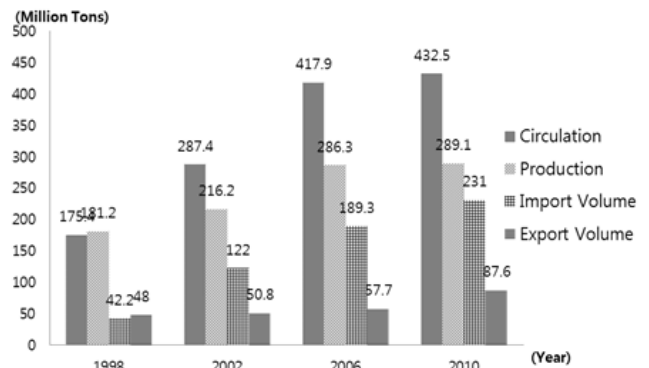


Fig. 1: Status of Chemical Statistics Survey (Ministry of Environment in Korea)

A survey result of about 15,000 chemicals for a total of 16,547 business sites in Korea's industrial process as of 2010 has shown that the volume of distribution was about 432.5 tons, the volume of production was 289.1 tons and the import and export amounts were 231 tons and 87.6 tons respectively. It is a trend that compared with 1998, the amount of chemical substances handled is steadily increasing.

2.2 Status and characteristics of chemical accidents

Since the era of industrialization in Korea has started in a full scale, various chemicals have been developed and utilized for convenient life due to the development of science and technology. However, as the use of chemicals increases,

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chemical accidents have also increased more than sevenfold in the last decade.

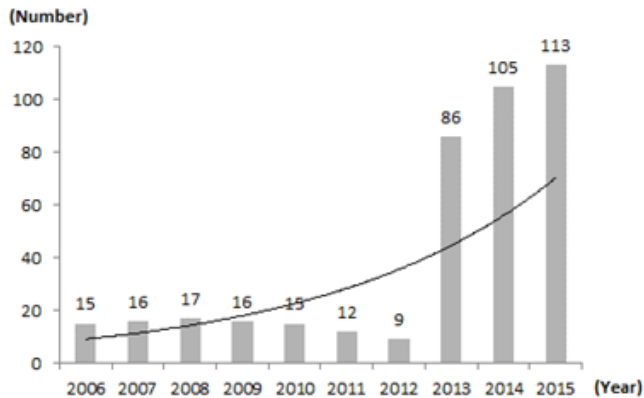


Fig. 2: Chemical Accident by year in Korea (Chemistry Safety Clearing-house)

Many people have recognized chemical accidents due to the hydrofluoric acid spill accident that occurred in the Gumi industrial complex, which recently suffered a lot of damage in Korea. This accident has provided an opportunity to increase the interest in chemical accidents. Even in 2013, numerous chemical spill accidents occurred successively and caused damages, such as the hydrofluoric acid spill accident in Cheong-Ju industrial complex, the hydrofluoric acid gas leakage accident in Samsung semiconductor plant, argon gas leak accident in Dang-Jin Steelworks so that there is a growing awareness of chemical spills.

2.3 Analysis on chemical accident cases

A series of chemical spill accidents have occurred such as the hydrofluoric acid spill accident in the Gumi industrial complex (2012.09.27.), the hydrochloric acid leak accident in Sang-Ju(2013.01.12.), and the hydrofluoric acid spill accident in Cheong-Ju. However, various problems have appeared such as early response, poor follow up measure, residents' right to know, etc.

On September 27, 2012, an accident that 12 tons of hydrofluoric acid leaks from H plant in Gumi happened. At the time of the spill accident, the early response was insufficient so that it caused exposure for 8 hours so that created a significant damage. 5 works died, more than 10,000 residents were treated at the hospital and damages to crops and surrounding environment were significant. In particular, it caused more damage because there was no information on leaked chemical and information of the handling company on the leaked chemical. Through this accident, it gives lessons that safety equipment must be installed in accordance with the characteristics of chemicals when installing safety equipment and handling chemicals, safety protective equipment must be worn and there is an important need to run regular safety management training.

On January 12, 2013, a hydrochloric acid leak accident happened in Sang-Ju. Although about 200 tons of leaks occurred through the crack in the hydrochloric acid storage tank, the damage was not big helped by an immediate response

taken by an employee right after the accident. However, it was a serious accident where people are potentially in danger and it reminded of the need to periodically check hazardous chemical handling facilities.

III. ANALYSIS ON CHEMICAL ACCIDENT CASES IN DEVELOPED COUNTRIES

3.1 Status and characteristics of chemical accidents in the US

The US is making great efforts to prepare for chemical accidents. In particular, database related to chemical accidents is established and policies to utilize that have been developed and an independent agency dedicated to chemical accident has been established and being operated. Also, as there is clear role for each dedicated agency depending on each correspondence, systematic accident response, investigation and prevention can be made in the event of a chemical accident.

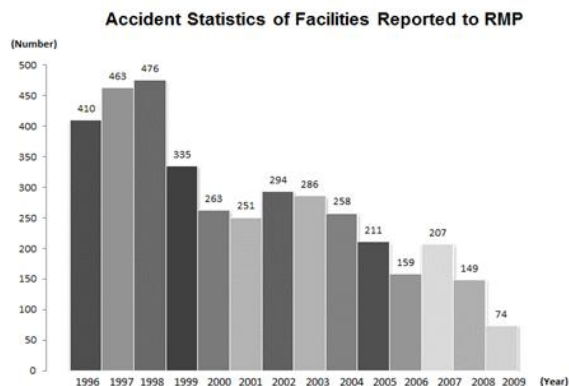


Fig. 3: Accident Statistics of Facilities Reported to RMP (EPA(2009a))

In the US EPA (2009) report, a total of 3,836 accidents occurred at RMP registered facilities between 1996 and 2009, and chemical accidents are gradually decreasing. Chemical accidents mainly occurred in the manufacturing industry and transportation and facility industry

3.2 Analysis on chemical accident cases in the US

In 2003, a chlorine gas leak occurred at a plant in Glendale, Arizona, USA, and an emergency evacuation was made to 7,500 residents nearby. Early responders quickly shared important information and communicated immediately after the accident. Since the early response was made quickly, there was little damage to the nearby residents. Through this accident, the importance of early response was recognized, and the necessity of pre - education on information of chemicals emerged. On October 11, 2008, a chemical called Oleum was leaked in Petrolia, Pennsylvania, and about 2,500 people were evacuated and an emergency was declared. Because there was a chemical expert on site after the accident, it was taken care actively. The necessity of chemical accident experts who can respond smoothly in case of accident was recognized.

3.3 Analysis on chemical accident cases in Europe

In 1974, a vapor cloud explosion at the Flixborough manufacturing plant in England killed 28 people. Through this

accident, the NIHHS Decree was enacted to thoroughly identify the possession of dangerous substances and as a result of a large scale of chemical accident involving dioxin leaks in Seveso, Italy in 1976, globally, countries have enacted systems and laws related to chemical accidents.

In Germany, on October 15, 2012, there was an accident where 4 tons of ammonium nitrate leaked and 1,800 nearby residents evacuated. However, 1,000 people including local firefighters were employed, and 100 of them were made up of chemical accident experts. In addition, they responded quickly and accurately by prohibiting the passage of nearby roads and bypassing the traffic in the railway accident area.

IV. DRAWING IMPLICATIONS THROUGH COMPARISON OF CHEMICAL ACCIDENT CASES

When reviewing the cases of chemical accidents in Korea, the US and Europe, there are several differences in responding to chemical accidents. In the US and Europe, quick evacuation of nearby residents and preparing the worst-case scenario were observed in the event of a chemical accident. In addition to the control of nearby roads, the wearing of protective equipment (mask, respirator, etc.) was perfectly implemented. A large number of chemical accident experts were employed among employed workforce, and information on the types of chemical substances leaked or exploded was quickly identified and dealt with in an appropriate manner.

On the other hand, in Korea, the evacuation of nearby residents was somewhat slow after the accident, and there were cases where the second damage occurred due to the return of residents the next day. Especially, in the case of the hydrofluoric acid spill accident in the Gumi, the absence of experts in the early response couldn't do proper measures and much bigger damages occurred.

V. CONCLUSION

This study aims to draw implications through a comparison with cases from the US and Europe where an advanced chemical accident response system has been established and prepare for the effective prevention and coping of chemical accidents. The result has shown that the United States and Europe have systematically responded to chemical accidents. During early response, reliable experts were included and employed and a proper response per the characteristics of the chemical was made by quickly identifying information on accident-related chemicals. In Korea, on the other hand, in the case of chemical accidents, the countermeasures were slower and the information of chemical substances was not well understood so that it also caused secondary damage by incorrect measures. Accident information in the United States and Europe is wide and has specific data. The analysis result on chemical accidents is also systematically shared through databases. This can be useful for recognizing the risk of chemical accidents and for preventing accidents and preparing countermeasures in case of accidents. If these systems are considered, it will be able to complement insufficient areas in domestic chemical accident related information collection and system. Also as there were a lot of damages due to insufficient early response which causes

secondary damage and causalities, it is considered that there is a need of an agency dedicated to the early response.

As this study has not been able to provide concrete and diverse case analysis and suggestions, this study will be able to create meaningful results if further in-depth study is made and similar studies are implemented.

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