CHEMICAL ENGINEERING TRANSACTIONS
VOL. 71, 2018
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Xiantang Zhang, Songrong Qian, Jianmin Xu

ISBN 978-88-95608-68-6; **ISSN** 2283-9216
DOI: 10.3303/CET1871109

Analysis and Countermeasure Research on Management Mechanism of Hazardous Chemicals Based on Active Safety Protection

Zhihong Liu

Xingtai University, Xingtai, Hebei 054001, China
liu77452@126.com

It is of great significance to protect dangerous chemicals and to establish reasonable and effective management and rescue mechanism of dangerous chemicals for preventing and reducing accidents and disasters caused by dangerous chemicals. Taking Dalian City as an example, this paper studies the management mechanism and Countermeasures of dangerous chemicals based on active safety protection, uses Google earth to obtain the geographical position information of the units using and managing dangerous chemicals, introduces Dijkstra algorithm to design the calculation process of the best relief route, and constructs city's traffic network with fluid network theory. The traffic network diagram shows that the best rescue route $v_{295}-v_{75}-v_{74}-v_{37}-v_{33}-v_{15}$ can be calculated by simulating the rescue site and the place where the hazardous chemical accident happens, and the shortest rescue time is 360 seconds. The results of this study are of great significance and practical application value to improve the rescue efficiency of hazardous chemical accidents and reduce the damage of the accidents.

1. Introduction

Dangerous chemicals are ubiquitous in our life, which can bring great convenience to our daily life. However, mismanagement may lead to safety problems, causing huge losses to the environment, life and property of people's lives (Scruggs, 2013). Especially with the rapid development of chemical industry, there are many kinds of chemicals and their characteristics are complex. No matter where problems occur, the consequences of their comprehensive effects are more serious, such as environmental pollution, human poisoning (Gardner et al., 2012) and so on (Gardner et al., 2012). Therefore, the management of hazardous chemicals has caused many countries in the world. Attach great importance to.

At present, all countries in the world have formulated corresponding management plans for hazardous chemicals according to their actual conditions. As the earliest country to study and control the technology of hazard sources, Britain has formulated a series of laws and regulations to prevent and control related industrial accidents (Burger, 1997). The annual occurrence and mortality of hazardous chemicals accidents in the United States are high. Therefore, in order to reduce accidents, the risk management plan regulation (Brandt and Wirth, 2009) was formulated. Because of the weak industrial foundation, the research on the control and evaluation of hazardous chemicals started late in China. Although some progress has been made, due to the low degree of attention paid to the safe production management of hazardous chemicals, the imperfect information transmission system, the non-standard emergency plan, the imperfect management and the weak support system, China has made great progress in the field of safety production management of hazardous chemicals. The judgment of hazard sources and the classification of hazard levels are not timely (Palaszewska-Tkacz and Czerczak, 2008), so safety accidents caused by hazardous chemicals often occur. Active and effective management mechanism of hazardous chemicals can avoid accidents or reduce the losses caused by them. Fluid network theory (Olie et al., 2015), as one of the branches of topological mathematics, has been widely used in military, information, management and other fields. From a macro point of view, we now live in a huge replication system consisting of various networks, and dangerous chemicals distributed in various locations of the city, which can also be seen as a network (Preston et al., 2008).

Please cite this article as: Liu Z., 2018, Analysis and countermeasure research on management mechanism of hazardous chemicals based on active safety protection, Chemical Engineering Transactions, 71, 649-654 DOI:10.3303/CET1871109

Therefore, the fluid network theory can be used to solve the management mechanism of hazardous chemicals, 2008.

Based on the above analysis, this paper takes Dalian as an example, on the basis of classification of dangerous chemicals, uses Goole Earth satellite map software to analyze and locate the distribution of dangerous chemicals, safety supervision and management departments and relevant rescue units, and introduces the best rescue route using fluid network theory. Determine the method, analyze the road accessibility and the calculation process of the best disaster relief route, and draw the traffic network topology map of Dalian City on this basis. In order to facilitate the rescue after the accident, the validity of the proposed stress rescue route for hazardous chemicals is verified. The location and rescue location of hazardous chemicals accident are simulated, and the optimal rescue route and the shortest time required for rescue are determined.

2. Hazardous Chemicals Information

2.1 Classification of Dangerous Chemicals

According to different standards, the classification of dangerous chemicals is also different. Figure 1 shows nine categories of dangerous chemicals (Lfstedt, 2010) according to the Dangerous Goods Name List and Dangerous Goods Classification and the Name Number of China.

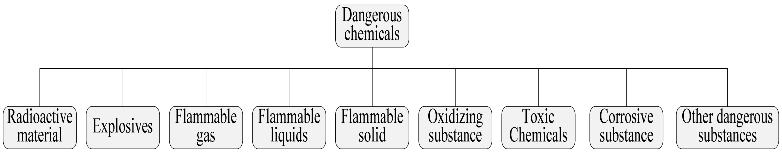

Figure 1: Classification of dangerous chemicals

2.2 distribution of dangerous chemicals in Dalian

2.2.1 Refueling and filling stations

With the continuous improvement of people's economic living standards, the number of residents'car ownership has increased dramatically, which also makes the number of gas stations in urban areas continue to rise, and natural gas has gradually become the fuel of automobiles due to environmental pollution factors and rising oil prices. According to statistics (Carillo et al., 2018), there are 330 gas stations in Dalian, of which 158 are in urban areas and 46 are in Xigang, Zhongshan, Shahekou and Ganjingzi districts. Therefore, gas stations and gas stations have become one of the main sources of dangerous chemicals in urban areas. It is necessary to understand and master their specific location information for management, prevention and accident rescue. Figure 1 shows the location of Dalian PetroChina Welcoming Road Gas Station in Goole Earth Satellite Map, No. 11 Welcoming Road, Ganjingzi District.

Figure 2: Dalian PetroChina Yingke Road Gas Station

2.2.2 Chemical Plant

According to statistics (Gabbert and Weikard, 2010), there are 51 petrochemical enterprises in Dalian city and its surrounding development zones. Their main products are petroleum, explosives, acetylene and other chemicals. In recent years, accidents of dangerous chemicals have occurred frequently in Dalian, so we know the sources of accidents. It is of great significance to establish a reasonable emergency rescue response mechanism. Figure 3 shows the specific location of Jinju Chemical Plant in Dalian: Shengli Road, Jinzhou District, Dalian.

Figure 3: Dalian Jinju Chemical Factory *Figure 4: Dalian Baili Tianhua Pharmaceutical Co., Ltd.*

2.2.3 Pharmaceutical Chemical Plants

After sorting out and analyzing, there are mainly five pharmaceutical chemical plants in Dalian, namely, Dalian Pharmaceutical Factory, Pfizer Pharmaceutical Co., Ltd., Huiren Pharmaceutical Co., Ltd., Dalian Aquatic Pharmaceutical Factory and Dalian Baili Tianhua Pharmaceutical Co., Ltd. The location of Dalian Baili Tianhua Pharmaceutical Co., Ltd. is shown in Figure 4, and the address is Honggang Road 298, Ganjingzi District.

2.3 Dalian public security fire bureau and safety production supervision and Administration Bureau

The main responsibility of the Safety Production Supervision and Administration Bureau is to take charge of comprehensive management of safety production, formulating relevant laws and regulations, conducting safety production education, organizing and coordinating emergency rescue work for safety production accidents. There are 17 brigades and 61 squadrons under the Dalian Public Security Fire Bureau, which are the first responding departments after the accident. Location of geographic information is very necessary. As shown in Figure 5, Dalian Safety Supervision and Administration Bureau is located at No. 2-6 Tangshan Street, and Dalian Public Security Fire Bureau is located at No. 50 Northeast North Road, Ganjingzi District, as shown in Figure 6.

Figure 5: Dalian Safety Production Supervision Administration

Figure 6: Dalian Public Security Fire Bureau

3. Management mechanism and Countermeasures of Hazardous Chemicals Based on Active Safety Protection

Active and effective management mechanism of dangerous chemicals can avoid accidents or reduce the losses caused by them. Based on the understanding of the distribution of dangerous chemicals, the management of dangerous chemicals for active safety protection should design the best rescue route (shortest route) in advance, estimate the time needed and avoid it. When disasters occur, the inability to pass the road delays the best rescue time, resulting in great loss of personnel and property.

3.1 Determination of the Best Disaster Relief Route

Bellman-ford algorithm, A* algorithm and Dijkstra algorithm are commonly used to determine the shortest route (Silva et al., 2018). Considering the characteristics of rescue route and urban traffic network, this paper chooses Dijkstra algorithm to calculate the best disaster relief route. Dijkstra algorithm (Stinson, 1994) extends from the starting point to the endpoint layer, and after traversing all nodes, the optimal solution of the shortest path is obtained.

3.2 Road Traffic Analysis

Assuming that the running speed of t vehicle at a certain time is $v(t)$, the time that the vehicle passes through the road I is t (i). The calculation formula is as follows (Hu and Raymond, 2004):

$$v(t) = \frac{v_0}{k_1 k_2 k_3} \tag{1}$$

$$t(i) = \frac{l(i)}{\bar{v}(i)} \tag{2}$$

k_1、k_2、k_3 are the impact factors of road congestion turning, slope and road surface. $\bar{v}(i)$ is the average speed and $l(i)$is the road length.

3.3 The Calculation Process of Best Disaster Relief Route

Figure 7 shows the flow chart of calculating the best disaster relief route (Kim et al., 2004). Its essence is to calculate the shortest path between the planned disaster relief location (v_k)and the accident location. The figure shows the best disaster relief route E_{ki}, and the minimum distance between them is edge cut, n is branch number, m is node number, E is branch set, V is node set.

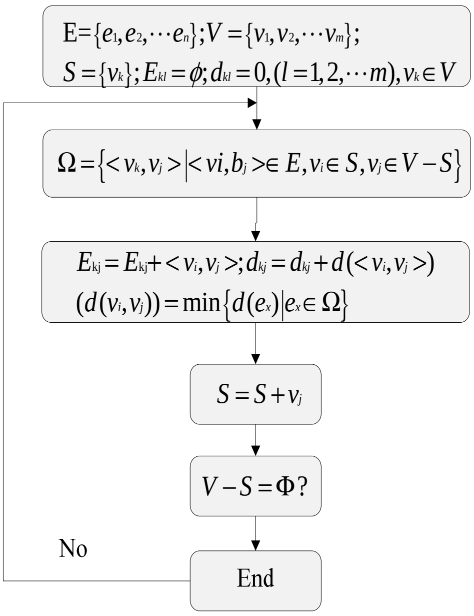

Figure 7: Best disaster relief route calculation flow chart

3.4 Urban Traffic Network Diagram and Its Topological Relationship

In order to prevent accidents and rescue them quickly and effectively, this paper constructs the topological relationship and traffic network diagram of Dalian urban traffic network on the basis of the above research, so as to study the emergency rescue mechanism of dangerous chemicals in Dalian. Figure 8 shows the urban traffic network of Dalian, in which the nodes v_1、v_2、v_3L are Road intersection information. v_1 represents the intersection of Yingquan Road and Honggang Road. e_1、e_2、e_3L are branch numbers, which can show the distance between the two nodes. The branch name of e_2 is Guodong Street. The distance between the node v_2 and node v_9 is 2000m.

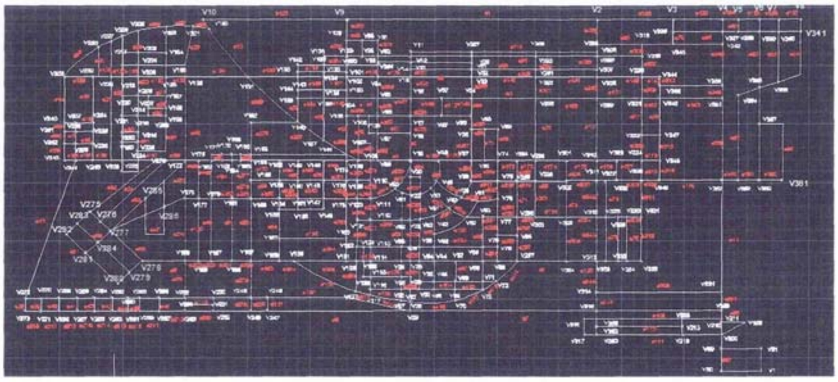

Figure 8: Dalian urban transportation network map

3.5 Hazardous Chemicals Accident Rescue Routes

Assuming that a fire accident occurs at the node of Shenda Gas Station (located near v_{15}), the fire brigade of Ganjingzi District is near v_{295} when it goes to rescue the vehicle. The distance between the two points is 1000m. The running speed of the vehicle is determined by the formula $v_{(t)} = \frac{v_0}{k_1 k_2 k_3}$. According to the relevant regulations (Zografos et al., 2000), the values of v_0、k_1、k_2、k_3 are 90 km/h, 2.71 and 1, respectively. The average speed of fire truck is 33 km/h. Using the calculation flow of the best rescue route proposed above, the shortest rescue time required is 360 s. The corresponding best rescue route $v_{295} - v_{75} - v_{74} - v_{37} - v_{33} - v_{15}$ is shown in Figure 9.

Figure 9: The shortest route from Ganjingzi District Fire Brigade to Shenda Gas Station

4. Conclusion

In order to prevent and reduce the losses caused by accidents of hazardous chemicals, this paper takes Dalian as an example to study the management mechanism and countermeasures of hazardous chemicals based on active safety protection. The specific conclusions are as follows:

(1) According to the classification of dangerous chemicals, using Goole Earth satellite map to locate the relevant enterprises and management rescue units of dangerous chemicals in Dalian.
(2) Introducing the fluid network theory, based on Google Earth location information, the traffic topology network map of Dalian is drawn.
(3) The calculation process of the best disaster relief route is designed, and the time and the best rescue route for the fire brigade of Ganjingzi District after the accident of dangerous chemicals occurred in Shenda Gas Station was obtained.

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