

Analysis of a hazardous factory explosion accident

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Abstract. Factory explosion accidents not only cause damages of factory facilities and equipment, or casualties usually, but also cause fire disaster due to various reasons, resulting in larger losses. After the occurrence of accidents, timely, accurate, and efficient response is an urgent need to protect the safety of people's lives and property. A hazardous Factory Explosion accident in North China in 2019 was taken as an example by this paper. It conducts research from four aspects, including the basic situation of the accident, the handling of the explosion accident, and the analysis of the cause of explosion accident. The useful advice and efficient disposal methods of accidents, the enhancement of disaster prevention and disaster relief capabilities, and the formation of a long-term mechanism to ensure the safety of people's lives and property are expounded in this paper, in order to provide a reference for similar accident management.

1 Introduction

In the winter of 2019, a gas explosion accident occurred in the production workshop of a foreign-funded enterprise in a region in North China, causing 4 deaths, 10 injuries and direct economic losses of 14.29563 million yuan. After the accident, the emergency forces of public security, fire protection, emergency management, health and other departments coordinated and worked together to deal with the accident, and immediately carried out the rescue and treatment of the wounded. At the same time, the stability maintenance and public opinion control of the casualties and their families were well-handled. Due to the timely handling of the accident, the loss of national property has been reduced, showing the achievements of the construction of the emergency rescue system for work safety accidents and disasters in a certain area of North China in recent years. At the same time, it also puts forward higher requirements for the on-site emergency response capabilities of the urban area^[1-4].

The following takes this accident as an example to discuss the emergency response to this hazardous factory explosion accident, hereinafter referred to as "North China X factory explosion accident".

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2 Basic situation of the accident

In this paper, the background of the "North China X factory explosion accident" from various aspects such as the company composition and architectural layout of the accident, gas facilities and cold storage conditions was analyzed. The details are as follows:

The enterprise involved is a foreign-funded enterprise, which was located in a district in North China. Its business scope includes bean paste, pastries, raw and auxiliary materials for pastries, food seasonings, and self-produced food packaging products. The company has a total of 662 employees and 12 departments, including life department and production department. The life department is responsible for the company's fire protection, safety and security, training and education. The production department is responsible for organizing production and production equipment management and production in accordance with the production plan. It is also responsible for Revising of management system, training and education of operating personnel's safety in production and operating procedures.

The main buildings of the company's factory area include office buildings, phase I production workshops, phase II production workshops (untapped), warehouses, attached rooms and sewage treatment facilities. The accident area is located in the middle of the north side of the first production workshops (see Figure 1), The workshop is a single-story main frame structure building with a partial two-story west side. The accident area mainly involved the gas cylinder room, cold storage, raw material storage, frying flour room, sieving room, additive storage, sugar storage, steam frying flour room and some rooms in the pastry workshop (see Figure 2).

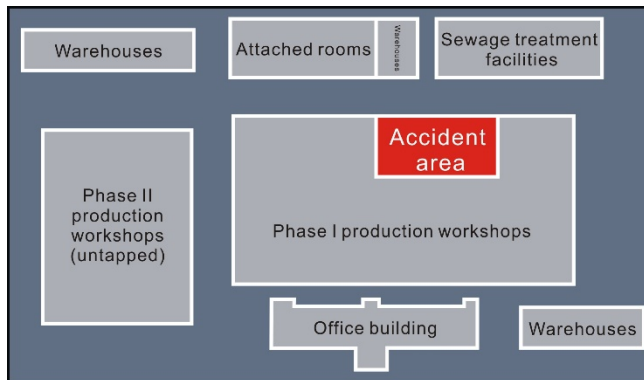


Fig. 1. Location of the accident.

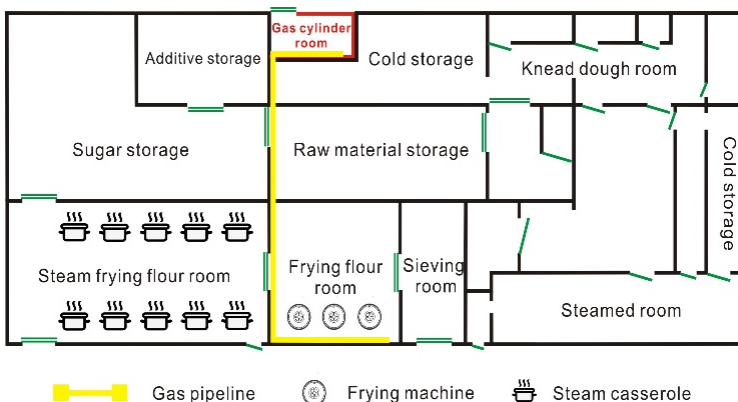


Fig. 2. Regional room layout diagram of accident occurrence.

The gas cylinder room is located on the north side of the phase I phase I production workshop, about 6 meters long from east to west, 3 meters wide from north to south, and 3 meters high from ground to ceiling. The north wall of the cylinder room contains doors, thermometers, explosion-proof lighting switches and windows from west to east. The other walls are solid partition walls with no door or window openings and connected to the roof; there is a ventilation pipe in the northeast corner to exhaust air to the outside of the room. Liquefied petroleum gas cylinders are placed in the southeast corner. The gas cylinders are connected to the gas pipeline through the manifold through the pressure reducing valve and the hose.

The gas pipeline was built by a relevant company in 2006. The diameter of the pipeline is 80 mm and the operating pressure is about 200 KPa. The gas pipeline is fixed horizontally at a distance of 1.2 meters from the ground on the south wall of the gas cylinders, and a pressure gauge is installed on the west side. The gas pipeline passes through the south wall of the gas cylinders from the pressure gauge to the south, and then bends upward, which is about 1.4 meters from the ground. Set the main pipeline valve (DN80 flange ball valve), and bend to the south about 3.5 meters above the ground, extend horizontally along the west wall shared by the gas cylinder room and the raw material warehouse, across the top of the cold storage, and pass through the southern partition of the cold storage and the south wall of the raw material warehouse enters the fried noodle room. The gas pipeline runs from the west wall to the south wall of the noodle room. The south wall of the noodle room is divided into 3 vertical branch pipes, extending to about 30 cm from the ground, and connected to 3 low-pressure stir-frying machines through hoses. The type of gas used in the stir-frying machine is liquefied petroleum gas, with a rated pressure of 1.96 to 3.23 KPa.

3 The handling of explosion accidents

After the accident, the involved company evacuated people from the factory area, reported the accident information, and cooperated with relevant departments to carry out emergency rescue and after-care work.

Seven minutes after the explosion, the Municipal Fire Rescue Corps received an alarm and then dispatched 54 fire trucks, 200 commanders and 6 search and rescue dogs to the scene to search and rescue the trapped people. The district emergency center sub-center has sent 10 ambulance teams and 14 vehicles to the accident site to treat the injured.

After the accident, the local committee and district government organize relevant departments and the local town government to carry out emergency response, dispatch emergency rescue teams and equipment to assist in emergency rescue work, and do a good job in zoning control of the accident site and isolation of surrounding areas. The local government established an accident handling temporary headquarters, formulated an accident emergency response work plan, and coordinated and organized the rescue of the injured, the comfort of the families of the injured and the dead, the aftermath treatment, and the release of follow-up information about the accident.

Relevant leaders of the Municipal Party Committee and Municipal Government rushed to the scene to direct emergency rescue work as soon as possible. The relevant departments such as the Municipal Public Security Bureau and the Municipal Emergency Bureau were present to coordinate and guide emergency response work. The Traffic Management Bureau of the Municipal Public Security Bureau, together with relevant local authorities, carried out traffic diversion and management around the accident site. The Municipal Emergency Bureau synchronously activated the emergency response mechanism and coordinated the relevant departments to do a good job in the release of accident information.

Fifty minutes after receiving the alarm, the open fire was extinguished; all the 5 people trapped in the accident were rescued, but 4 of them died and 1 was injured. A total of 108

people were injured and hospitalized in the accident. After 14 days , all the injured were discharged.

4 Analysis of the cause of the accident

After comprehensive analysis of relevant technical appraisals, site surveys, inquiry transcripts and video data by the public security organs and expert groups, the suspicion of deliberate arson and explosions was ruled out. The company's gas explosion accident was determined to be a major production safety responsibility. The specific causes of the accident are as follows.

The flange gaskets (Figure 3, A and B) of the main valves of the gas pipeline in the phase I production workshop are made of methyl vinyl silicone rubber, which is subject to long-term corrosion by the mixed gas of liquefied petroleum gas and dimethyl ether in the pipeline. Physical and mechanical performance of the flange gaskets declines. The small cracks develop and gradually grow on the flange gaskets, resulting local breakages. The B gasket is torn and a leak is formed, under the action of the internal pressure of the pipeline. A large amount of gas leaks into the gap between the outer wall of the refrigerator and the surrounding wall in the cold storage, which spreads to the inside of the cold storage, the top space and adjacent areas such as the mixing room, the batching room, the raw material storage, etc.. An explosive mixture of gas in the inner and outer spaces of the cold storage was formed. Meanwhile, the fan in the cold storage also accelerates the mixing of the leaked gas and the air. When an ignition source such as an electric spark explodes, a high-voltage shock wave is quickly formed and spreads around, igniting the combustibles at the scene, leading to an accident. The accident was judged to be a liquefied petroleum gas explosion, and the explosion center was located in the cold storage area.

The involved institution was suspected with the problems such as engaging in hazardous chemical business activities beyond the business method approved by the business license, illegally repackaging, and illegally storing hazardous chemicals.



Fig. 3. Gas pipeline main valve and flange gasket diagram.

5 Conclusion

Generally speaking, it's was a complete success of the rescue and disposal work in this accident. In this rescue operation, the authors participated in the accident disposal. This paper mainly discusses from the perspective of management and command. In view of the accident's leakage diffusion radius, cause of death and injury, LPG explosion equivalent,

building model, etc., further detailed research will be carried out, and comparison with other accidents will be carried out to further summarize relevant experience and lessons.

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