A Reference to Sea Water in Oil Tank Fire of Coastal Oil Depot

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Abstract. With the rapid development of China’s economy, China has become the second oil consumption country which ranks only second to the America, strategic oil petroleum reserve has also become the most essential link of national energy security system. The reserve fuel quantity excursion brings a great challenge to the safety of depot. In recent years, accidental explosions of oil and gas happened constantly. Effectively control and successfully rescue of large floating roof tank seal ring fire is the core of fire safety. When in case a fire occurs in a floating roof sealing ring, the existing fixed fire extinguishing equipment is unable to put out fire quickly and effectively, usually it needs a lot of firefighting truck rushing to the scene, firefighters have to board on roof to do artificial saves, this will cost large amount water. For this reason, this article puts forward a kind of nitrogen and integration of sea water mist fire extinguishing system, with functions of lightning fire prevention and quickly put out a fire without delay, the reference of sea water enhances the usability of location, and also improves the security of the floating roof tank.

1. Preface
With the sustained and rapid development of China's economy, China has become the world's second largest oil consumer after the United States. Strategic Petroleum Reserve has also become the most important part of the national energy security system. According to the spirit of the national plan for "13th Five-Year" , The Regional planning of the Yangtze River Delta region and The Zhejiang ocean economy development demonstration area regulation, especially about under the state council shall set up Zhejiang Zoushan islands new district and the establishment of Zoushan approval of free trade port area, Zhejiang Zoushan islands new district will become our country commodity storage and transportation construction transfer processing and trade center. According to the plan of Zhejiang ocean economy demonstration area, a number of important energy and resources storage and transportation bases are planned and constructed in Liuheghshan Island, Huangzeshan Island, Shulanghu Island, Majishan Island and other islands in Zoushan, so as to improve the capacity of transit storage and transportation and build an international oil storage and transportation base. At present, the total capacity of Zoushan oil depot has reached 4*10⁷ m³, and Zoushan islands has been built into an important national petroleum strategic reserve base and the largest commercial crude oil storage and transportation base of China.
2. Floating roof tank seal fire
The dramatic increase in oil storage has brought great challenges to safety. In recent years, safety accidents involving oil and gas explosions constantly happened, among which the lightning strikes on floating roof tank seals have occurred many times. For example, in August 1989, Qingdao Huangdao oil storage tank fire accident, 19 people died, more than 100 people injured and directly economic losses of 35.4 million yuan. July 16th, 2010, Dalian Dagushan Xingang Petrol CNPC’s pipelines suddenly exploded, causing crude oil spill, and a 100,000-cubic-meter oil tank exploded. The fire was completely extinguished after 20 days. According to the statistics of 81 large-scale floating-roof tank fire accidents with a diameter of more than 30m occurred between 1951 and 1995, the American Institute of Petroleum (API) accounted for 72.8% of the statistical accidents. Therefore, the seal ring fire is the main form of fire for large-scale floating roof tanks. Effective control and successful suppression of large-scale floating roof tank seal ring fire is the focus of fire safety research.

2.1. Characteristics of floating roof tank seal fire
(1) Lightning strike is the main cause, often accompanied with bad weather, such as strong winds and heavy rain.
(2) A flash explosion usually occurs first in the seal ring, and if there is sufficient combustible gas, continuous combustion occurs.
(3) There are multiple explosion points in the seal ring. Seals are often fired at multiple locations at the same time. The burning point is not continuous. The length of the seal ring at each ignition point is a few meters long, and the length is longer than ten meters. Failing to put out early fire will definitely lead to the complete ignition of the entire seal ring.
(4) The initial fire is relatively small. If the fire is not timely, it will rapidly develop into a large fire.

2.2. Fire severity and present situation of fire extinguishing system
The average annual storm interval in Zhoushan is about 60 days. Lightning strike on oil tanks is with high risk. Once a lightning accident causes a fire accident, it will cause great losses to people’s lives and properties and will have a serious impact on the construction of the Zhoushan Islands New Area. This will increase the fire water consumption in the oil depots dramatically.

In the fire extinguishing means, fire water supply system, foam fire extinguishing system, water spray cooling system and fire monitoring system are set up, and some mobile fire extinguishing equipment is equipped. Most large floating roof tanks in China use the tank wall foam fire extinguishing system. The main feature is that the foam pipeline is fixed to the outside of the tank wall. The foam generator is installed at the top of the tank wall. The foam nozzle is evenly distributed in the circumference of the top of the tank, and the ejector is facing to the tank. The foam generator of this foam fire extinguishing system is simple in design, not easy to be damaged in fire and easy to maintain in peacetime. But the fire extinguishing system not only produces errors in the time of foam convergence, but also requires a large number of fire engines to go to the scene for close fire extinguishing, which not only missed the best fire extinguishing period to cause the fire to spread. More losses and increasing the amount of water needed for later firefighting are a great waste of resources.

3. Seawater mist fire extinguishing mixed with sea water
The fresh water resource on the earth is very limited. In the process of human development and progress, even if we try hard to economize, it is difficult to fully meet the needs of people's production and life. At present, China is a seriously water shortage country. A large part of the cities is short of water or even seriously lack of water. Under such circumstances, we should turn our attention to the oceans that are widely covered by the earth. Use the sea water to serve our country possibly. The oil depots in Zhoushan are basically off the coast, and the fire water for the oil depot is huge. It makes full use of the geographical advantages of Zhoushan and makes the operation of the fire control system of
the oil depot more efficient and saves resources. The fire extinguishing of the mixed sea water mist is very meaningful.[1]

The nitrogen density is slightly lighter than the air, and it will spread rapidly in the whole space after injecting the annular airbag of the large oil storage tank seal ring, and its inerting isolation effect is greatly influenced by the sealing performance of the storage tank. If a fire breaks the storage tank sealing ring against the rain board, nitrogen will not be able to extinguish the fire.

For nitrogen extinguishing technology, GB16670-2006 "cabinet type gas fire extinguisher" and "design specification for GB50370-2005 gas fire extinguishing system" have included the nitrogen fire extinguishing system, which shows the feasibility of nitrogen extinguishing. Konstantin and other people compared the fire extinguishing performance of nitrogen and carbon dioxide. The overall volume ratio and weight ratio, nitrogen and carbon dioxide have the same fire extinguishing effect. Joseph Su compares the fire extinguishing performance of nitrogen and carbon dioxide. It is considered that the density difference between the two kinds of extinguishing agents has effect on the effect of extinguishing fire. Nitrogen is less dense than carbon dioxide, is easier to mix with the air, and nitrogen has the characteristics of stability, no corrosion, insulation and so on. Nitrogen fire extinguishing technology is suitable for high fuel saving. The fire in dangerous places and relatively sealed spaces indicates that the nitrogen fire extinguishing is suitable for the fire of the sealing oil in the floating roof oil tank.

Nitrogen as inerting medium can reduce the operating cost, but it only plays the role of dilution of oxygen to make up for the shortage of fire extinguishing and fire control ability, and the use of nitrogen gas with micro water mist as inerting medium can achieve good effect. The injection of micro water mist can rapidly heat exchange with combustible oil and gas, and rapidly reduce the ambient temperature in the sealed area of storage tank. The advantage of water mist in heat transfer is that it has a larger surface area, for example, when 1 liters of water are divided into small water droplets with a grain size of 10 m, the sum of the surface area is increased by 24000 times. The expanded surface area means that the heat transfer from the surrounding oil to the droplet surface is more easily transferred from the surrounding oil to the droplet through conduction and convection. With the decrease of the ambient temperature, the evaporation rate of crude oil can be slowed down. Water mist has the characteristics of no pollution to the environment, rapid fire extinguishing, less water consumption and small damage to the protection object, which has become one of the hot topics in the international fire science research. If water mist is injected into the seal area of the tank in an accidental fire, the fine water mist will quickly heat and vaporize after it is directly ejected or rolled into the flame, and the volume can expand 1700-5800 times according to the temperature of different fire fields. As the content of water vapor increases rapidly, oxygen content decreases sharply and oxygen dilution inhibits the rate of combustion reaction. Because water has a larger specific heat capacity, water mist will absorb a large amount of heat and partial heat radiation. This heat capacity also inhibits the flow of the combustion reaction and reduces the thermal feedback and reaction of the crude oil. The volume component of the combustible gas in the stress area reduces the amount of heat needed for the chemical reaction in the excitation reaction zone, thus playing a role in restraining and extinguishing the initial fire in the sealing area of the storage tank. In addition, the solution of water mist can also add carbon dioxide and other additives, when the dissolved carbon dioxide dissolved in water evaporates and escapes, restraining the spread of the fire.

The time of fire extinguishing is the key assessment index of the fire extinguishing performance of the water mist system. As a new Halon alternative fire extinguishing system, the seawater mist fire extinguishing system is completely effective for the suppression of the ship compartment fire.

Compared with the fresh water fog, the fire extinguishing time of the four kinds of fire sources in the experiment is obviously lower than the fresh water fog, and the 6 kinds of water fog are used. The effect of seawater mist fire extinguishing on sprinklers has been greatly improved. Especially with oil pool fire and wooden stack fire, sea fog fire extinguishing is more obvious than fresh water fog.

Because of the existence of the salt of the sea fog, the fog characteristics of the sea fog change. Compared with the fresh water fog, the fog momentum of the sea fog is larger than the fog droplet
diameter. It also leads to the strong ability of the sea fog droplets to penetrate the plume and the flame area in the fire extinguishing process. The tensile and tear strength of the flame is also enhanced, so the fire extinguishing ability of the sea fog is correspondingly increased.

For the barrier oil and oil fire, the area of the horizontal baffle will affect the fog flux directly acting on the oil pool fire, and the side panel has a strong influence on the water mist. The straight barrier baffle has a great influence on the water mist fire extinguishing effect, which directly affects the water mist flux in the oil pool fire. The bigger the volume of the oil and oil fire, the more obvious the effect of the water mist to the barrier fire[2].

4. Conclusion
The integrated system of nitrogen inerting and water mist fire extinguishing is used to compare the efficiency of the integrated system of nitrogen inerting and water mist fire extinguishing, which is more efficient and more extensive, and compares with the fire water. The use of seawater will save energy resources and make full use of the coastal advantages.

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