

Study on Intelligent Fire Fighting System for Large External Floating-roof Tank

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ABSTRACT

Fire on sealing ring is the main fire form of large external floating-roof tanks. Once fire occurs on the large-scale external floating-roof tank ring, the existing fixed fire extinguishing equipment cannot put out the fire quickly and efficiently, which would result in giant losses. The fire signal can be detected, the fire source can be located automatically and the fire can be extinguished precisely through the combination of the applicable image fire monitoring system of the intelligent fire-extinguishing system and the automatically fire-fighting gun control system. The capacity of self-explosion prevention and control, fire control and extinguishing of the large scale oil tank will be promoted by extinguishing the fire at the early stage, which will ensure the safety of the operation of the large scale oil tank storage base.

INTRODUCTION

In the 21st century, the development of large oil tanks were very rapidly, the capacity of the largest oil storage tank in China has reached $15 \times 10^4 \text{m}^3$ and several hundreds of $10 \times 10^4 \text{m}^3$ large oil storage tanks has been completed. Large-scale storage tank has become the main direction of development of the oil storage tanks at home and abroad. However, fires and explosions at large oil storage cause heavy casualties, property losses and extensive environmental pollution. American Petroleum Institute (API) investigated 81 fires accidents occurred between 1995 and

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1999 at the external floating-roof tanks with a diameter of more than 30 m, 72.8% of which were the seal ring fire accidents. Ring fire is the main fire form of the large external floating-roof tanks. Therefore, the effective control and successful fighting of the large fires of the external floating-roof tanks is the priority of our research. [1-2]

LARGE FLOATING ROOF OIL STORAGE TANK SEAL CLASSIFICATION AND RISK ANALYSIS

The large oil tank roof has such structures as external floating roof, internal floating roof, self-supporting dome roof and columns supporting cone roof. External floating roof structure is applied in the large scale oil tank of more than 100,000 cubic meters. External floating-roof tank is mainly used for storage of crude oil and the floating roof structure has two types, single disc and double disc and the primary sealing structures are the mechanical seal and soft sealing (material and liquid filling). [3-5]

Mechanical Seal Structure and Risk Analysis Of External Floating-roof Tanks

Mechanical sealing structure mainly rely on mechanical spring bracket to distract the primary sealing oil and gas separator through the metal sealing shoe plate, and always keep in contact with the tank wall in order to achieve the sealing effect. (1) Oil and oil seal diaphragm spacing is large, where explosive gas mixtures appears consecutively (0 area). (2) Since the tank wall is irregular, there is a gap between the metal shoe plate and the tank wall of the mechanical primary seal during the tank operation, so that the explosive gas mixtures may form between the primary and secondary sealing during operation (1 area).

There is a gap between the metal shoe plate and the tank wall in the tank which makes up the primary mechanical seal during operation, while 3m a static guide plate in addition to the tank is running there is a discharge gap with the upper part of the secondary seal every oil and gas separator. When the tank being struck by lightning, the tank wall and the floating disc is easy to form high and low potential difference, sparks are likely to form in the gap between its. The first and second seal area with combustible gas is more easily causing an explosion or fire.

Tank Structure and Risk Analysis of Soft Seal Structure Floating Roof.

Elastic soft seal packing foam is mainly two kinds of foam seal sealed tube. Foam rubber ring seal structure is in three core cavity filled cavernous. Tubular inner annular seal is filled kerosene rubber filler and the floating disc, close contact with the tank wall, in order to achieve the sealing effect. The advantage is good sealing effect, no hydrocarbon vapor space, normal middle without the presence of oil and gas space. Seal and the tank wall is not in contact with metal objects, no

discharge gap during a thunderstorm. The disadvantage is that the foam is easy to aging and life is short. Once the damaged pipe seal leaks will be fully disabled. Floating disc with the oil agitation may produce displacement. It can also cause a local soft seal gap increase, while the upstream oil and gas overflows exist between the first and second seal. When floating disc displacement wobble plate or tray easily extruded rubber seal causing damage, broken sealing materials are difficult to recycle.

EXISTING LARGE OIL STORAGE TANK FIRE FIGHTING MEANS

The vast majority of large external floating-roof tanks tank walls use foam fire extinguishing system. The main features of the outer foam line are fixed in the tank wall, and foam generator is mounted on top of the tank wall. [6-7] Thought that is designed simply, it cannot be easily damaged by fire, and it is easy to be maintained at present most of the domestic use of this tank design. However, the fire extinguishing system has obvious drawbacks:

(1) Since the foam injection port is provided at the top of the tank, sprayed foam is easily dispersed by the wind and the bubble is diluted, resulting in significant loss of the foam, when the wind outside is large.

(2) When the ring is not in the ignition point just below the top of the tank foam injection port, foam shedding from the top of the tank cannot flow directly into the inner ring, and so only after the bubble completely submerged into the ring, the person can enter into seal to put out the fire. For the volume of 10×10m⁴ larger external floating-roof tanks, the foam collected in the annular space requires at least 9 min, therefore, which may have missed the best time to fire.

(3) Since a lightning strike caused a fire that ring is often accompanied by heavy rain, spray foam is diluted with rainwater. Meanwhile the rain still carries a lot of foam through the bottom drain outlet weir plate to the floating disk, which may affect extinguishing to some extent.

INTELLIGENT FIRE EXTINGUISHING SYSTEM

Intelligent Fire Extinguishing System Works

Fire system uses image recognition technology, initiate parallel signal fire detection, automatic positioning fire, and pinpointing fire. Fire control on-site host intelligent control center monitoring, remote manual control and manual control of three cross-site equipment control strategies. Site manual control takes priority over manual control of the remote central monitoring host, however central monitoring host remote manual control of a higher priority than the host site Intelligent Control. [8-9]

Fire Detectors

Main feature:

- 1) Non-contact, high-definition image detection mode.
- 2) Fire area no dead-round monitoring, combined with a security system.
- 3) X Stealth Nano wipers, sticky water, non-stick oil, repel dust, high hardness special carbon steel by fluorine carbon spraying, explosion-proof, dust-proof and water-proof.

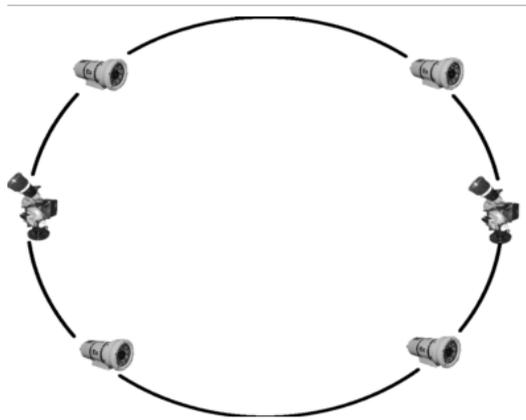


Figure 1. Intelligent fire extinguishing system arrangement.

Engineering arrangement

Theoretically tank top edge need just four 45-degree angle of the camera to achieve full coverage tank top, but taking into account the margin engineering, fire detector with 6mm lens design, viewing angle is about 60 degrees, even with 4 cameras located in the top of the tank wall, so you can cover the entire top of the tank, and in the wall at a certain mutual cross-coverage.

Intelligent fire artillery

The main features of intelligent fire artillery

- (1) DC servo motor nozzle for horizontal and vertical adjustment, closed-loop control.
- (2) The unique flow design, low friction losses.
- (3) Water concentration range, small water loss.
- (4) Fast response, flexible installation, easy maintenance, high reliability.

The top of each tank mounted symmetrically has two intelligent fire guns, and guns are substantially 45° inclined installation. Each gun protect sector in the region nearest gun firing range of the body. Fire detectors and surveillance situation is shown in Figure 1.

Fire Locator

Fire detectors are mounted on the servo positioning artillery fire for fire with fire detectors fire point positioning.

Main feature:

- (1) Non-contact, high-definition image detection mode.
- (2) High-strength aluminum alloy manufacturing, small size and light weight.
- (3) Monitor the scope and objectives fixed.
- (4) Special seismic processing, auxiliary infrared lighting to adapt to different environments.

System pipe network

Network mainly is made up of external piping, deluge valve, sensors and other components. External piping have two types of the feed line and outlet road, and water pipeline system can access a network of water to supply station up or existing fire cooling tube network, or through fire hydrants, fire engines and other temporary site water. Sensors are used to monitor system pipe network operation, including flow meters and pressure transmitter.

CONCLUSION

Intelligent fire extinguishing system is a combination of the structural characteristics of large oil storage tanks, fire detection system and application image automatic gun fire control system for the implementation of a combination of large-scale monitoring of the oil intelligent fire place. It is useful to achieve automatic fire alarm and fire linkage of spatial orientation closed-loop control, and it also solves the traditional firefighting techniques problem of large oil tank fire response slow, low efficiency of fire-fighting, rescuing difficult and other shortcomings, which has a fast response, pinpoint fighting, and remote visualization fire and so on.

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