

## Design of Recycling Fire Drencher System

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**Abstract.** Installing fire drencher system is one of the most effective methods for fire prevention and heat insulation. But because of its large water consumption, the application range is confined. Furthermore, the numerous water quantity stored in water tank will be used for just fire prevention rather than extinguishing fire, which results in waste of water. In order to improve water usage efficiency, the construction of traditional drencher system is improved, the concept of new type recycling drencher system is put forward, and its merits are described.

### 1. Introduction

Fire is a phenomenon of combustion out of control, usually accompanied by a great of smoke and heat. Therefore, fire engineering designers tend to use separation technology measures to block heat radiation and prevent fire spreading. Fire drencher system, as known as water curtain system by common people, can prevent smoke and combustion from spreading from one area to the adjacent ones, and block smokes to diffuse everywhere, especially applied in large space buildings. Usually, fire drencher system is composed of open sprinkler head or water curtain nozzle, pipeline, deluge valve or temperature sense valve and alarm device<sup>[1]</sup>. It can form dense water which spray as water wall or water curtain.

### 2. The limitation of traditional fire drencher system

The limitation of traditional fire drencher system mainly lies in the large amount of water consumption. If a fire drencher system is placed instead of a firewall, its length may reach more than ten meters and its working period may reach three hours, then it results in excessive use of water which should be used in practical fire fighting primarily. The large amounts of water is stored for passive fire prevention, while not for active fire extinguishing, actually causing waste. So the national standard " Code of design for sprinkler systems (GB50084) " shortly as "sprinkler standard" stipulates in 4.2.10 provision that, fire separation drencher system should not be used in an opening more than 15m (width) by 8m (high), thus intending to limit the use for fire protection water curtain.

In order to make it clear, an example of comparative computation analysis will be put forward next: supposed in a large space building, a water curtain system will be installed as fire prevention separation and its length is 12m. According to the "sprinkler system", when the water spray height is less than or equal to 12m, sprinkling intensity  $Q$  equals to  $2L/s \cdot m$ , and the duration time can be assumed as 2 hours (when water curtain system serves as the fire protection separation, its function is equivalent to the firewall, so the duration time should be determined based on fire resistance grade of buildings, generally for 2 ~ 3h), then the water amount is:

$$V=Q \cdot L \cdot h=2 \times 15 \times 2 \times 3600/1000=216m^3。$$

If suppose the average flow of automatic sprinkler system is  $30l/s$  (that is  $108m^3/h$ ), and sprinkling duration time is one hour, the water amount equals  $108m^3$  per hour. So relatively

speaking, the water consumption of drencher system which is used for fire separation is larger than the sprinkler system mentioned above. In deed, this large amount of water is used not for controlling or distinguishing fire directly, but used for forming fire compartment, resulting that much water runs off and cause huge waste.

While, Many experiments by scholars proved the merits and insubstitutability of drencher system, for example: Qin Jun et al<sup>[2]</sup> measured the thermal shielding efficiency of the drencher system was 97% by simulating experiment on oil tank cooling curtain system; Zhong Tao<sup>[3]</sup> studied the insulation performance of drencher system in large space from the angle of temperature reduction. The experimental results show that drencher system can effectively prevent the fire from spreading, cooling and heat insulation effect is remarkable. Xu Jun<sup>[4]</sup> proved that the large-span cabin in the ship can be separated by the installation of drencher system. Ge Xiaoxia<sup>[5]</sup> concluded that fire drencher system can block radiation ability of fire with high density water curtain shape. Therefore, the drencher system has outstanding advantages in prevent the fire from spreading and impede heat from transferring. In a long time it will continue to occupy a place in the design of building fire control. But it is necessary to improve its design of saving water, and by making best use of the advantages and bypass the disadvantages to boost its development.

### 3. Concept of new type recycling drencher system

So, how to overcome the traditional defects of large water consumption of drencher system and promote the application? Increasing the efficiency of using water becomes the key to solve the problem. Therefore, the author puts forward the concept of the recycling type fire drencher system on the basis of traditional design of water curtain system. That is to say, by adding some necessary components of the recovery devices of water, this system can make use of water repeatedly, thus improving the water using efficiency.

Liu Zhongxiang has designed the fire curtain with a circulation type water drencher system<sup>[6]</sup>. In his design of new type fire curtain, a water circulation system including water storage tank, pipe pump, water pipe and electromagnetic valves is placed on the bottom. Connected with the water collecting tank, the control valve can set the water in the tank pumped back to the water sprayers automatic. The device can be used as water curtain water flowing down back to the suction tank, recycling cooling fire shutter. The principle of recycling water curtain system designed in this paper is as similar as the system.

### 4. design of new type recycling drencher system

The design of recycling drencher system is as shown in Figure 1.

#### 4.1 Water-receiving ground and water-collecting slot

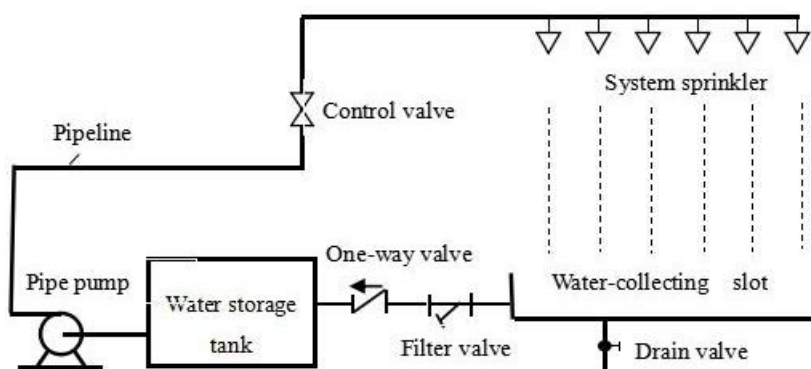


Fig.1. Design of recycling drencher system

Water-receiving ground and collecting slot should be set beneath the recycling drencher system, which can receive drainage water and collect it into the underground water slot. Ground slope setting should guarantee the drainage smooth. The length of water slot should be not less than the width of drencher system and the width should be determined according to the spraying thickness of system protection after experiment is verified. the volume of water collecting slot shall be determined after flow calculation according to usage demand, to ensure that the drainage water to ground could be collected effectively and timely. In order to prevent pipeline blockage, the upper part of the water slot should set a filter trap and regular inspection check should be carried out for clearing debris.

There should be a drain valve under the water-collecting slot. The valve could be open in non fire condition, while it should be closed in use. The main function of drain valve is discharging sewage in it or surface water on the ground. The water which is collected by water slot will flow into a water storage tank. The pipe between the tank and slot should install a filter valve and a one-way valve. The diameter of the pipeline shall be determined by calculation.

#### 4.2 The water storage tank of recycling drencher system

The water storage tank of recycling drencher system should be set as an independent type, with no pollution to other sources. The storage tank can be installed in the underground pump room, so as to make the water collected flow back smoothly by gravity action. The function is not only providing the initial water consumption, but also storing used water after filtration. Then working pump should set apart from other pumps which are used for fighting fires directly. And an extra water supply pipe may be installed and controlled by a float valve, to insure the water is insufficient. Moreover, an overflow pipe can prevent the overflow and a sensor on the wall can be set up to monitor the water level.

#### 4.3 The choice of sprinklers

In order to improve the water recovery efficiency of recycling drencher system, the sprinkler should choose water curtain type. The reason lies in: the sprinkler of this type can spray and maintain a curtain shape, its average thickness is small enough to form a narrow range on the ground, so the cooling water collection efficiency is high. Figure 2 is a ZSTMC-T type water curtain type sprinkler. And from Figure 3 we can see when the height is 3m, the width of water curtain on the ground is only 0.5m. The Ground design should ensure the water collecting.

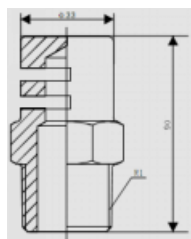


Fig.2. ZSTMC-T sprinkler

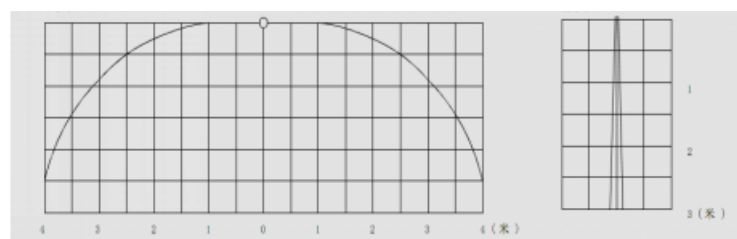


Fig.3. Spraying curve of ZSTMC-T sprinkler

#### 4.4 Analyzation of water recovery efficiency

Idealized recycling drencher system may spray down all the water into the water slot. But in fact, due to water loss caused by evaporation and absorption, the water recovery efficiency can not be 100% at all. If this efficiency is represented by the letter  $\eta$ ,  $\eta < 1$ . And:  $\eta = Q_h/Q_p$ .  $Q_h$  refers to the water recovered after the measurement, the unit is  $m^3$ .  $Q_p$  refers to the water sprayed by the sprinklers, the unit is  $m^3$ , too. Because  $Q_p$  is a relatively fixed value, the efficiency depends on the increase of  $Q_h$ . The main design is known as the slope of the ground, permeable rate of filter net, water volume of collecting slot and the diameter of backwater pipe.

#### 4.5 the applicable places of recycling drencher system

In accordance with the requirements of the code of automatic sprinkler system design, drencher system is generally applicable to be a firewall or can be set in a local opening part and the upper part of fireproof rolling shutter or fireproof curtain. Recycling type drencher system can overcome the traditional shortage of consuming excess amount of water, especially may be used for in the transformation of existing traditional type system and specific places that requires fireproof separation in use of water, such as a large exhibition hall or a large garage. But this system should not be used in the rooms, workshops and warehouse there may be flammable liquid leakage or flowing at the same time.

#### 5. conclusion

The concept of recycling drencher system is put forward and aimed at mending the drawback of the traditional drencher system and the structure composition is improved appropriately. It will realize use of water repeatedly, reduce the waste and raise the water use efficiency. Technically it's feasible, through combination with building construction. The construction difficulty is not increased and the cost is in the acceptable range. Recycling drencher system should be designed to ensure the recovery efficiency of water. At the time of maintenance, the administrators should pay special attention to assure the smooth liquidity of the water collecting slot and pipelines.

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