Multifunctional Emergency Plugging Test and Simulation Training Method

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Abstract. This research involves multifunctional belt pressure emergency leak test and simulation training methods, through a lot of water pressure test, Flow meter, pressure transmitter, liquid level meter, inverter and other effective flow, pressure, liquid level sensors, motor frequency data, to provide emergency leak test and simulation training scientific reference data and theoretical basis.

1. Technical Background
With the development of China’s economy, the amount of inflammable, explosive and toxic and harmful substances has increased greatly. Therefore, the fire rescue personnel must be able to quickly and accurately determine the type of accident, the development of the corresponding rescue plan, which puts forward higher requirements for rescue personnel training. Therefore, it is of great significance to carry out the study of accident leakage and emergency plugging test and simulation training for the preparation of accident emergency plan and emergency rescue for major hazard sources.

2. Research Implementation Method
In this paper, a multifunctional emergency plugging test and simulation training device and test training method with pressure are provided to simulate the leakage situation of tank body, pipeline, flange, valve and other real vehicle tank vehicles, so as to realize emergency plugging test and simulation training. The structure diagram of leakage test and training method of simulated tank car is shown in figure 1, the table of performance parameters is shown in table 1.
Figure 1. Structure diagram of simulated tank car leakage test and training method
Table 1. Research object table of performance parameters

| Simulated leakage pressure range (MPa) | 0-2.5 |
|--------------------------------------|-------|
| Number of leakage ports (pcs)       | 22    |
| Leak port simulation objet           | Tank body, pipeline, flange, valve, manhole, safety valve, level gauge, barrel body weld, barrel body and head weld |
| Leakage of medium                    | water |
| Motor power (KW)                     | 18.5+7.5 |
| Capacity (L)                         | 2000  |
| The control mode                     | Automatic control |

The leakage port is set as follows:
1. Leakage point of low temperature operation box with pressure.
2. Simulate flange leakage point 1#.
3. Simulate flange leakage point 2#.
4. Simulate pipe leak points 1#.
5. Simulate pipe leak points 2#.
6. Simulate valve leak point 1#.
7. Simulate pipe leak points 3#.
8. Leakage point of normal temperature and pressure operation box.
9. Small tank leakage point Φ10.
10. Small tank leakage point Φ5.
11. Small tank leakage point 2*50.
12. Manhole leak point.
13. Relief valve leakage point (Open at pressure above 0.8MPa)
14. Level gauge leak point.
15. Cylinder weld leakage point Φ10.
16. Cylinder weld leakage point Φ5.
17. Cylinder weld leakage point 2*50 1#.
18. Cylinder weld leakage point 2*50 2#.
19. Leakage point of welding seam between cylinder and seal head Φ10 1#.
20. Leakage point of welding seam between cylinder and seal head 2*50.
21. Leakage point of welding seam between cylinder and seal head Φ10 2#.
22. Leakage point of welding seam between cylinder and seal head Φ5.

3. Methods and Steps of Emergency Plugging Test and Simulation Training

In order to achieve the purpose of test and training, the device platform includes a software control system and a leakage simulation system, in which the leakage simulation system is composed of a water supply system, a simulated tank body, pipelines and a leakage port.

Figure 2. System setting interface
Figure 3. Object distribution diagram of leak simulation system

1. Start the automatic operation control system, and the water supply system will deliver the pressurized water to the pipeline system to simulate the leakage of the pressurized pipeline. The water supply system delivers pressurized water to the simulated leakage flange, which simulates the pressure leakage; The water supply system delivers pressurized water to the simulated leakage valve, which simulates the pressure leakage of the valve.

2. The water supply system delivers pressurized water to the simulated leakage tank to simulate the leakage of a variety of tanks, and simulates the manhole damage leakage plugging test and simulation training.

3. The water supply system delivers pressurized water to the simulated leakage tank to simulate the leakage of a variety of tanks, and simulates the damage leakage of the safety valve in this region, and conducts the safety valve damage leakage plugging test and simulation training.

4. The water supply system delivers pressurized water to the simulated leakage tank to simulate the leakage of a variety of tanks, and simulates the damage leakage of the liquid valve gauge in this region, and conducts the damage leakage plugging test and simulation training of the liquid level gauge.

5. The water supply system delivers pressurized water to the simulated leakage tank to simulate the leakage of a variety of tanks, and simulates the failure and leakage of the welding seam of the cylinder body in this region, and conducts the sealing test and simulation training for the failure and leakage of the welding seam of the cylinder body.

6. The water supply system delivers pressurized water to the simulated leakage tank to simulate the leakage of a variety of tanks, and simulates the interface failure leakage in this region to conduct the interface bad leakage plugging test and simulation training.

4. Evaluation Criteria for Research Methods

Selection of leak, set the leak pressure, click start. According to the program setting, lights flashing, according to leak specification 22 leak can be divided into five types, pressure from 0.1~2.5MPa is divided into 25, double control system for variable (leak and pressure level), fuzzy set piecewise function algorithm, the control variables (electric control calve opening, two high pressure water pump frequency), 35 seconds after the countdown, corresponding to the leak of Solenoid valve is opened, warning voice broadcast at the same time, in the process of collision, pipeline pressure changes, the system according to the built-in intelligent algorithm, 3 seconds to adjust a motorized valve opening is
opened, warning voice broadcast at the same time, in the process of collision pipeline pressure changes, the system according to the built-in intelligent algorithm, 3 seconds to adjust a motorized valve opening, in order to ensure that the pipeline pressure is constant, when the pipeline flow is less than or equal to 10L/min, it means that the plugging is successful, click stop, the plugging is over.

The optimal parameters of pump test and training are shown in table 2 and table 3. According to the analysis of test data in table 1 and table 2, ordinary water pump motor with pressurized water (pressure range 0.1-0.6mpa) only needs to be started with 7.5KW water pump motor, and it can operate under the given power pump motor, and it can operate under the given power frequency. For medium pressure water (pressure range 0.7-2.0mpa), both 7.5KW and 18.5KW pumps should be started at the same time, and the operation below the given power frequency is required. High pressure water (pressure range 2.0-2.5mpa) should open both 7.5KW and 18.5KW pumps at the same time, and operate at a given power frequency condition; The results show that the test data meet the requirements of test and training, and provide scientific reference data and theoretical basis for emergency plugging test and simulation training.
Table 2. Optimal parameters of pump group test and training.

| NO. | Set pressure (MPa) | 7.5KW Pump given frequency (Hz) | 18.5KW Pump given frequency (Hz) | 24# valve status |
|-----|--------------------|---------------------------------|----------------------------------|------------------|
| 1   | 0.1                | 35                              | 0                                | Open             |
| 2   | 0.2                | 40                              | 0                                | Open             |
| 3   | 0.3                | 45                              | 0                                | Open             |
| 4   | 0.4                | 45                              | 0                                | Open             |
| 5   | 0.5                | 50                              | 0                                | Open             |
| 6   | 0.6                | 50                              | 0                                | Open             |
| 7   | 0.7                | 33                              | 33                               | Closed           |
| 8   | 0.8                | 35                              | 35                               | Closed           |
| 9   | 0.9                | 40                              | 35                               | Closed           |
| 10  | 1.0                | 40                              | 40                               | Closed           |
| 11  | 1.1                | 45                              | 40                               | Closed           |
| 12  | 1.2                | 45                              | 40                               | Closed           |
| 13  | 1.3                | 45                              | 40                               | Closed           |
| 14  | 1.4                | 45                              | 45                               | Closed           |
| 15  | 1.5                | 45                              | 45                               | Closed           |
| 16  | 1.6                | 45                              | 45                               | Closed           |
| 17  | 1.7                | 45                              | 45                               | Closed           |
| 18  | 1.8                | 45                              | 45                               | Closed           |
| 19  | 1.9                | 45                              | 45                               | Closed           |
| 20  | 2.0                | 50                              | 50                               | Closed           |
| 21  | 2.1                | 50                              | 50                               | Closed           |
| 22  | 2.2                | 50                              | 50                               | Closed           |
| 23  | 2.3                | 50                              | 50                               | Closed           |
| 24  | 2.4                | 50                              | 50                               | Closed           |
| 25  | 2.5                | 50                              | 50                               | Closed           |

Table 3. Results of automatic control

| Category | Leakage | Set pressure (MPa) | Duration (min) | results |
|----------|---------|--------------------|----------------|---------|
| 1        | 1-8, 12 | 0.2/0.5/1.0/1.5/2.0/2.5 | 30 | The feedback pressure is consistent with the set pressure. The smoke machine, alarm light and sound work normally. |
| 2        | 9, 15, 19, 21 | 0.2/0.5/1.0/1.5/2.0/2.5 | 30 | The feedback pressure is consistent with the set pressure. The smoke machine, alarm light and sound work normally. |
| 3        | 10, 16, 22 | 0.2/0.5/1.0/1.5/2.0/2.5 | 30 | The feedback pressure is consistent with the set pressure. The smoke machine, alarm light and sound work normally. |
| 4        | 11, 18, 20 | 0.2/0.5/1.0/1.5/2.0/2.5 | 30 | The feedback pressure is consistent with the set pressure. The smoke machine, alarm light and sound work normally. |
| 5        | 13       | 0.8/1.0/1.5/2.0/2.5    | 5   | The feedback pressure is consistent with the set pressure. The smoke machine, alarm light and sound work normally. |

5. References

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