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# Spring-loaded Safety Valve Instructions

A safety valve is a valve mechanism for the automatic release of pressure from the pressure equipment, vessel or pipeline. When the pressure in the system protected exceeds preset limits, it opens automatically to discharge extra medium as to prevent the pressure from rising. When the pressure decreases to certain specified value, the valve closes automatically as to ensure normal operation.

## I. Main technical parameters of spring-loaded safety valve

|                          |   |
|--------------------------|---|
| Nominal pressure:        | 150 Lb ~ 2500 Lb                                  |
| Inside nominal diameter: | 1/4 in ~ 16 in                                    |
| Applicable temperature:  | -196°C ~ 550°C                                    |
| Applicable medium:       | water, air, oil product, steam, natural gas, etc. |

## II. Main technical specifications of spring-loaded safety valve

|             |   |
|-------------|---|
| ISO 4126-1  | Safety valves; Part 1: General requirements   |
| API std 526 | Flanged steel pressure relief valves  |
| API 520     | Sizing, Selection and Installation of Pressure-relieving Devices in Refineries                          |
| API std 527 | Seat Tightness of Pressure Relief Valves  |
| ASME        | American Society of Mechanical Engineers<br>Boiler and Pressure Vessel Code Sec VIII<br>Pressure Vessel |

## III. Structure and functions of main fittings

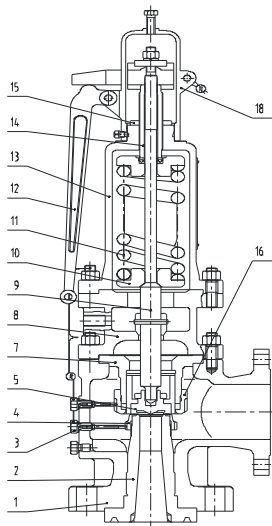


Fig.1

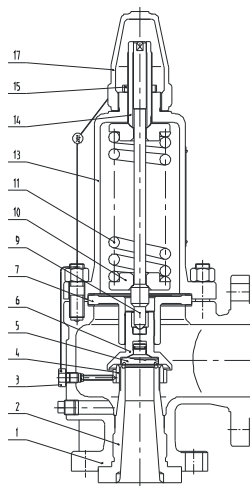


Fig.2

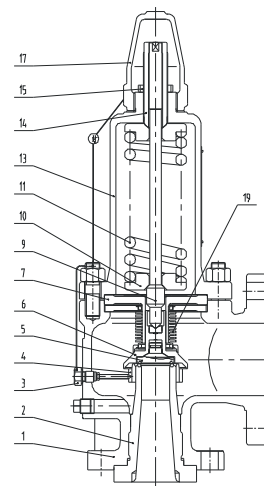


Fig.3

| No. | Part Name           | Main Functions   |
|-----|---------------------|--|
| 1   | Body                | Valve shell and main pressure part   |
| 2   | Nozzle              | Inlet pressure bearing part and main sealing fitting                                 |
| 3   | Set screw           | Prevent nozzle ring from loosening   |
| 4   | Lower nozzle ring   | Adjust re-seating pressure, relieving pressure and lift                              |
| 5   | Disc                | the key fitting for open and seal  |
| 6   | Disc holder         | Promote the disc to rise when counterforce occurred during the discharge of medium   |
| 7   | Guide               | Guide and positioning of disc  |
| 8   | Radiator            | Main fitting of high-temperature valve for lowering the temperature of spring cavity |
| 9   | Stem                | Transfer the spring force to disc (or disc holder)                                   |
| 10  | Spring washer       | Support spring   |
| 11  | Spring              | Main fitting of safety valve for loading and pressure adjustment                     |
| 12  | Lifting level       | Manually discharge   |
| 13  | Bonnet              | Sealed safety pressure part used for connecting part and spring cavity               |
| 14  | Adjusting bolt      | Adjust the set pressure of safety valve  |
| 15  | Adjusting bolt nut  | Prevent the adjusting bolt from loosening  |
| 16  | Upper nozzle ring   | Adjust the re-seating pressure, relieving pressure and lift                          |
| 17  | Cap                 | Prevent the medium from leakage  |
| 18  | Pulling yoke of cap | Manually open the valve fittings   |
| 19  | Bellows             | Balance backpressure or avoid leakage of poisonous gas                               |

#### 1. Working Principle of Spring-loaded Safety Valve

Spring-loaded safety valve gets sealed by adjusting spring force to overcome the medium pressure. When the spring force is larger than the normal medium pressure, the disc is closed. When the medium pressure exceeds the set pressure, the spring is under compression and forces the disc sealing face separated, as a result, the valve will open automatically and fully discharge. When the medium pressure falls to the normal value, the spring force pushes the disc to the nozzle then disc sealing face overlaps the nozzle sealing face, the valve closes automatically.



The precision and cleanness of sealing face of disc and nozzle directly have close relationship with the sealing performance of valve.

#### IV. Selection of safety valve

The following points should be taken into consideration when select and verify the parameters of safety valve: the nominal pressure of safety valve is determined by the working pressure, the applicable temperature range is determined by the medium temperature, the pressure stage of spring is determined by the set pressure value of safety valve, materials and structure of safety valve are determined by the medium used, throat diameter of the safety valve is calculated by the discharge capacity of safety valve. That how to properly apply safety valves is directly related to economic benefit of end users as well as to the safety of operators and equipment. Hereunder are some key points during selection:

##### 1. Determination of working pressure

The working pressure and nominal pressure of safety valves, and spring pressure stage differ in meaning. The working pressure refers to a static pressure before the valve under normal working condition and is same with working pressure of system protected or equipment. The spring pressure stage refers to allowable working pressure limits of a certain spring; within such pressure limits, the set pressure (namely opening pressure) of safety valve may be regulated by changing precompression amount of the spring. Safety valve of the same nominal pressure may be divided into several different working pressure stages as required by spring design. Premise for division is enough to ensure that both the upper limit and lower limit of each working pressure stage may conform to action performance index stipulated by relevant standards. The set pressure is set at the lower limit of working pressure stage before the safety valve leaves the factory. The working pressure stage shall be determined according to required set pressure value during its selection.

## 2. Selection Conditions

### (1) Selection of nominal diameter

The nominal diameter shall be determined subject to discharge capacity required by the system protected. That is to say, the safety valve selected should have rated discharge capacity bigger than required discharge capacity. Discharge capacity required by the system protected refers to the medium amount must be discharged when the system has abnormal overpressure as to avoid excessive overpressure. It is decided by factors such as working conditions of system or equipment, volume and causes that may result in superhigh pressure.

### (2) Material determination

The material for safety valve selected shall take working temperature, working pressure and performance of the medium as well as material manufacturability, economy and other factors into consideration. In order to select appropriate safety valve, main fittings for general safety valves and related technical data are given in Table 1. Generally, users may select them from our safety valve sample book which outlines different models, working temperatures, pressure limits and using medium. As to safety valve of special shape, you may inquire us when ordering.

Table 1

| Material of main fittings |        |        |        |                              |                          | Applicable working condition         |                           |
|---------------------------|--------|--------|--------|------------------------------|--------------------------|--------------------------------------|---------------------------|
| Body                      | Nozzle | Disc   | Bonnet | Spring                       | Material of sealing face | Applicable medium                    | Applicable temperature °C |
| WCB                       | 304    | 304    | WCB    | 50CrVA                       | Co-based hard alloy      | Air, oilgas, liquid, steam, etc.     | ≤300                      |
| CF8                       | 316    | 316    | CF8    | 50CrVA fluoroplastic wrapped | Co-based hard alloy      | Corrosive medium such as nitric acid | ≤200                      |
| CF8M                      | 316    | 316    | CF8M   | 50CrVA fluoroplastic wrapped | Co-based hard alloy      | Corrosive medium such as acetic acid |                           |
| CF3M                      | 316L   | 316L   | CF3M   | 50CrVA fluoroplastic wrapped | Co-based hard alloy      | Media with strong oxidizing property |                           |
| WC6                       | 304    | 17-4PH | WCB    | 50CrVA                       | Co-based hard alloy      | High temperature steam               | ≤510                      |
| WC9                       | 304    | 17-4PH | WCB    | 30W4Cr2VA                    | Co-based hard alloy      | High temperature steam               | ≤550                      |

Refer to the sample book provided by our company for model selection and applicable working conditions.

## **V. Handle and storage of safety valve**

Improper handle and storage of safety valves before installation and application after manufacture may cause harm to their performance and even make them useless. Generally, safety valves should be packed and fixed before transport. Keep it from violent shock in transit. The safety valve shall be stored in a dry and ventilated room. The inlet/outlet port shall be covered during storage and transport. Inspect the valve before storing in the warehouse. Clean the cap at the entrance and exit if there is any rainwater or dirt. Seal the entrance and exit with wax paper or plastic plate and store it in a dry and ventilated place.

## **VI. Installation of safety valve**

Before installation, the caps of entrance and exit should be removed and the inner cavity of entrance should be cleaned with kerosene or petrol. Make sure the inlet pipeline is cleaned and free of rust, foreign objects or other defects that affect the sealing precision of safety valve. Proper installation ensures the safety valve to operate normally and exert its due role as well as directly benefits its performance index such as action performance, sealing performance and discharge capacity.

### **1. Installation site of safety valve**

Following points should be attended during the selection of installation sites of system or equipment protected:

- 1) The safety valve should be vertically installed in positions most sensitive to pressure, such as top half of pressure vessel, main pipe of high temperature steam.
- 2) The pressure source of the system is a mechanism with pulse (such as air compressor). When the pulse upper limit of the pressure is quite close to the opening pressure of the safety valve, the valve should be mounted at a position with appropriate distance from pressure source or manostat as to avoid abnormal chatter.
- 3) Try not to mount the safety valve at the position where the equipment will vibrate so as to prevent the safety valve from earlier opening or leaking.
- 4) The valve should be mounted in the places convenient for dismounting and regular inspection and maintenance. The valve should be verified at least once every year.

### **2. Requirements on inlet pipeline laying**

- 1) For connecting pipes between pressure vessel and safety valve and the body size hole of pipe fittings, their sectional area should not be less than that of inlet, and the connection pipes should be as short and straight as possible.
- 2) When two or above safety valves are mounted in one connector of pressure vessel, the inlet sectional area of this connector should be at least equal to the total inlet sectional area of these valves.
- 3) It is not suitable to mount check valve between valve and pressure vessel. However, in some special occasion, to not stop production and for the verification and overhaul, the block valve can be mounted between valve and pressure vessel. The structure and diameter of block valve should not obstruct the discharge of safety valve.

### **3. Discharge pipeline laying**

In order to possibly reduce the affect of discharge pipeline to the safety performance, following points should be attended during pipelining:

- 1) The bore of discharge pipe should be larger than outlet diameter of the valve as to cause excessive backpressure which may affect the action of valve. As to safety valves of different media, the laying type of discharge pipe shall vary (see Fig. 4, 5 and 6)

- 2) The pipeline should be properly supported as to prevent the pipeline stress (erection stress and thermal stress) from attaching to the valve which may affect the valve performance. Fig. 9 shows one laying type of discharge pipeline.
- 3) In principle, it is advisable that one safety valve be employed with one discharge pipe. When two or more safety valves share one manifold, the manifold should be provided with adequate discharge area. At the joint position of discharge pipe connecting with the manifold, the flow turnover degree should be possibly small.
- 4) The discharge connecting pipe should be hatched with proper tapping holes as to avoid rain, snow or other condensates accumulate in the pipe and overflow from spring cavity mouth to corrode the valve.
- 5) As to the safety valve with high relieving pressure and large discharge capacity, a muffle should be set in the middle of discharge pipe to reduce noise.
- 6) It is unreasonable that the discharge pipe is supported by the outlet bypass of safety valve. It shall be supported by a specific support. The support may prevent the pipeline from moving or flutter due to counterforce produced at discharge.



Warning: the safety valve should be mounted after verified by local technical supervision authority.



Warning: When the equipment is under strength test, do not mount safety valve lest foreign objects in the pipeline equipment damages the sealing face when the safety valve opens.

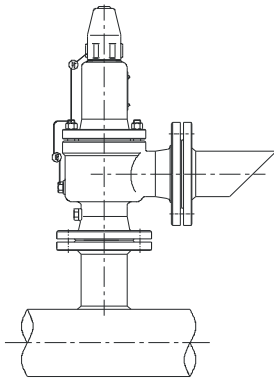


Fig. 4 For air or other gas

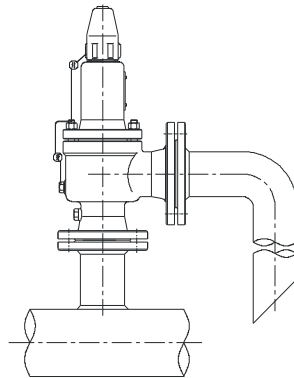


Fig. 5 For water or other liquid

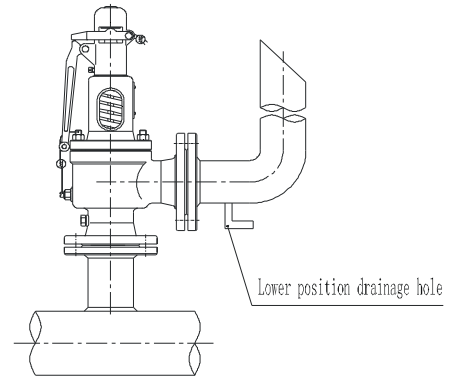


Fig. 6 For steam

## VII. Guidelines for performance tuning of safety valve

Safety valves provided by us have undergone routine test under normal temperature as per standard. Because actual operating condition has difference in temperature with regulated pressure under normal temperature, deviation in set pressure (opening pressure) between them is caused. In this connection, safety valve with relatively large temperature difference must undergone site thermal pressure regulating. As a general rule, it will regulate set pressure (opening pressure) and discharge and re-seating pressure. Take our typical product as an example for explanation (see Fig. 1, 2, and 3):

### 1. Set pressure (opening pressure) adjustment

The adjustment of opening pressure is achieved by opening the upper lead seal, removing the pulling yoke, dismantling the bonnet and loosening the Adjusting bolt nut, finally rotating the Adjusting bolt as to change the precompression amount of the spring (see Fig. 8). During adjustment, slowly increase the valve inlet pressure to make two hops. If the opening pressure is on the low side, remove the inlet pressure and clockwise screw down the Adjusting bolt; if the pressure is on the high side, anticlockwise loosen the Adjusting bolt. When the desired opening pressure is obtained, screw down the Adjusting bolt nut and restore the bonnet. If the required opening pressure exceeds working pressure limits of the spring, then another spring of different working pressure stage should be replaced with and readjust. After replacement, the data on the nameplate should be correspondingly modified.

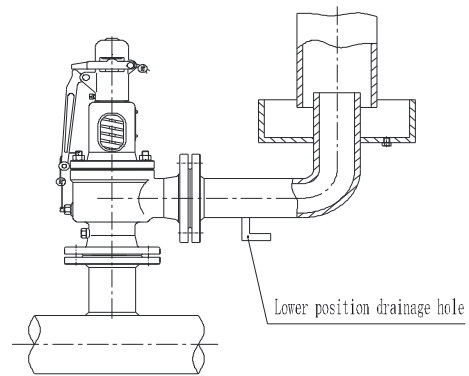


Fig. 7 For steam

Following points should be attended during adjustment:

- 1) Before adjustment, the valve cavity should be cleansed and debug with clean medium..
- 2) When the pressure before valve approaches to opening pressure (namely exceeding 70% of opening pressure), do not turn adjusting bolt lest the disc turns and damages the sealing face.
- 3) Under allowable condition, it is better to employ medium parameter close to actual working conditions for adjustment as to ensure accuracy of opening pressure.

If impossible, safety valve for gas or steam may employ air medium to adjust set pressure; safety valve for liquid or water may employ water of normal temperature to adjust. If actually used medium temperature differs greatly with the medium temperature during adjustment, temperature compensation should be taken into account.

- 4) Pressure gage for set pressure adjustment should take regular verification with its precision not lower than 0.4 class. The pressure value should be from one third to two thirds of gage range and the diameter of its dial should be not smaller than 150 mm.

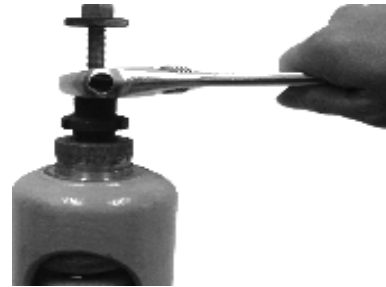


Fig. 8 Adjustment method of set pressure

## 2. Adjustment of relieving pressure and re-seating pressure

- 1) As to safety valve with already adjusted opening pressure, if relieving pressure or re-seating pressure is unqualified, it may be adjusted by relocating the nozzle ring. The safety valve is available with single nozzle ring and double nozzle rings (see Fig.9). The adjustment procedure is as below: open the lead seal, slacken set screw on the nozzle ring, then stretch from the bolt hole with a thin iron bar and alike to turn the gear wheel. If the valve outlet is not provided with connecting tube, the iron bar may be stretched directly from the outlet for adjustment. For the sake of safety, the valve inlet pressure should be properly decreased prior to adjustment (usually it shall be lower than 70% of the opening pressure) as to prevent the valve from sudden open which may cause accident.
- 2) For each adjustment, the nozzle ring should not be turned too greatly, preferably at two to five teeth. After adjustment, tighten the set screw of nozzle ring immediately and locate its end in the beard between two teeth of the nozzle ring and keep certain clearance lest looseness of nozzle ring and collar tightness may apply force to seal pair.
- 3) As to safety valve with both upper and lower nozzle rings, generally the upper one will be regulated first as to enable the relieving pressure to reach preset limit. After then, the lower ring will be regulated. It may occur mutual interference during debugging, thus the ring should be repeatedly adjusted until satisfied.

When turn the upper nozzle ring anticlockwise, its position ascends, re-seating pressure increases while relieving pressure slightly rises; on the contrary, when the position of upper nozzle ring descends which may facilitate to open the disc, its re-seating pressure reduces while relieving pressure decreases slightly.

When turn the lower nozzle ring anticlockwise, its position ascends, relieving pressure descends while re-seating pressure decreases slightly; on the contrary, when then the lower nozzle ring clockwise, its position descends, relieving pressure rises while re-seating pressure increases slightly.

- 4) The test bed for relieving pressure and re-seating pressure adjustment should be provided with large enough air source flow as to ensure full open (namely the lift) of the valve and test may start. Otherwise the Relieving pressure and re-seating pressure measured are not correct.
- 5) The relative position between the upper and lower nozzle rings after adjustment should not be too close, or it may affect the discharge capacity of the valve. Under general condition, the circular area between the upper and lower nozzle rings should not be smaller than the sectional area of nozzle throat.



Fig. 9 Adjustment method of relieving pressure and re-seating pressure

- 6) During debugging, abnormal actions such as chatter and flutter should be avoided as to protect against damage to the sealing face. In any way, thermal pressure regulating is a task involving complex and meticulousness. Both suppliers and customers must collaborate mutually. Generally, end users may independently finish pressure regulation according to *User's Manual of Safety Valves*. As to demand from users for door to service by us, we will charge according to the location of user and on the basis of mutual consultation.



#### Precautions

- a) At first operation of newly mounted safety valve, it is forbidden to hoist the disc by mechanical method. Try to reduce action cycles during debugging.
- b) Lead sealing after verification. Do not remove the lead sealing during the running of boiler or vessel.
- c) To keep the disc and nozzle from sticking together due to long-term non performance, please regularly carry out manual discharge test on safety valve.

### VIII. Common failures and troubleshooting of safety valve

Common failures and its solutions are as following:

| Cause   | Solution   |
|---|--|
| <b>Leakage</b>  |  |
| 1. Broken sealing face  | Dismantle the valve. Use grinding or grinding after lathe-turning to make good subject to extent of damage. After that, the sealing face should be level and its degree of finish should not be less than 0.2.   |
| 2. Improper installation  | Reinstall or remove additional load on the pipeline  |
| 3. High temperature   | As to the improper selection, reselect the safety valve applicable for high temperature medium according to working temperature, such as the one with radiator or other special structure.<br>As to the leakage cause by high temperature, take proper heat insulation measures. |
| 4. Opening pressure is too proximate with device working pressure | Reset the pressure as permitted by spring working pressure limits, if exceeded, replace the spring correspond to its working pressure stage.   |
| 5. Vibration of vessel and pressure equipment                     | The safety valve shall be mounted on the proper position.  |
| 6. Dirt sealing face  | Use lifting lever or other methods to open the valve for several times as to blow away the dirt; if failed, dismantle the valve to clear before reassembly and debugging.  |
| 7. Over re-seating pressure                                       | According to the adjustment requirement of relieving pressure and re-seating pressure, reduce re-seating pressure by using upper and lower nozzle rings.   |
| <b>Dumb action</b>  |  |
| 1. Blocked moving parts   | It may be caused by improper assembling, dirt, part erosion or other reason. Find out the cause and clear it.  |
| 2. Part bruising, napping or iron rust                            | Repair or replace subject to extent of damage.   |
| 3. Overhigh temperature of equipment or pipeline                  | Improper selection, overhigh medium temperature, blocked fitting due to thermal expansion  |
| 4. No overhaul for a long time                                    | Dismantle for wash or replace the valve as per part damage, and establish system of regular overhauling.   |
| <b>Undesirable action performance</b>                             |  |
| 1. The deviation of opening pressure exceeds tolerance range      |  |
| a. Operational error of set pressure or loose adjusting bolt      | Readjust the adjusting bolt and screw down the adjusting bolt nut after that.  |
| b. Change of existing pressure of discharge pipeline              | Find the cause for change of backpressure and solve it. If it changes greatly, select the safety valve of backpressure balance bellows.  |



|  |   |
|--|---|
| c. Change of working temperature                       | When adjusting the set safety valve for high temperature occasions under normal temperature, the opening pressure may decrease which may be adjusted by the Adjusting bolt.   |
| d. Corrosion of spring                                 | Replace the spring. As to occasions with medium with strong corrosiveness, please choose the spring covered with fluoroplastic, spring made of special material, or safety valves with bellows isolation mechanism.   |
| e. Error when verification                             | The pressure gauge shall be checked effectively, the diameter of dial plate shall be not less than 150 mm, and the precision shall be not lower than 0.4. The verification medium of safety valve is normal air in the factory. For the verification by other medium or temperature, since the inconsistency of medium compression ratio, set pressure deviation will be generated. According to the actual conditions, turn the Adjusting bolt to reach conformity standard. |
| 2. Change of relieving pressure or re-seating pressure |   |
| a. Translocation of nozzle ring                        | Retrial and screw down the set screw on the ring and sealed with lead.  |
| b. Excessive flow resistance of discharge pipe         | Enlarge the diameter of the discharge pipe or shorten its length.   |
| c. Improper selection of model                         | If the using temperature is higher than 350°C, please choose the safety valve with radiator lest the rigidity and re-seating pressure of spring reduce due to high temperature.   |
| 3. Valve chatter                                       |   |
| a. Excessive discharge capacity                        | Recalculate and choose safety valve according to its discharge capacity as required by the device.  |
| b. Excessive resistance of inlet pipeline              | Enlarge the bore of inlet pipeline to make it bigger than the diameter of valve inlet or shorten the length of the pipeline.  |
| c. Excessive resistance of discharge pipe              | Enlarge the bore of discharge pipe or shorten its length.   |
| d. Too big spring rigidity                             | Check whether the spring working pressure stage is in agreement with the opening pressure of the valve.   |
| e. Improper nozzle ring position                       | Readjust. Tighten the set screw and add lead sealing after adjustment.  |

#### **IX. Service & Maintenance of safety valve**

In order to ensure proper service and maintenance, following points should be followed:

- 1) The safety valve shall be packed and fixed properly in the box before transport. Avoid violent vibration in transit.
- 2) Inspect the valve before storing in the warehouse. If the inlet and outlet plugs and lead sealing is found falling, clean the inlet and outlet and cram the plugs and add the lead seal.
- 3) The valve shall be vertically stored in a dry room and kept from damage. The processing surface of fittings should be coated with antirust and the spring surface should be applied oil to prevent rust.
- 4) It is recommended to store the spring, as the spare part, in a dry room and pack it with paper and vertically put on the shelf or in the box if for long time storage. The spring surface should be applied with oil to prevent rust.
- 5) Regularly dismantle the safety valve for thorough cleansing. It may be again put into service only after inspection and verification.
- 6) Regularly check the safety valve in service whether it has abnormalities such as leakage, blockage and spring rust, observe the Adjusting bolt and the locknut on the set screw of the ring whether loose or not, if found, proper measures should be timely taken.
- 7) It is recommended to set up using cards for each safety valve. A copy of valve conformity certificate of supplier shall be kept in the using card, as well as the copy of repair, inspection and adjustment record.
- 8) During the operation of safety valve, if permitted, the range between opening pressure and working pressure shall be as large as possible to prevent from frequent opening of valve and prolong the service life.
- 9) DO NOT open the safety valve as less as possible or use it as warning signal.
- 10) Safety valves mounted outdoor should be guaranteed with protective measures as to avoid the invasion of dirt such as rain, mist, dust and rust into the valve and discharge pipeline. When the ambient temperature is below 0°C, necessary anti-freezing measures should be taken as to ensure the reliability of valve operation.