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Design code for instrument selection

自动化仪表选型设计规范

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Design code for instrument selection

1 General provisions

1.0.1 This Code was formulated in order to unify the technical requirements for the selection of measurement and control instruments in the chemical industry, promote the standardization of engineering design for the selection of chemical measurement and control instruments, and achieve the goals of technological advancement, economical rationality, safety and applicability.

1.0.2 This Code is applicable to the selection and design of measurement and control instruments in new construction, expansion and renovation projects in the chemical industry.

1.0.3 In addition to complying with the requirements of this Code, the selection and design of measurement and control instruments shall also comply with the relevant current national standards.

4 Temperature instrument

4.1 General requirements

4.1.1 The unit and measuring range of temperature instruments shall meet the following requirements:

- 1** The unit of temperature instruments shall use Celsius (°C).
- 2** The measurement of temperature instruments shall use direct reading type.
- 3** The measuring range of temperature instruments should be consistent with the standard series of finalized products.

4.1.2 The immersion depth of temperature detection elements shall meet the following requirements:

- 1** The selection of the immersion depth of temperature detection elements shall be based on the principle that the temperature detection element is inserted into a representative area where the temperature of the measured medium changes sensitively.
- 2** When a temperature detection element is installed vertically on a full fluid pipeline or at an angle of 45° to the pipe wall, the length of the end of the temperature detection element immersed in the inner wall of the pipeline shall not be less than 50 mm and should not be greater than 125 mm.
- 3** When a temperature detection element is installed on the equipment, the length of the end of the temperature detection element immersed in the inner wall of the equipment shall not be less than 150 mm. When installed on flues, furnaces and insulating masonry equipment, it shall be selected according to actual needs.

4.1.3 The selection of protective sleeves for temperature detection elements shall meet the following requirements:

- 1** The material of protective sleeve for temperature detection elements shall be selected according to the design temperature, design pressure and anti-corrosion requirements of the pipeline and the characteristics of the measured medium.
- 2** The protective sleeve for temperature detection elements should select an integrally drilled tapered protective sleeve.
- 3** In situations where the temperature, pressure and flow rate of the process fluid are high, it should perform vibration calculations on the protective sleeve.

- 4 The detection elements used for measurement of ambient temperature and surface temperature shall not use protective sleeves, but should use armored temperature detection elements or assembled temperature detection elements.

4.2 Local temperature gauge

4.2.1 The selection of the accuracy level of local temperature instruments shall meet the following requirements:

- 1 It should select grade 1.5 for industrial thermometers.
- 2 It shall select grade 0.5 or grade 0.25 for thermometers used for precision measurement.

4.2.2 The selection of the measuring range of local temperature instruments shall meet the following requirements:

- 1 The maximum measured value shall not be greater than 90 % of the upper limit of the instrument's measuring range, and the normal measured value should be around 50 % of the upper limit of the instrument's measuring range.
- 2 The measured value of pressure thermometers shall be between 50 % and 75 % of the upper limit of the instrument's measuring range.
- 3 For measurements of low temperature below 0 °C, the upper limit of the instrument's measuring range shall cover the ambient temperature.

4.2.3 The selection of bimetal thermometers shall meet the following requirements:

- 1 For local temperature detection, it should select a bimetal thermometer.
- 2 The diameter of the bimetal thermometer shell should be $\phi 100$ mm. In places with poor lighting conditions, high installation positions or long observation distances, it shall select $\phi 150$ mm.
- 3 For the connection method between the bimetal thermometer instrument shell and the protective tube, it should select the universal type, or it can select the axial type or the radial type according to the principle of convenient observation.

4.2.4 For local or local panel display with low temperature below -80 °C, inability to observe at close range, vibration and low accuracy requirements, it can select a pressure thermometer. The capillary tube of pressure thermometers shall be protected and the length should be less than 10 m.

4.2.5 Liquid-in-glass thermometers can be used in situations with high measurement accuracy, small vibration, no mechanical damage and convenient observation.

- 6 In situations where the temperature measurement requires fast response speed and there is vibration, the temperature detection element should select the armored type; in situations where flexible installation is required, the temperature detection element should select the armored type.
- 7 When detecting the surface temperature of equipment, pipe outer walls and rotating bodies, it should select surface (end) type, compression spring fixed type, cable type or armored thermal resistors and thermocouples.
- 8 When measuring the temperature of flowing media containing solid particles, it should select a wear-resistant protective sleeve.
- 9 When multi-point measurements are required in the same detection element protection tube, it should select a multi-point (branch) thermal resistor and thermocouple.
- 10 If the detection temperature is higher than 870 °C or in reducing gas situations where the hydrogen content is greater than 5 %, it should select a blowing thermocouple.
- 11 The connection between the protective sleeve and the process should be the flange connection. In situations where flange connections are not allowed, it can use welded connections for protective sleeves. In places where the pressure level is not greater than CLASS 150Lb and for non-hazardous media (such as water, air, etc.), it can also use threaded connections for protective sleeves. Flange connections shall be used for protective sleeves in the following situations:
 - 1) Installation in equipment, lined pipelines and non-metallic pipelines;
 - 2) Multi-point temperature measurement of catalyst layer;
 - 3) Crystallization, scarring, clogging and highly corrosive media;
 - 4) Measurement of flammable and explosive media.

4.3.2 For position controls and alarms, it can select an electric contact thermometer.

4.3.3 In situations where standard signal transmission is required, it shall use a temperature transmitter. The selection of temperature transmitters shall meet the following requirements:

- 1 In situations where the ambient temperature at the temperature detection point is greater than 60 °C, it should select a separate on-site temperature transmitter.
- 2 If the installation environment temperature conditions are met, it can use a temperature transmitter integrating measurement and transmission.
- 3 The accuracy of temperature transmitters shall meet the measurement requirements.

- 4 The temperature transmitter shall have a thermocouple cold end compensation function.
- 5 The signal output status of temperature transmitters in case of burnout (open circuit) shall have “over range” and “under range” functions.

4.3.4 In situations require measuring the temperature of multiple points, it can select a multi-channel temperature converter, but multi-channel temperature converters must not be used in situations of temperature calculation, control and safety interlocking.

4.3.5 When a thermocouple cannot be used to measure the temperature of an ultra-high temperature heating furnace, if the environmental conditions meet the installation requirements, it can use a radiation pyrometer.

4.3.6 When a thermocouple cannot be used to measure the surface temperature of a ultra-high temperature object, if the environmental conditions meet the installation requirements, it can use a radiation pyrometer.

4.3.7 For safety monitoring of oil storage tanks and gas storage tanks, safety monitoring of long-distance pipelines and temperature measurement in harsh temperature measurement environments such as strong corrosion and strong electromagnetic interference, it should select an optical fiber temperature sensor. The selection of optical fiber temperature sensors shall meet the following requirements:

- 1 Depending on factors such as measuring range, accuracy level, number of detection points, installation environment, it can use an optical fiber grating temperature transducer or distributed optical fiber transducer.
- 2 Depending on the use situation, it can use the insulation type, high temperature type and load type protections.
- 3 For the temperature of key detection points, when using a distributed optical fiber transducer, it shall select a redundant optical fiber, and the system shall have an automatic alarm function for optical fiber breakage.

4.3.8 For monitoring temperature changes in the monitoring areas of oil storage tanks, gas storage tanks, oil pipelines, gasifiers, reaction tanks, coal conveying belts, coal bunkers, cable trays and cable trenches, it can use a hot spot detector.

5.2.4 For places where the design pressure of the measured gas is greater than or equal to 2.5 MPa and the design pressure of the measured liquid is greater than or equal to 6 MPa, it shall select a pressure gauge with a pressure relief device.

5.2.5 For pressure gauges used to measure pulse pressure or used in situations where over-range protection is required, it should be equipped with an over-range protection device.

5.2.6 The selection of the accuracy level of pressure measuring instruments shall meet the following requirements:

- 1 For pressure gauges, capsule pressure gauges and diaphragm pressure gauges for measurement, it should select grade 1.0, grade 1.6 or grade 2.5.
- 2 For pressure gauges for precision measurement, it should select grade 0.4, grade 0.25 or grade 0.16.

5.2.7 The selection of the external dimension of pressure measuring instruments shall meet the following requirements:

- 1 For pressure gauges installed on pipelines and equipment, the dial diameter should select $\phi 100$ mm or $\phi 150$ mm.
- 2 For pressure gauges installed on the pneumatic pipeline of the instrument and its auxiliary equipment, the dial diameter should select $\phi 60$ mm.
- 3 For pressure gauges installed in situations with low illumination, high position or where the indication value is difficult to observe, the dial diameter should select $\phi 150$ mm.

5.2.8 The selection of the measuring range of pressure measuring instruments shall meet the following requirements:

- 1 When measuring stable pressure, the normal operating pressure value shall be within the range of $1/3 \sim 2/3$ of the instrument's measuring range.
- 2 When measuring the pressure of pulsating media (such as the pressure at the outlet of pumps, compressors and fans), the normal operating pressure value shall be within the range of $1/3 \sim 1/2$ of the instrument's measuring range.

5.3 Selection of transmitter

5.3.1 It should select a pressure transmitter for pressure measurement. When measuring tiny pressures (less than 500 Pa), it should select a differential pressure transmitter.

5.3.2 When measuring the differential pressure of equipment or pipelines, it should select a differential pressure transmitter.

6.1.8 If the measurement requirements are met, it should use a differential pressure flowmeter. The specific selection shall comply with the provisions of Appendix A of this Code.

6.1.9 When measuring two-phase flow, it should select a wedge, electromagnetic, ultrasonic or balanced flowmeter.

6.2 Selection of differential pressure flowmeter

6.2.1 It should select standard throttling devices for differential pressure flowmeters. The selection of standard throttling devices shall comply with the current national standard “*Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*” GB/T 2624. For the purpose of this Code, standard throttling devices include standard orifice plates, standard nozzles, classic venturi tubes and venturi nozzles.

6.2.2 The material of throttling devices shall be at least 304SS.

6.2.3 The selection of standard throttling devices shall meet the following requirements:

- 1** When the fluid Reynolds number is greater than 5000, a standard orifice plate (concentric, sharp-edged orifice plate) should be the first choice for the throttling device.
- 2** In situations where low permanent pressure loss is required, it should select a standard nozzle, venturi tube and venturi nozzle.

6.2.4 It can use non-standard throttling devices under the following circumstances:

- 1** In situations where the length of the straight pipe section is short and a relatively large measuring range is required, it can select a multi-hole orifice plate.
- 2** If the Reynolds number is greater than 5000 and less than 100000, and the measured medium is clean gas or liquid, it can select a 1/4 round nozzle.
- 3** For dirty media (such as blast furnace gas, mud) that may produce sediment before and after the orifice plate, it can select a round orifice plate.
- 4** In situations where the measured medium is clean gas or liquid, and the required pressure loss is low, it can select a velocity-averaging tube flowmeter.
- 5** For micro flow measurement of clean liquids, steam and gases without suspended solids, when the measuring range ratio is not greater than 3:1, the measurement accuracy requirements are not strict, and the pipe diameter is less than $DN50$, it can select a built-in orifice flowmeter.

6 When it is the flow of high-viscosity liquids containing suspended solids that are easy to crystallize, the required pressure loss is low, and the Reynolds number is less than 500, it should select a wedge flowmeter.

7 For flow measurement of clean liquids, steam and gases without suspended solids, and no additional pressure loss is required, it should select an elbow flowmeter.

6.2.5 The selection of the pressure tapping method of orifice flowmeters should meet the following requirements:

$D < 50$ mm: corner pressure tapping;

$50 \text{ mm} \leq D \leq 300$ mm: flange pressure tapping or corner pressure tapping;

$D \geq 350$ mm: diameter distance pressure tapping.

6.2.6 The β value of throttling devices shall be $0.10 \sim 0.75$.

6.2.7 It can select a double transmitter to expand the measuring range of throttling devices.

6.3 Variable area flowmeter (rotameter)

6.3.1 In fluid measurement situations where the accuracy is not better than level 1.5 and the measuring range ratio is not greater than 10:1, it should select a rotameter.

6.3.2 For the rotameter, it should select a metal tube rotameter.

6.3.3 When the fluid does not contain magnetic substances, fibers and particles, it can select an ordinary metal tube rotameter.

6.3.4 When the measured medium is easy to crystallize, has high viscosity or is easy to vaporize, it can select a jacketed metal tube rotameter. Pass heating or cooling medium through the jacket.

6.3.5 For flow measurement of corrosive media, it can select an anti-corrosion metal tube rotameter.

6.3.6 For small and medium flow, micro flow measurements and local indication of the flow of fluids with pressure less than 1 MPa, temperature less than 100 °C, that are clean, transparent, non-toxic, no danger of burning and explosion and non-corrosive and non-adhesive to glass, it can use a glass rotameter.

6.3.7 The rotameter should be installed on a vertical pipeline, with the fluid flowing from bottom to top; it can also be installed on a horizontal pipeline, but the measuring tube of the rotameter shall be installed vertically.

6.3.8 The installation location shall have low vibration and be easy to observe and maintain. It should set upstream and downstream cut-off valves and bypass valves.

6.5 Positive displacement flowmeter

6.5.1 The selection of oval gear flowmeters shall meet the following requirements:

- 1** It is suitable for the measurement of clean and high-viscosity liquids, requiring more accurate flow measurement values, and the measuring range ratio shall not be greater than 10:1.
- 2** When measuring liquid media containing gas components and requiring accurate measurement, it shall add a gas eliminator.
- 3** The flowmeter shall be installed on a horizontal pipeline with the indicating dial surface in a vertical plane; it should set upstream and downstream cut-off valves and bypass valves.
- 4** A filter shall be set upstream of the flowmeter.

6.5.2 The selection of waist wheel flowmeters shall meet the following requirements:

- 1** It is suitable for clean gases or liquids, especially lubricating oils, which require accurate flow measurement values.
- 2** The flowmeter shall be installed horizontally, and it should set upstream and downstream shut-off valves and bypass valve.
- 3** A filter shall be set upstream of the flowmeter.
- 4** When measuring liquid media containing gas components and requiring accurate measurement, it shall add a gas eliminator.

6.5.3 The selection of scraper flowmeters shall meet the following requirements:

- 1** Continuous measurement of liquid flow, especially accurate measurement of various oil products.
- 2** When installing a scraper flowmeter, the pipeline shall be filled with fluid, and it shall be installed horizontally so that the counter numbers are in a vertical plane.
- 3** When measuring liquid media containing gas components and requiring accurate measurement, it shall add a gas eliminator.

6.6 Magnetic flowmeter

6.6.1 The magnetic flowmeter should be used for the flow measurement of media with conductivity greater than 5 $\mu\text{S}/\text{cm}$.

6.6.2 The magnetic flowmeter should be used for the flow measurement of liquid-solid two-phase media.

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