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JAPANESE INDUSTRIAL STANDARD

Refrigerating systems — Test methods — General requirements

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In the event of any doubt arising,
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Refrigerating systems — Test method
— General requirements

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1. Scope This Japanese Industrial Standard specifies the general requirements of test methods for determining overall refrigerating capacity, net refrigerating capacity and useful refrigerating capacity, and electric power consumption on the refrigerating systems of vapour compression type (hereafter referred to as "refrigerating systems") being operated under steady conditions.

- Remarks
1. The pressures used in this Standard, unless particularly defined, are the absolute pressures.
 2. The vapour compression type refrigerating systems in this Standard do not include the refrigerating systems having the condenser of spray type or evaporative type.
 3. The standards cited in this Standard are given in the following:
 - JIS B 8606 Testing of refrigerant compressors
 - JIS C 1102 Electrical indicating instruments
 - JIS Z 8762 Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes
 4. The Draft International Standard (ISO/DIS) corresponding to this Standard is given in the following:
 - ISO/DIS 916-1.2 Refrigerating systems — Test methods — Part 1: Testing of systems for cooling liquids and gases using a positive displacement compressor

2. Definitions For the main terms used in this Standard, the following definitions apply (see Fig. 1):

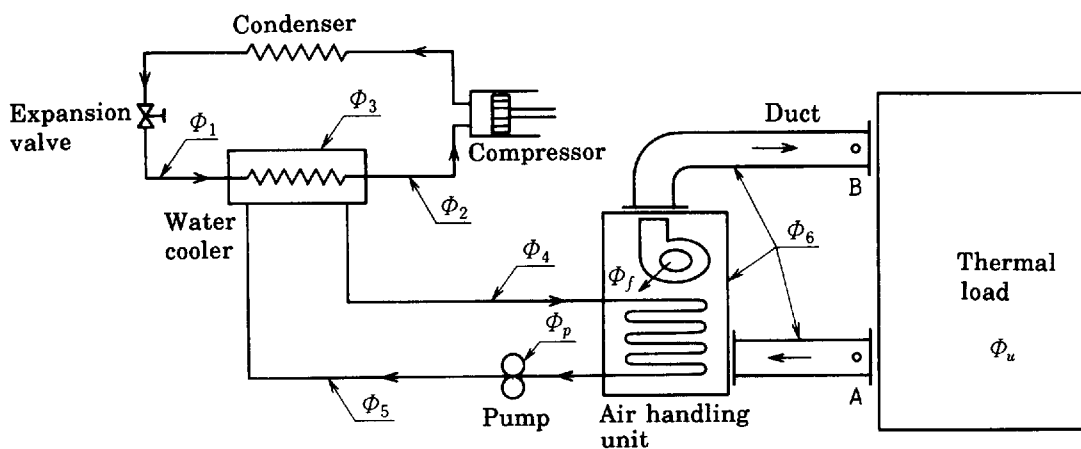
- (1) vapour compression type refrigerating system Refrigerating system comprising machines to compress, condense, isenthalpically expand and evaporate the refrigerant together with interconnecting pipelines and ancillary equipment required for performing a complete refrigerating cycle.
- (2) overall refrigerating capacity (Φ_0) Heat per unit hour removed by the circulating refrigerant in refrigerating cycle from the cooled medium or the secondary cooling medium, the ambient air at the low pressure side, etc.

Remarks: The overall refrigerating capacity is the value of the specific enthalpy difference of the refrigerant between the inlet of compressor and the inlet of expansion valve multiplied by the mass flow rate of the refrigerant circulating in the refrigerating cycle. However, as to the refrigerating cycle having the liquid-gas heat exchanger, it shall be calculated assuming that the heat may not be removed from the refrigerating cycle by the liquid-gas heat exchanger.

- (3) net refrigerating capacity (Φ_n) Heat per unit hour removed by the circulating refrigerant in the refrigerating cycle from the cooled medium or the secondary cooling medium.
- (4) useful refrigerating capacity (Φ_u) Heat per unit hour removed by the refrigerant or the secondary cooling medium from the cooled medium between the two points (points A and B in Fig. 1) where the refrigerating capacity is determined.
- (5) cooled medium Any medium to be cooled finally as the object of the refrigerating system (air to be the thermal load in Fig. 1).
- (6) secondary cooling medium The medium mainly of liquid or the like (cold water of water cooler in Fig. 1) to be used for transmitting heat to the refrigerant from the cooled medium to be cooled.
- (7) steady working conditions The conditions under which the respective running condition values of the refrigerating system have reached equilibrium during the predetermined period of time.

Remarks: The steady working conditions are judged by observing the indicated values of respective meters which indicate several parameters influential to the performances of the refrigerating system.

Fig. 1. Example of refrigerating system



Remarks: The calculated values of the respective refrigerating capacities in the refrigerating system of Fig. 1 result in the heat per unit hour in which the intruding heat flow (Φ_1 to Φ_6) and pump-shaft input Φ_p , and fan-shaft input Φ_f have been corrected. However, when the electric motors of the pump and fan are built in the secondary cooling medium circuit, the inputs of electric motors shall be used for Φ_p and Φ_f .

Overall refrigerating capacity

$$\Phi_0 = \Phi_u + \Phi_1 + \Phi_2 + \Phi_3 + \Phi_4 + \Phi_5 + \Phi_6 + \Phi_p + \Phi_f$$

Net refrigerating capacity

$$\begin{aligned} \Phi_n &= \Phi_0 - \Phi_1 - \Phi_2 \\ &= \Phi_u + \Phi_3 + \Phi_4 + \Phi_5 + \Phi_6 + \Phi_p + \Phi_f \end{aligned}$$

Useful refrigerating capacity

$$\begin{aligned}\Phi_u &= \Phi_0 - \Phi_1 - \Phi_2 - \Phi_3 - \Phi_4 - \Phi_5 - \Phi_6 - \Phi_p - \Phi_f \\ &= \Phi_n - \Phi_3 - \Phi_4 - \Phi_5 - \Phi_6 - \Phi_p - \Phi_f\end{aligned}$$

3. Quantitative symbols and unit symbols to be used The main quantities, quantitative symbols and unit symbols to be used in this Standard shall be in accordance with Table 1.

Table 1. Quantities, quantitative symbols and unit symbols

Quantity	Quantitative symbol	Unit symbol
Heat exchange surface area	A	m^2
Specific heat	c	$\text{J}/(\text{kg}\cdot\text{K})$
Specific enthalpy	h	J/kg
Overall heat transfer coefficient	K	$\text{W}/(\text{m}^2\cdot\text{K})$
Insulation thickness	l	m
Electric power consumption	P	W
Pressure	p	Pa
Mass flow rate	q_m	kg/s
Temperature	t	$\text{K}, ^\circ\text{C}$
Heat transfer coefficient	α	$\text{W}/(\text{m}^2\cdot\text{K})$
Temperature difference	Δt	$\text{K}, ^\circ\text{C}$
Thermal conductivity	λ	$\text{W}/(\text{m}\cdot\text{K})$
Heat flow	Φ	W
Refrigerating capacity (overall, net and useful)	Φ_0, Φ_n, Φ_u	W

4. Test methods in general

4.1 Types of test methods There are the following three types: the refrigerating capacity test method by the direct method, the refrigerating capacity test method by the indirect method and the electric power consumption method. However, the test on the refrigerating capacity shall generally be in accordance with the direct method.

The refrigerating capacity test method by the indirect method shall be applicable to the case where the direct method is not practical due to the construction, intended use, etc. of the refrigerating system, where the measuring accuracy is better than the direct method or it is performed for the purpose of confirming the refrigerating capacity test by the direct method.

4.2 Measuring instruments to be used in tests The instruments to be used in the tests shall satisfy the accuracies specified in Table 2. The instruments shall be so installed as not to disturb the normal operation of the refrigerating system, selecting those with less measuring errors due to frosting, heat flow, etc. Particularly, the measurement of the flow rate shall be carried out so as not to be influenced due to pulsation in the pipelines and the mingling of oil.

When the accuracy of the instrument to be used in the installation site test does not satisfy the values of Table 2, it shall be as agreed upon between the parties concerned with delivery.

Table 2. Accuracy of instruments to be used in tests

Instrument		Item	Factory test	Installation site test
Thermometer		Temperatures of refrigerant, heating medium, cooling medium and wet bulb	$\pm 0.1^{\circ}\text{C}$	$\pm 0.2^{\circ}\text{C}$
		Dew point temperature (0°C or under)	$\pm 2.0^{\circ}\text{C}$	$\pm 3.0^{\circ}\text{C}$
		Others	$\pm 0.3^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$
Pressure gauge		Low pressure side refrigerant and cooling gas medium (reading of absolute pressure)	$\pm 1.5 \%$	$\pm 2.0 \%$
		High pressure side refrigerant (reading of absolute pressure)	$\pm 2.0 \%$	$\pm 3.0 \%$
Flow meter		Liquid refrigerant, cooling liquid medium (reading)	$\pm 1.5 \%$	$\pm 2.0 \%$
		Refrigerant vapour, gas and air (reading)	$\pm 2.0 \%$	$\pm 3.0 \%$
Time		(lapsed time)	$\pm 0.1 \%$	$\pm 0.1 \%$
Mass		(reading)	$\pm 0.5 \%$	$\pm 1.0 \%$
Electric meters	Indicating instrument	That of grade 1.0 specified in JIS C 1102	$\pm 1.0 \%$	$\pm 1.0 \%$
	Integrating meter	(reading)	$\pm 1.0 \%$	$\pm 1.0 \%$

4.3 Test running conditions The running conditions in the tests shall be in accordance with the following:

- (1) The test shall be carried out under the ordinary working conditions of refrigerating system. When test conditions are different from these, the test results by the intruding heat from the auxiliary machines and ambient air shall be corrected.
- (2) When the test is carried out, the refrigerating system shall be in operation under the steady working conditions and be stable within the range of the maximum permissible fluctuation specified in Table 3.

When the permissible fluctuation under the steady working conditions in the installation site test does not satisfy the value of Table 3, it shall be as agreed upon between the parties concerned with delivery.

Table 3. Maximum permissible fluctuations
under steady working conditions

Fluctuations	Factory test	Installation site test
Secondary cooling liquid medium temperatures at evaporator outlet	$\pm 0.2^{\circ}\text{C}$	$\pm 0.3^{\circ}\text{C}$
Air (gas) temperatures at inlets of evaporator and cooler	$\pm 1.0^{\circ}\text{C}$	$\pm 1.5^{\circ}\text{C}$
Cooling water temperature at inlet of condenser	$\pm 0.3^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$
Cooling air temperature at inlet of condenser	$\pm 1.0^{\circ}\text{C}$	$\pm 1.5^{\circ}\text{C}$
Cooling water mass flow rate of condenser	$\pm 2.0 \%$	$\pm 3.0 \%$
Cooling air mass flow rate of condenser	$\pm 4.0 \%$	$\pm 5.0 \%$
Cooling or heating medium mass flow rate	$\pm 2.0 \%$	$\pm 3.0 \%$
Rotational speed of compressor (except closed type)	$\pm 1.0 \%$	$\pm 1.5 \%$
Electric source voltage	$\pm 3.0 \%$	$\pm 4.0 \%$

- (3) The cooling and heating medium of the heat exchanger shall be the specified medium or that of the same as this in its type and properties substantially.
- (4) The tests shall be carried out not only on one of the three refrigerating capacities of refrigerating system specified in (2) to (4) of 2., which is testable actually and most conformable to the intended use, but also on the electric power consumption.
- (5) In order to obtain the refrigerating capacity and electric power consumption under the specified conditions, the tests shall be carried out twice under the same conditions as the objects. In each test, take readings three times or over at an interval of 10 min to 20 min periodically, and the results shall be calculated from the arithmetic mean of the readouts of each item. However, when two types of tests, direct and indirect methods, are carried out at the same time, results may be calculated from these tests performed once.