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**Testing methods of refrigerant
condensing units**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Society of Refrigerating and Air Conditioning Engineers (JSRAE)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS B 8623**:2002), which has been technically revised.

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Testing methods of refrigerant condensing units

1 Scope

This Japanese Industrial Standard specifies testing methods for determining, by use of a refrigerant, the refrigerating capacity and power consumption of a refrigerant condensing unit which utilizes as its refrigerant inert fluorocarbons including non-azeotropic mixed refrigerants, and CO₂.

The refrigerant condensing units covered by this Standard consists of a displacement compressor, condenser or gas cooler (hereafter referred to as condenser etc.) and accessories such as a receiver.

This Standard does not apply to room air conditioners, car air conditioners, or other condensing units manufactured integral with specific evaporators.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS B 8606 *Testing of refrigerant compressors*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

Pressure requirements in this Standard are given in absolute pressure unless otherwise indicated.

3.1

refrigerating capacity

product of the refrigerant mass flow rate per unit of time and the difference between the specific enthalpy of the liquid refrigerant leaving the condensing unit and the specific enthalpy of the refrigerant vapour entering the condensing unit

3.2

power consumption

electric power input at the condensing unit

NOTE This includes the power which auxiliaries necessary for maintaining the operation of condensing units such as lubricating oil pumps and air-cooled condensers consume.

3.3

steady state

state in which the indications of significant instruments are observed not to vary by more than the maximum permissible variations given in Table 4 by continuous monitoring during warm-up period or all through testing including the warm-up period

3.4

circulated oil content

in mixture of refrigerant and lubricating oil circulated within the cycle during the test, the ratio of the mass of lubricating oil to the mass of the mixture

3.5

displacement compressor

compressor that increases the pressure of gas inside the compression chamber by changing the internal volume of the compression chamber

NOTE A displacement compressor may be of reciprocating type, rotary type or other types.

3.6

condenser

heat exchanger which cools, with air or water, a high-temperature and high-pressure refrigerant (gas) compressed by a compressor, thereby condensing (liquefying) the refrigerant

3.7

gas cooler

heat exchanger which cools, with air or water, a high-temperature and high-pressure refrigerant (gas) compressed by a compressor, thereby forcing the refrigerant to dissipate heat

NOTE Gas coolers are distinguished from condensers in that in gas coolers, CO₂ refrigerant is not condensed (liquefied) depending on the air or water condition due to the CO₂ refrigerant having a critical temperature of about 31 °C.

3.8

air-cooled

type of condenser etc. that is cooled by air

3.9

water-cooled

type of condenser etc. that is cooled by water

3.10

supercritical

state in which a refrigerant at a temperature and pressure exceeding the critical point no longer condenses (liquefies) by further increase in pressure

3.11

non-azeotropic mixed refrigerant

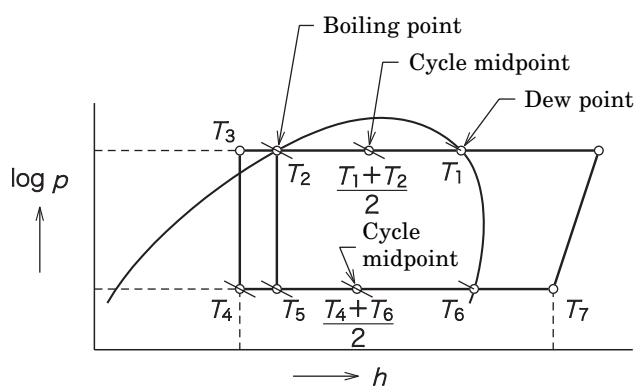
mixed refrigerant whose evaporation starting temperature (boiling point) and ending temperature (dew point) differ by 1 °C or more under standard atmospheric pressure

3.12

cycle midpoint method

method which specifies the condensing temperature and the saturation temperature corresponding to the suction pressure of a non-azeotropic mixed refrigerant as follows:

- condensing temperature** mean value of the dew point temperature, T_1 , under the refrigerant gas pressure at the condenser inlet and the boiling temperature, T_2 , under the refrigerant pressure at the condenser outlet, as shown in Figure 1
- saturation temperature corresponding to suction pressure** mean value of temperatures T_4 and T_6 , where T_4 is the temperature at the intersection of the isenthalpic line of the liquid refrigerant temperature at the condensing unit outlet and the suction gas pressure of the condensing unit, and T_6 is the dew point temperature under the suction gas pressure of the condensing unit, as shown in Figure 1



Condensing temperature (°C)	$(T_1 + T_2)/2$
Saturation temperature corresponding to suction pressure (°C)	$(T_4 + T_6)/2$
Degree of superheat of suction gas (°C)	$T_7 - T_6$

Figure 1 Temperature and degree of superheat of non-azeotropic mixed refrigerant

4 Symbols of quantities and units

The symbols of quantities used in this Standard, their definitions and units shall be as given in Table 1.

Table 1 Symbols of quantities, their definitions and units

Symbol	Definition	Unit
c	specific heat of heating medium	$\text{kJ}/(\text{kg} \cdot \text{K})$
c_o	specific heat of oil	$\text{kJ}/(\text{kg} \cdot \text{K})$
F_1	heat leakage factor	kW/K
h_{f1}	specific enthalpy of refrigerant liquid at the outlet of condensing unit	kJ/kg
h_{f2}	specific enthalpy of refrigerant liquid at the inlet of expansion valve	kJ/kg
h_{f3}	specific enthalpy of refrigerant liquid at the outlet of water-cooled condenser or that of refrigerant at the outlet of water-cooled gas cooler	kJ/kg

Table 1 (concluded)

Symbol	Definition	Unit
h_{g1}	specific enthalpy of refrigerant vapour at the inlet of condensing unit	kJ/kg
h_{g2}	specific enthalpy of refrigerant at the outlet of calorimeter	kJ/kg
h_{g3}	specific enthalpy of refrigerant at the inlet of water-cooled condenser etc.	kJ/kg
P	power consumption of condensing unit	kW
p	pressure of refrigerant	Pa
q_{ml}	mass flow rate of heating medium	kg/s
q_{mc}	mass flow rate of cooling water	kg/s
q_{mf}	mass flow rate of refrigerant, as determined by test	kg/s
q_v	volume flow rate of mixture of refrigerant and oil	m ³ /s
t_a	ambient air temperature	°C
t_c	average surface temperature of calorimeter	°C
t_f	temperature of saturated refrigerant corresponding to pressure of refrigerant at the outlet of condensing unit or temperature of the outlet of condensing unit (in the case of supercritical fluid)	°C
t_g	temperature of refrigerant vapour at the inlet of condensing unit	°C
t_p	temperature of saturated refrigerant corresponding to pressure of the secondary fluid	°C
t_r	temperature of saturated refrigerant corresponding to pressure of refrigerant in water-cooled condenser or temperature of the outlet of water-cooled gas cooler (in the case of supercritical fluid)	°C
t_1	temperature of heating medium or cooling water at the inlet of calorimeter	°C
t_2	temperature of heating medium or cooling water at the outlet of calorimeter	°C
x	circulated oil content	—
ρ	density of liquid refrigerant	kg/m ³
ρ_o	density of oil	kg/m ³
ϕ_o	refrigerating capacity of the condensing unit	kW
ϕ_h	heat input to the calorimeter when determining heat leakage factor of calorimeter	kW
ϕ_1	heat input to the calorimeter when determining refrigerating capacity	kW
T_1	dew point temperature of inlet of condenser at the refrigerant gas pressure	°C
T_2	boiling point temperature of outlet of condenser at the refrigerant pressure	°C
T_3	liquid refrigerant temperature at the outlet of condensing unit	°C
T_4	temperature at the intersection of the isenthalpic line of the liquid refrigerant temperature at the outlet of condensing unit and the suction gas pressure of the condensing unit	°C
T_5	temperature at the intersection of the isenthalpic line of the boiling temperature at the refrigerant pressure at the condenser outlet and the suction gas pressure of the condensing unit	°C
T_6	dew point temperature of condensing unit at the suction gas pressure	°C
T_7	suction gas temperature of condensing unit	°C
The units used for temperature and differential temperature are °C and K, respectively.		

5 Tests

5.1 Test methods

A suitable test method selected from among the following five shall be used.

- a) Secondary fluid calorimeter method (Method A)
- b) Dry system refrigerant calorimeter method (Method C)
- c) Refrigerant vapour flowmeter method (Method D1)
- d) Refrigerant liquid flowmeter method (Method F)
- e) Water-cooled condenser method (Method G)

The parenthesised designations correspond to the test methods given in **JIS B 8606**.

5.2 Preparation for test

The following preparation shall be made prior to the test.

- a) Set up the condensing unit under test with all the auxiliary equipment required for normal operation.
- b) Purge non-condensable gas from the refrigerating cycle of the condensing unit and the test system, and fill the cycle with refrigerant and lubricating oil specified by the manufacturer.
- c) Make sure that there is no leakage of refrigerant from the condensing unit and test system.
- d) If the discharge of lubricating oil from the condensing unit is not confirmed to be less than 1.5 % of the mass flow rate of the refrigerant, determine the circulated oil content by the method specified in Annex A or Annex B, or by other method whose accuracy of measurement is equal to or better than these, and correct for the effect of the lubricating oil on the refrigerating capacity. This correction is unnecessary for the secondary fluid calorimeter method (Method A), dry system refrigerant calorimeter method (Method C), and water-cooled condenser method (Method G), in which circulation of lubricating oil does not affect test results.

5.3 Instruments used in testing

The instruments used in testing shall be as follows.

- a) **Measuring points** The instruments shall be mounted at the following points.
 - 1) Pressure and temperature at the inlet of the condensing unit shall be measured at a position in the upstream of the inlet of the condensing unit and on straight run of piping (without steps), at a distance equal to at least eight times the outside diameter of piping from the inlet of the condensing unit, or from the inlet of a stop valve if provided. If this measuring point is infeasible due to construction of auxiliary equipment, any position at a distance of at least four times the piping outside diameter and not less than 150 mm from the inlet of the condensing unit, where influence of heat from the condensing unit is negligible, may be selected.
 - 2) Pressure and temperature at the outlet of the condensing unit shall be measured at a point that is at a distance equal to at least four times the piping outside

diameter and not less than 150 mm from the outlet of the condensing unit, or from the outlet of a stop valve if provided, where influence of heat from the condensing unit is negligible.

- b) **Uncertainty of measurement** All the instruments used for testing shall have been calibrated. Uncertainty of measurement should be within the values given in Table 2.

NOTE Calibration may be performed by the manufacturers themselves.

Table 2 Uncertainty of measurement

Category	Measured item	Uncertainty of measurement ^{a)}
Temperature	Temperature of heating medium of calorimeter or cooling water	0.1 °C
	Temperature of air entering the air-cooled condenser etc.	0.2 °C
Pressure	Suction pressure and discharge pressure (absolute pressure readings)	1.0 %
	Other pressures (absolute pressure readings)	2.0 %
Flow rate	Liquid refrigerant and cooling water	1.0 %
	Gas refrigerant	2.0 %
Mass	Mass of refrigerant, lubricating oil, etc.	1.0 %
Electric instrument	Indicating type	0.5 %
	Integrating type	0.5 %
Note ^{a)} Estimated interval containing the true value of the measurand at a confidence level of 95 % (see ISO/IEC Guide 98-3:2008).		

5.4 Test conditions

Test conditions shall be selected from rated temperature conditions classified into Divisions A to D as given in Table 3 or as agreed between the parties concerned with delivery. In the case of non-azeotropic mixed refrigerant, condensing temperature, saturation temperature corresponding to suction pressure, and degree of superheat of suction gas (temperature) shall be in accordance with the cycle midpoint method.

Table 3 Rated temperature conditions

Class	Saturation temperature corresponding to suction pressure (°C)	Suction gas			Water-cooled ^{a)}						Temperature of air entering air-cooled condenser etc. (°C)	Ambient air temperature (°C)
		Degree of superheat (K)	Temperature (°C)		Condensing temperature (°C)				Temperature of cooling water of condenser etc. (°C)			
			I	II	III	I	II	III	IV	Inlet		
A	5	10	18	—	35	40	45	50	32	37	32	32
B	-10	10	18	—	35	40	45	50	32	37	32	32
C	-40	10	18	-20	35	40	45	50	32	37	32	32
D	-60	10	18	-20	35	40	45	50	32	37	32	32
NOTE Ambient air temperature is the temperature of air surrounding the equipment.												
Note ^{a)} For water-cooled system, either of the two criteria, condensing temperature or temperature of cooling water of condenser etc. (inlet/outlet), may be selected.												