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Centrifugal water chillers

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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 The Japan Refrigeration and Air Conditioning Industry Association (JRAIA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS B 8621**:2011 is replaced with this Standard.

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Centrifugal water chillers

1 Scope

This Japanese Industrial Standard specifies requirements for the centrifugal water chillers (hereafter referred to as chillers) which perform cooling or heating of water by the refrigerating cycle consisting of a centrifugal compressor, compressor driving motor, evaporator, water cooled condenser, auxiliary refrigerant pipings and control system. The refrigeration capacity or heat pump heating capacity covered by this Standard is 150 kW and over according to the standard rating specified by this Standard.

Further, this Standard is applicable to chillers for use with a functional refrigerant having a saturation vapour pressure of not more than 3 MPa at the temperature of 35 °C; those chillers which depends on use of brine other than water to perform cooling and heating, or chillers intended for drinking water are not covered by this Standard.

NOTE All pressures indicated in this Standard are gauge pressures.

2 Normative references

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

JIS B 8240 *Construction of pressure vessels for refrigeration*

JIS Z 8731 *Acoustics—Description and measurement of environmental noise*

3 Terms and definitions

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

3.1

rating

characteristics of the chiller when it is operated under the prescribed manufacture standard conditions

There are standard rating and non-standard rating.

3.2

standard rating

rating where the manufacture standard conditions of the chiller are standard rating conditions

3.3

non-standard rating

rating where the manufacture standard conditions of the chiller are non-standard rating conditions

3.4

rated refrigeration capacity

heat quantity, in kW, which is removed from the cold water passing through the evaporator when the chiller is operated at the standard rating conditions or non-standard rating conditions

In the case of heat pump heating exclusive type, it is called the heat source refrigeration capacity, and in the case of heat recovery type, it is called the heat recovery refrigeration capacity.

3.5

rated refrigeration required input

electric power, in kW, consumed by the compressor driving motor and auxiliary devices during operation of the chiller at rating conditions

The power consumption of auxiliary devices includes the power consumption by the oil pump (if provided), inverter (if provided), and their respective control circuits that are running during operation, but does not include the power consumption by the oil heater, extraction apparatus and their control circuits.

3.6

chiller shaft power

electric power, in kW, consumed by the compressor input shaft during operation of the chiller

When a speed-up gear is provided, this value is the electric power consumed by the speed-up gears input shaft (including the coupling loss).

3.7

rated output

rated output, in kW, of the compressor driving motor

3.8

exhaust heat quantity

quantity of heat, in kW, to be exhausted to the cooling water passing through the condenser

3.9

heat pump heating

system in which the refrigerant in the evaporator absorbs heat from the water at the heat source side and then heats the hot water passing through the condenser

3.10

heat pump heating capacity

quantity of heat, in kW, with which the hot water passing through the condenser is heated when the chiller is operated under the heat pump heating condition

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3.11

heat pump required input

electric power, in kW, which is consumed by the compressor driving motor and auxiliary devices when the chiller is operated under the heat pump heating condition

The power consumption of the auxiliary devices includes the power consumption by the oil pump (if provided), inverter (if provided), and their control circuits that are running during the operation, but does not include the power consumption by the oil heater, extraction apparatus and their control circuits.

3.12

heat pump shaft power

electric power, in kW, which is consumed by a compressor input shaft when the chiller is operated under the heat pump heating condition

When a speed-up gear is provided, this value is the power consumption by the speed-up gear input shaft (including coupling loss).

3.13

minimum capacity

minimum refrigeration capacity or heat pump heating capacity, in kW, that can be controlled by capacity control function

It may be expressed by the rated capacity ratio %.

3.14

rated flow rate

flow rate of water passing through a chiller when the chiller is operated at the rating conditions

It is expressed in the unit of L/s, L/min or m³/h.

3.15

cooling water

water passed through the condenser to exhaust heat from the chiller

3.16

cold water

water passed through the evaporator to be cooled by the chiller

3.17

hot water

water passed through the condenser to be heated by the chiller during heat pump heating operation

3.18

power source water

water passed through the evaporator for recovery of heat during heat pump heating operation

3.19

rated pressure loss

difference of pressure, in kPa, between entering water and leaving water when water is passed through an evaporator or a condenser at the rated flow rate

3.20

hermetic type

hermetic structure in which the compressor, motor, speed-up gears, etc. can be operated in the same refrigerant atmosphere

3.21

open type

structure in which the moving part of the compressor or speed-up gears is connected to the outside motor through a coupling or shaft seal apparatus

3.22

extraction apparatus

apparatus which removes non-condensed gas, water vapour, etc. from the inside of the chiller

It is provided in chillers whose inside pressure is not more than the atmospheric pressure during operation.

3.23

surface contamination factor

thermal resistance, in $\text{m}^2 \text{K/kW}$, due to the contamination (adherence of fur, scale, etc.) of the heating surface

3.24

type inspection

inspection on function and performance, carried out for each model of products produced by the same manufacturer

3.25

delivery inspection

inspection performed on delivery of a product which is identical in design and manufacture to those verified to satisfy individual manufacture standards or accepted in the type inspection

3.26

Coefficient of Performance (COP)

Either of the following:

- a) **For refrigeration exclusive type, heat pump heating exclusive type and switchable type** The value of the refrigeration capacity or heat pump heating capacity divided by the refrigeration required input or heat pump required input.

- b) **For heat recovery type (refrigeration-heating simultaneous operation type)**
The total of the refrigeration capacity and the heat pump heating capacity divided by the heat pump required input.

3.27

agreed value

value agreed between the interested parties, normally indicated in the specification document

3.28

load factor

ratio of the refrigeration load of the equipment at the use side to the rated refrigeration capacity of the chiller

3.29

part load value

ratio of the total quantity of heat that the chiller refrigerates throughout the refrigeration operation period to the total power it consumes in the same period

It is a coefficient to factor in the variation during the considered period, calculated based on load points 100 %, 75 %, 50 % and 25 % with the cooling water condition and weighting factor assigned to each load point.

3.30

Integrated Part Load Value (IPLV)

part load value of a chiller at standard rating conditions

3.31

Non-standard Part Load Value (NPLV)

part load value of a chiller at non-standard rating conditions

3.32

heat balance

rate, in %, of the exhaust heat quantity (or the total of the exhaust heat quantity and the heat pump heating capacity) to the total of the refrigeration capacity and the required input

4 Types and standard composition

4.1 Types

The types of chillers shall be as follows.

a) **Types by function**

- 1) **Refrigeration exclusive type**
- 2) **Switchable type**, switchable between refrigeration exclusive operation and heat pump heating exclusive operation.

- 3) **Heat recovery type (refrigeration-heating simultaneous operation type)**, in which refrigeration and heat pump heating are simultaneously carried out, and which can also be switched to refrigeration-exclusive operation.
- 4) **Heat pump heating exclusive type**
- b) **Heat exchange system of condenser** Water cooling system
- c) **Types by the configuration of compressor, heat exchanger, etc.**
 - 1) **Integral type**, in which the main devices are integrally constructed on a common bed or a heat exchanger.
 - 2) **Separate type**, in which the compressor, heat exchanger, and other devices are constructed on separate foundations and connected by piping.
- d) **Drive unit of compressor** Motor-driven
- e) **Types by the structure of compressor**
 - 1) **Hermetic type**
 - 2) **Open type**
- f) **Types by the speed control system of compressor driving motor**
 - 1) **Constant speed type**
 - 2) **Variable speed type** (inverter control system, etc.)

4.2 Standard composition

The standard composition of the chiller shall be as follows.

- a) **Compressor** The single-stage or multiple-stage centrifugal type compressor, provided with the capacity control function for part load operation.
- b) **Driving unit**
 - 1) **Hermetic type** The motor and, if necessary, speed-up gears, etc. are integral with the compressor.
 - 2) **Open type** The motor and, if necessary, speed-up gears, etc. are independent from a compressor.
- c) **Lubricating system** If necessary, a lubricating system is provided in a compressor, motor, or other devices.
- d) **Condenser** The heat exchanger between refrigerant and cooling water or between refrigerant and hot water. The design pressure of cooling water side or hot water side shall be 0.7 MPa in principle.
- e) **Evaporator** The heat exchanger between refrigerant and cold water. The design pressure at the cold water side shall be 0.7 MPa in principle.
- f) **Refrigerant pressure relief device** If required, a safety valve, bursting disc or the like shall be provided.
- g) **Refrigerant flow rate control device** The refrigerant flow rate control device such as an expansion valve, orifice or the like shall be provided.

h) **Control equipment** The following devices for safety function, operation control function, etc. shall be provided.

1) **Safety function**

- 1.1) Refrigerant high pressure shutoff function
- 1.2) Cold water anti-icing function (cold water low-temperature shutoff function, refrigerant low-temperature shutoff function, refrigerant low-pressure shutoff function, etc.)
- 1.3) Cold water pump interlock or cold water suspension/reduction shutoff function
- 1.4) Cooling water pump interlock or cooling water suspension/reduction shutoff function
- 1.5) Oil pressure reduction shutoff function (if lubricating system is provided)
- 1.6) Main motor malfunction shutoff function (including functions that respond to malfunction of starting device or inverter control device)

2) **Operation control function**

- 2.1) Cold water or hot water temperature control function
- 2.2) Main motor current restriction function
- 2.3) Main motor restart restriction function
- 2.4) Monitoring/controlling function (lamp, relay, switch, timer, terminal, required wiring, etc.)
- 2.5) Compressor speed control function (in the case of inverter control)

3) **Operation monitoring indicator**

- 3.1) Pressure indicator (evaporation, condensation, oil pressure, etc.)
- 3.2) Temperature indicator (oil temperature etc.)
- 3.3) Level monitoring window (level gauge etc.)

i) **Starting board for compressor driving motor** The starting board system can be selected from among the following upon agreement between the interested parties. The starting board shall be provided with the main contactor, starting controlling equipment, protective function and in-board wiring that are required.

- 1) Reactor starting
- 2) Star-delta starting
- 3) Korndorfer (compensator) starting
- 4) Direct starting
- 5) Inverter starting etc.

j) **Extraction apparatus**

k) **Auxiliaries**, as follows. The details are subject to the agreement between the interested parties.

- 1) Vibration control equipment and earthquake resistant equipment
- 2) Operational state monitoring device, communication device, etc.
- 3) Refrigerant and lubricating oil (initial amount required)
- 4) Name plates
- 5) Delivery documents (delivery specifications, instruction manual, procedure specifications, inspection report, etc.)

4.3 Power source

The power source shall be in accordance with Table 1.

Table 1 Standard for main motor and controlling power source

Unit: V

Frequency (Hz)	Main motor power source			Controlling power source
	High voltage (AC three phase)		Low voltage (AC three phase)	
	Class 6 000	Class 3 000	Class 400	
50	6 000, 6 600	3 000, 3 300	400, 415	100, 200
60	6 600	3 300	440	100, 110, 200, 220

5 Rating conditions

5.1 Standard rating conditions

The standard rating conditions shall be as specified in Table 2.

Table 2 Standard rating conditions

Unit: °C

Item	Use side		Exhaust heat side or power source side	
	Cold water/hot water		Cooling water/ power source water	
	Entering water temperature	Leaving water temperature	Entering water temperature	Leaving water temperature
Refrigeration capacity	(12) ^{a)}	7	32	37
Heating capacity	40	45	12	7
Surface contamination factor	0.086 m ² K/kW		0.086 m ² K/kW	
Note ^{a)} Informative value				

5.2 Non-standard rating conditions

The non-standard rating conditions are subject to agreement between the interested parties.