

Automotive parts - air conditioner

- Test method of dissipation for subcool-condenser

1. Scope

This standard specifies the method for testing heat dissipation in subcool-condensers using HFC 134a (condenser designed to have a supercooling region) used in vapor compression air conditioners for automobiles.

2. Definitions

Definitions of main terms used in this Standard shall be as follows:

a) Heat dissipation volume

The amount of heat released from the refrigerant, i.e., the sum of the condensing section heat dissipation volume and the supercooling section heat dissipation volume. Expressed in kilowatts (kW).

b) Refrigerant heat dissipation volume

The amount of heat released from the refrigerant per unit hour measured under test conditions. Expressed in kilowatts (kW).

c) Receiver

Container for liquid refrigerant in which liquid and vapor separation is performed. Various types are used, such as a receiver integrated with the condenser, a receiver separate from the condenser, and a receiver equipped with dryer and strainer (See **Figure 1**).

d) Condensing section

Portion that starts at the subcool-condenser inlet and ends immediately before the receiver inlet.

e) Supercooling section

Portion that starts at the receiver outlet and ends at the subcool-condenser outlet.

f) Condensing section heat dissipation volume

The amount of heat released from the refrigerant in the condensing section per unit hour measured under test conditions. Expressed in kilowatts (kW). Defined as the difference between the enthalpy at subcool-condenser inlet and the enthalpy at condensing section outlet on the Mollier chart, multiplied by the refrigerant flow rate. Alternatively defined as the difference between the enthalpy at the subcool-condenser inlet and the enthalpy at the intersection of the straight line that connects the inlet and the outlet of subcool-condenser and the saturated liquid line, multiplied by the refrigerant flow rate (See **Figure 2**).

g) Supercooling section heat dissipation volume

The amount of heat released from the refrigerant in the supercooling section per unit hour measured under test conditions. Expressed in kilowatts (kW). Defined as the difference between the enthalpy at the supercooling section inlet and the enthalpy at subcool-condenser outlet on the Mollier chart multiplied by the refrigerant flow rate. Alternatively defined as the difference between the enthalpy at the intersection of the straight line that connects the inlet and the outlet of subcool-condenser and the saturated liquid line and the enthalpy at subcool-condenser outlet multiplied by the refrigerant flow rate.

h) Air heat reception volume

The amount of heat received by the air per unit hour measured under test conditions. Expressed in kilowatts (kW).

i) Refrigerant pressure loss

The difference in static pressure between the refrigerant subcool-condenser inlet and outlet measured under test conditions. Expressed in kilopascals (kPa).

j) Air pressure loss

The difference in static pressure between the subcool-condenser air inlet and outlet measured under test conditions. Expressed in pascals (Pa).

k) Effective frontal area of condenser

The projected area where a tube and a fin contact with the air, thus contributing to heat exchange. Expressed in square meters (m^2).

l) Inlet air temperature

The mean inlet temperature of air that passes through the subcool-condenser. Expressed in degrees ($^{\circ}\text{C}$).

m) Condensing pressure

The mean pressure at the subcool-condenser inlet and outlet. Expressed in kilopascals (kPa).

n) Inlet wind velocity

The average velocity of air directly in front of the subcool-condenser. Expressed in meters per second (m/s).

o) Inlet superheat degree

The difference between the saturation temperature obtained from the refrigerant pressure at the subcool-condenser inlet and the actual refrigerant temperature in superheating. Expressed in degrees ($^{\circ}\text{C}$).

p) Outlet supercooling degree

The difference between the saturation temperature obtained from the refrigerant pressure at the subcool-condenser outlet and the actual refrigerant temperature in supercooling. Expressed in degrees ($^{\circ}\text{C}$).

q) Oil circulation

The mass percentage of the entire circulation volume that is comprised of oil that circulates in the refrigerating cycle together with the refrigerant. Expressed in percentage (%).

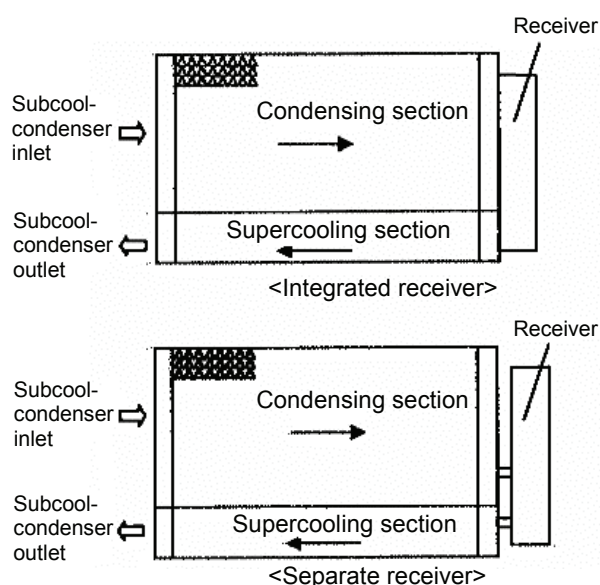


Figure 1 Subcool-condenser

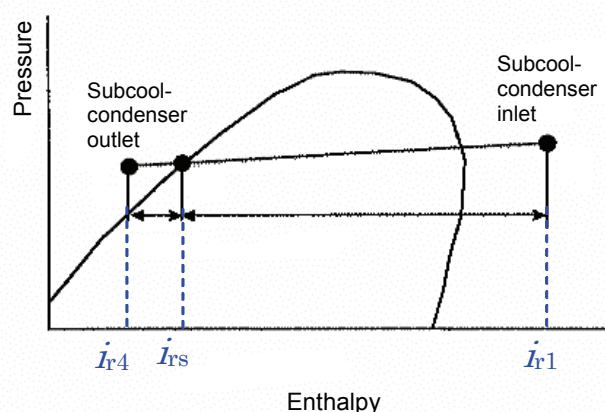


Figure 2 Definition of condensing section and supercooling section on Mollier chart

3. Test items

Tests must be carried out relating to the following items. With regard to the heat dissipation volume, calculate the following items according to the concept shown in **Figure 2** and the formulas given in **7.2**.

- a) Condensing section heat dissipation volume
- b) Supercooling section heat dissipation volume
- c) Heat dissipation volume (sum of condensing section heat dissipation volume and supercooling section heat dissipation volume)
- d) Refrigerant Pressure Loss
- e) Air Pressure Loss
- f) Outlet supercooling degree

4. Test conditions

Conditions applied for testing heat dissipation volume, refrigerant pressure loss and air pressure loss are specified in **Table 1**.

Table 1 Test Conditions

Test Conditions		Set values
Inlet air temperature	°C	35.0±0.5
Inlet wind velocity	m/s	1.0 to 5.0
Condensing pressure	kPa	1620±20
Inlet superheat degree	°C	25.0±2.0
Oil circulation	%	1.0 or less

5. Test apparatus and instruments

5.1 Test apparatus

The test apparatus shall be capable of correctly measuring the items shown in **6.1** required for determining the performance of subcool-condensers. The test apparatus largely consists of the refrigerant circuit and the air circuit (wind tunnel). An example is shown in **Figures 3** and **4**.

A single device may be used if it is furnished with both functions including the heat dissipation testing device shown in **Figure 3** and the air pressure loss testing device shown in **Figure 4**.

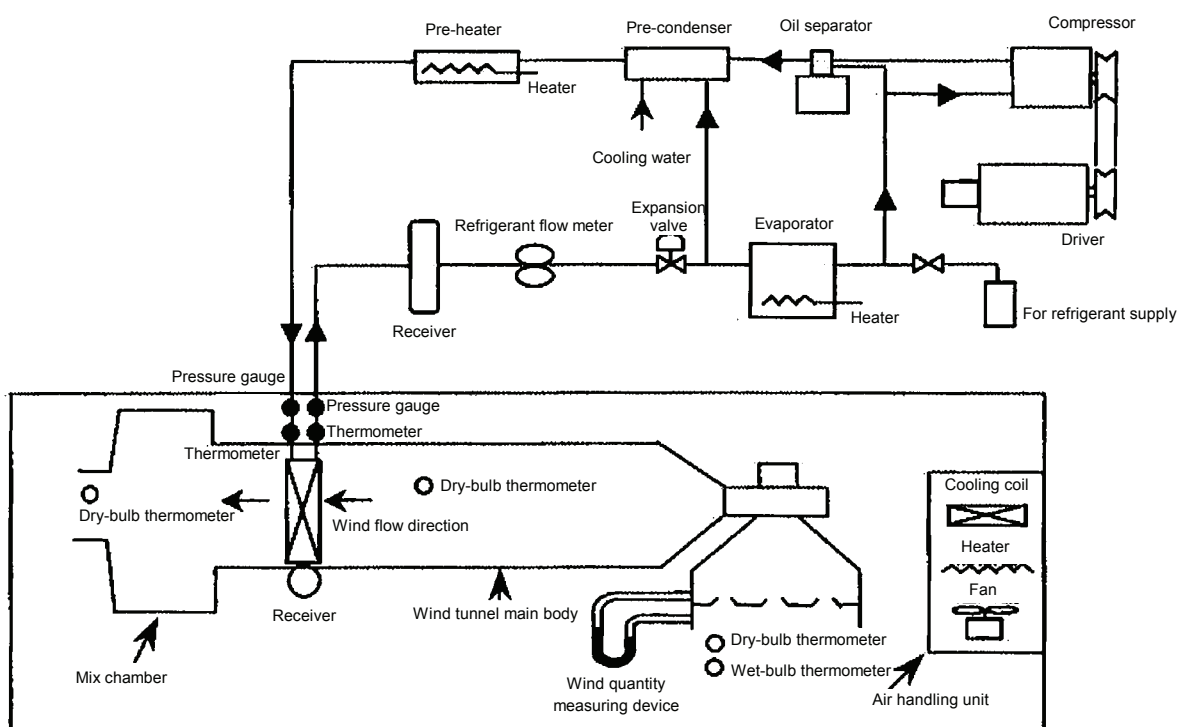


Figure 3 Heat dissipation testing device

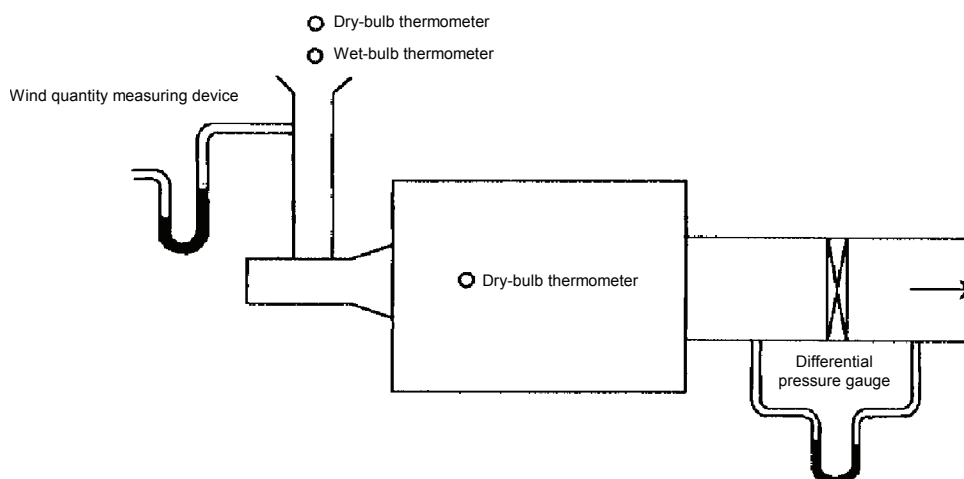


Figure 4 Air pressure loss testing device

5.1.1 Refrigerant circuit

- The apparatus must be capable of adjusting the condensing pressure and the inlet superheat degree of the subcool-condenser.
- The pre-condenser, the pre-heater, and the capacity of the expansion valve must be adjustable to the subcool-condenser capacity.
- The oil circulation of the apparatus must be adjustable within the range specified in 4.

5.1.2 Air circuit

- a) The inlet wind velocity of all subcool-condensers, regardless of size, must be adjustable within the range specified in 4.
- b) The mix chamber at the downstream of the subcool-condenser must be constructed using a heat insulated structure that minimizes the influence of the ambient temperature.

5.2 Instruments

All measurement instruments shall be calibrated prior to testing to meet the allowable margins of error shown in **Table 2**.

Table 2 Instrument accuracy

Instrument		Accuracy	
Refrigerant flow meter	%	of maximum scale value	± 0.5
Refrigerant thermometer	$^{\circ}\text{C}$		± 0.5
Air thermometer	$^{\circ}\text{C}$		± 0.2
Differential pressure gauge (nozzle)	%	of maximum scale value	± 0.5
Refrigerant pressure gauge	%	of maximum scale value	± 0.5
Air pressure gauge	%	of maximum scale value	± 0.5

6. Test and measuring methods

6.1 Test method

6.1.1 Heat dissipation test

- a) Attach the subcool-condenser to the heat dissipation testing device shown in **Figure 3**. Then, gradually increase the charge of refrigerant, and find the point at which the outlet supercooling degree exhibits a stabilizing tendency. In the stable region (which should be near the middle section of the refrigerant fill region where the supercooling degree is nearly constant), run the condenser under the conditions specified in 4, and measure the items specified in 6.1.1 b). Also measure the wind volume and the refrigerant flow rate, and calculate the subcool-condenser heat dissipation volume (condensing section heat dissipation volume, supercooling section heat dissipation volume, and the sum of the two) in accordance with 7. Use the instruments specified in **Table 2**.
- b) Perform a dummy run for 30 minutes or more under the conditions specified in 4 until a stable condition is reached. Measure until a value of $\pm 5\%$ is reached in the difference between the heat dissipation volume obtained from the refrigerant and the heat reception volume obtained from the air. Item to be measured are as follows.
- 1) Differential pressure of nozzle
 - 2) Dry and wet-bulb temperatures of nozzle inlet air
 - 3) Dry-bulb temperature of subcool-condenser inlet air
 - 4) Dry-bulb temperature of subcool-condenser outlet air
 - 5) Refrigerant temperature and pressure at subcool-condenser inlet
 - 6) Refrigerant temperature and pressure at subcool-condenser condensing section outlet⁽¹⁾
 - 7) Refrigerant temperature and pressure at subcool-condenser supercooling section inlet⁽¹⁾
 - 8) Refrigerant temperature and pressure at subcool-condenser outlet
 - 9) Refrigerant flow rate

Note:⁽¹⁾

May be omitted if measurement is not possible or not required.