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Performance of refrigerant recovery and/or recycling equipment

Performance des matériels de récupération et/ou de recyclage des fluides frigorigènes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11650 was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 8, *Refrigerants and refrigeration lubricants*.

Annexes A and B form a normative part of this International Standard.

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Performance of refrigerant recovery and/or recycling equipment

1 Scope

This International Standard specifies the test apparatus, test gas mixtures, sampling procedures and analytical techniques used to determine the performance of refrigerant recovery and/or recycling equipment (hereinafter, “equipment”).

This International Standard also specifies the refrigerants to be used for the evaluation of equipment, i.e. halogenated hydrocarbon refrigerants and blends containing halogenated hydrocarbons.

This International Standard is not intended for use as a guide in defining the maximum levels of contaminants in recycled refrigerants used in various applications.

This International Standard is not intended to define safety requirements. It is strongly recommended that the product be designed, constructed, assembled, and installed in accordance with recognized safety requirements.

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2 Terms and definitions

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

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2.1
recover
to remove refrigerant in any condition from a system and store it in an external container

2.2
recycle
to reduce contaminants in used refrigerants by separating oil, removing non-condensables, and using devices such as filter-driers to reduce moisture, acidity, and particulate matter

2.3
reclaim
to process used refrigerant to new product specifications, and to verify by chemical analysis of the refrigerant that new product specifications have been met

NOTE The identification of contaminants and required chemical analyses are specified by reference to national or International Standards for new product specifications.

2.4
standard contaminated refrigerant sample
mixture of new or reclaimed refrigerant and specified quantities of identified contaminants which constitute the mixture to be processed by the equipment under test

NOTE These contaminant levels are expected only from severe service conditions.

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2.5
recycle flow rate
amount of refrigerant processed divided by the time elapsed in the recycling mode

NOTE For equipment which uses a separate recycling sequence, the recycle rate does not include the recovery rate (or elapsed time). For equipment which does not use a separate recycling sequence, the recycle rate is a rate based solely on the higher recovery rate, of liquid or of vapour, by which the contaminant levels would have been measured.

2.6
compression-suction method
recovery method of transferring liquid refrigerant from a system to a recovery cylinder by lowering the pressure in the cylinder and raising the pressure in the system, and by connecting a separate line between the system liquid port and the cylinder

2.7
equipment
a refrigerant recovery or recycling system, including a compressor or pump or equivalent means, which is capable of recovering refrigerant to a final recovery vacuum of 100 kPa (absolute) or less without the assistance of components contained within an air-conditioning or refrigeration system

2.8
blends
refrigerants consisting of mixtures of two or more chemical compounds, often used individually as refrigerants for other applications

2.9
vapour recovery rate
the average rate that refrigerant is withdrawn from the mixing chamber between two pressures as vapour recovery rate is changing depending on the pressure

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NOTE The initial condition is vapour only at saturation pressure and a temperature at either 24 °C or at boiling point (100 kPa absolute), whichever is higher. The final-pressure condition is 15 % of the initial pressure, but not lower than the equipment final recovery vacuum and not higher than 100 kPa (absolute).

2.10
clearing equipment
the process of removing refrigerant from internal equipment volume before recovering or recycling a different refrigerant in order to minimize cross-contamination

3 Equipment requirements

3.1 Operating instructions

The equipment manufacturer shall provide operating instructions including connections, necessary maintenance procedures, and source information for replacement parts and repair. These instructions shall match those furnished to customers.

3.2 Replacement of filter/drier

If the equipment contains any filter/drier(s), the equipment shall indicate when the filter/drier(s) needs replacement. This requirement can be met by use of a sight glass/moisture indicator, by a moisture transducer and indicator light, or by some measurement of the amount of refrigerant processed such as a flow-meter or hour-meter. Written instructions such as “to change the filter every 200 kg, or every 30 days” shall not be acceptable except for systems where the filter/drier(s) are changed for every operation.

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3.3 Purge of non-condensables

If non-condensables are to be purged, the equipment shall either perform this operation automatically or provide a means to guide this process.

3.4 Purge loss

The total refrigerant loss due to purging non-condensables, draining oil, and clearing refrigerant (see 9.5) shall be less than 3 % (by mass) of total processed refrigerant.

4 Refrigerant sample

4.1 Contaminated refrigerant sample

The equipment shall be tested with a standard contaminated refrigerant sample having the characteristics specified in annex A except as provided in 4.2.

4.2 Exception

Recovery equipment not rated for any contaminant (see 9.9) shall be tested with new or reclaimed refrigerant.

5 Test apparatus

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The test apparatus is described in the following paragraphs. If alternate test apparatus are employed, the tester shall be able to demonstrate that they produce results equivalent to the specified referee apparatus.

5.1 Apparatus

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The apparatus is shown in Figure 1 and shall consist of the following.

5.1.1 Mixing chamber, consisting of a tank with a conical shaped bottom, a bottom port and conduit for delivering refrigerant to the equipment, various ports and valves for adding refrigerant to the chamber and stirring means for mixing.

5.1.2 Storage cylinder, filled (but not more than 80 % by volume) with transferred and cleaned refrigerant and at the same pressure of the recovered refrigerant at the beginning of the test.

5.1.3 Vapour-refrigerant feed means, consisting of a means of evaporation to create a 3,0 °C superheat condition at an evaporating temperature of (21 ± 2) °C, control valves and conduit.

An alternative method for vapour feed consists of passing the refrigerant through a boiler and then through an automatic pressure regulating valve, set at different saturation pressures, and thus moving the refrigerant from the saturated pressure at 24 °C to the final pressure of recovery.

5.1.4 Liquid-refrigerant feed means, consisting of control valves, sampling port and conduit.

5.1.5 Measurement instrumentation, capable of measuring mass, temperature, pressure and refrigerant loss, as required.

5.2 Size

The size of the mixing chamber, the bottom port, and the refrigerant feed means shall depend on the size of the equipment. Typically, the mixing chamber shall be 0,09 m^3. For large equipment to be used on chillers, the minimum inside diameter of ports, valves and conduit shall be the smaller of the manufacturer's recommendation or 37 mm.

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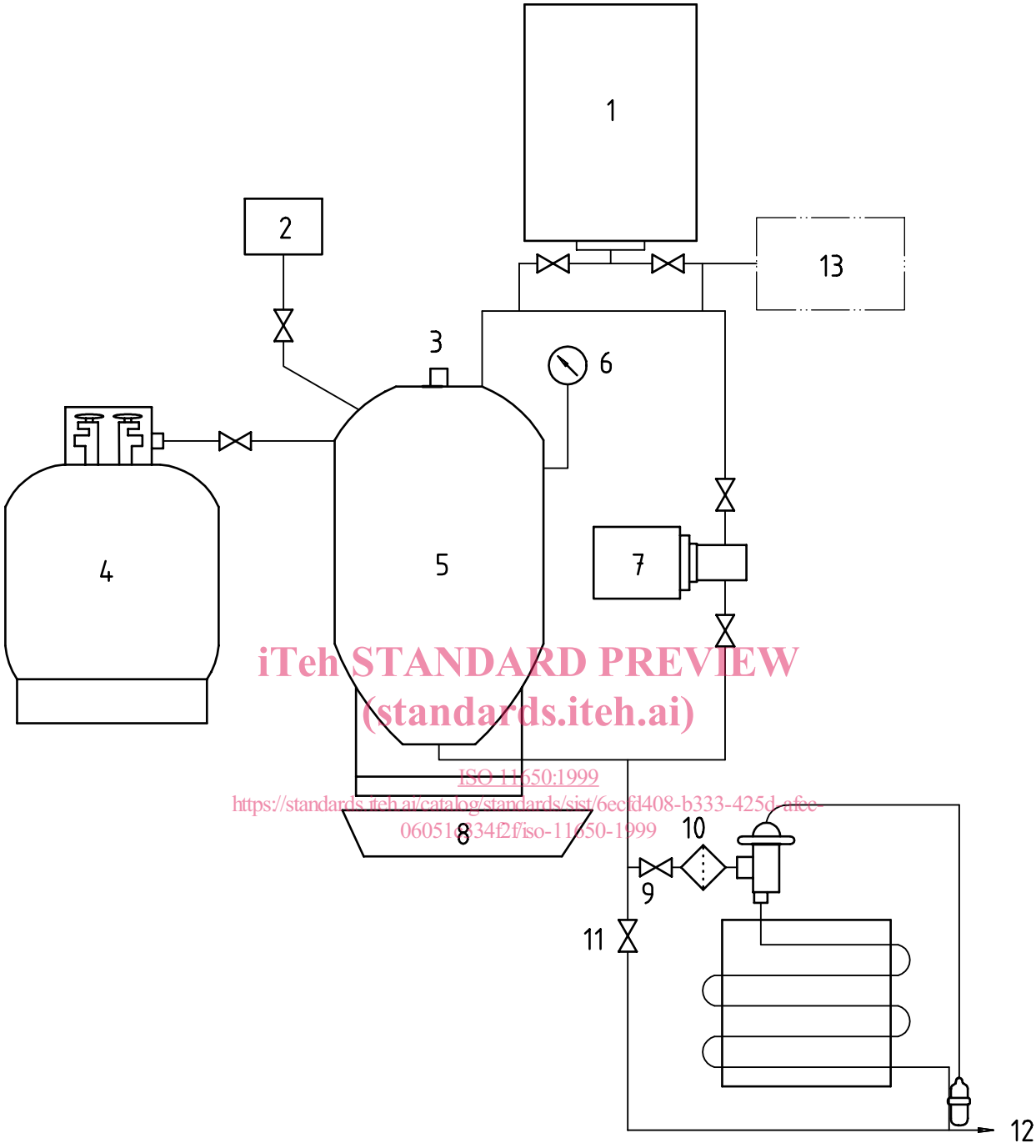

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Key

1 Moisture, particulate, acid, lubricant
2 Non-condensable gas
3 Push/pull vapour port
4 Refrigerant storage cylinder
5 Mixing chamber
6 Pressure gauge
7 Circulating pump
8 Scale
9 Vapour valve
10 Particulate filter
11 Vapour valve
12 To recovery and/or recycle unit
13 Valved membrane arrangement [a]

[a] Optional so refrigerant from circulating pump can wash the contaminants into the mixing chamber.

Figure 1 — Test apparatus

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6 Performance tests

6.1 Test conditions

The test conditions shall be as follows:

6.1.1 Temperature

Testing shall be conducted at an ambient temperature of (24 ± 1) °C. For vapour recovery, the evaporator conditions of 5.1.3 shall be maintained as long as liquid refrigerant remains in the mixing chamber.

6.1.2 Refrigerants

The equipment shall be tested for all designated refrigerants (see 10.2).

All tests in clause 6 shall be completed for each refrigerant before starting tests with the next refrigerant.

6.1.3 Selected tests

Tests shall be as appropriate for the equipment type and rating parameters selected (see 9.10, 10.1 and 10.2).

6.2 Equipment preparation and operation

The equipment shall be prepared and operated in accordance with operating instructions (see 3.1).

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6.3 Test batch

The test batch consisting of refrigerant sample (see clause 4) of the test refrigerant shall be prepared and thoroughly mixed. Continued mixing or stirring shall be required during the test while liquid refrigerant remains in the mixing chamber. The mixing chamber shall be filled to 80 % capacity by volume.

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6.4 Recovery tests (recovery and recovery/recycle equipment)

6.4.1 Determination of recovery rates

6.4.1.1 The liquid- and vapour-refrigerant recovery rates shall be measured during the first test batch for each refrigerant (see 9.1, 9.2 and 9.4).

Equipment preparation and recovery cylinder changeover shall not be included in elapsed time measurements for determining the liquid- and vapour-refrigerant recovery rates. Operations such as to sub-cool the recovery cylinder shall be included.

6.4.1.2 If the vapour-refrigerant recovery rate is elected, the average vapour flow rate shall be measured to the accuracy specified in 9.4 under conditions with no liquid refrigerant in the mixing chamber. The liquid-recovery feed means shall be used. At initial conditions of saturated vapour, at the higher of 24 °C or the boiling temperature (100 kPa absolute), the mass of the mixing chamber and the pressure shall be recorded. At final conditions, representing pressure in the mixing chamber of 15 % of the initial condition, but no less than the final recovery vacuum (see 9.6) nor more than 100 kPa (1,0 bar), measure the mass of the mixing chamber and the elapsed time.

6.4.1.3 If the liquid-refrigerant recovery rate is elected, the recovery rate using the liquid-refrigerant feed means (see 5.1.4) shall be determined. After the equipment reaches stabilized conditions of condensing temperature and/or recovery cylinder pressure, stop the recovery process and measure the initial mass of the mixing chamber (see 9.2). Continue the recovery process for a period of time sufficient to achieve the accuracy specified in 9.4. Stop the recovery process and measure the final mass of the mixing chamber.

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6.4.2 Oil draining

Capture oil from the equipment at intervals as required in the instructions. Record the mass of the container. Completely remove refrigerant from oil by evacuation or other appropriate means. The mass difference shall be used in 9.5.

6.4.3 Final recovery vacuum

At the end of the first test batch for each refrigerant, close the liquid and vapour valves of the apparatus. After waiting 1 min, record the pressure of the mixing chamber (see 9.6).

6.4.4 Trapped refrigerant

6.4.4.1 This test evaluates the mass of refrigerant trapped in the equipment after operation and the potential for mixing refrigerants.

6.4.4.2 At the end of the last test for each batch for each refrigerant, the equipment (2.7) shall be disconnected from the test apparatus (Figure 1). Recycle the refrigerant in accordance with 6.5, if appropriate. Clear refrigerant from the equipment as described in the instruction manual. Capture and record any refrigerant which may have been emitted to the atmosphere while clearing the equipment for use in 9.5. If two loops are used for recycling, measure any trapped refrigerant for both.

6.4.4.3 Evacuate an empty test cylinder to 1 kPa (0,01 bar) absolute. Record the empty mass of the test cylinder. Place the test cylinder into a dry-ice bath for a period of 30 min. Open all valves to the equipment so as to provide access to all trapped refrigerant. Connect the equipment to the test cylinder and operate the valves to recover the trapped refrigerant. Record the mass of the test cylinder.

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6.4.5 Cross-contamination

For equipment rated for multiple refrigerants, this test evaluates the cross-contamination when changing refrigerant types. Use the same initial conditions as described in 6.4.4.2. Process a quantity of the next refrigerant (no contaminants) equal to one half the vapour-refrigerant recovery rate (hourly), but no less than 10 kg through the equipment. Analyse the processed refrigerant for presence of the first refrigerant using gas chromatography.

6.5 Recycling tests (recovery/recycle and recycle equipment)

6.5.1 Recycle operation

6.5.1.1 As each recovery cylinder is filled in 6.4.2, recycle the refrigerant contents according to operating instructions. Note any non-condensable purge measurement in 9.5.

NOTE There will not necessarily be a separate recycling sequence.

6.5.1.2 While recycling the first recovery cylinder for each refrigerant, the recycling flow rate shall be determined by appropriate means (see 9.3) to achieve the accuracy specified in 9.4.

6.5.2 Non-condensable sample

After completing 6.4.3, prepare a second test batch (see 6.3). Recover the refrigerant in accordance with 6.4.2 until the current recovery cylinder is filled to 80 % capacity by volume. Recycle the refrigerant in accordance with 6.5.1. Mark this cylinder and set it aside for taking the vapour sample in 7.3. For equipment with an internal tank of at least 3 kg refrigerant capacity and an external recovery cylinder, mark two recovery cylinders and set them aside. The first shall correspond to the aforementioned cylinder. The second shall correspond to a recovery cylinder, filled with refrigerant to 80 % capacity by volume, and recycled.

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6.5.3 Liquid sample for analysis

6.5.3.1 Repeat steps 6.3, 6.4.2 and 6.5.1 with further test batches until indication that the filter/drier(s) need replacing (see 3.2).

6.5.3.2 For equipment with a separate recycling circuit (multiple pass), set aside the current cylinder and draw the liquid sample (see 7.4) from the previous cylinder.

6.5.3.3 For equipment with a single-pass recycling circuit, draw the liquid sample (see 7.4) from the current cylinder.

6.6 Measuring refrigerant loss

Determine refrigerant loss due to non-condensables using the appropriate means (see 9.5.2).

NOTE Loss can occur in 6.4.1, 6.4.2 and 6.5.1.

7 Sampling procedures

7.1 Representative sample

Special precautions should be taken to make sure representative samples are obtained for analysis. Sampling shall be performed by trained laboratory personnel following accepted sampling procedures.

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7.2 Cylinders and cleaning instructions

The stainless steel test cylinder (approximately 500 ml capacity with valves at each end) shall be prepared as follows for obtaining vapour and liquid phase samples:

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a) clean the test cylinder (with valves) with 5 ml to 20 ml portions of reagent grade 1,1,1-trichloroethane or a suitable solvent;

b) purge the test cylinder with dry nitrogen containing not more than 3×10^{-4} % (3 ppm) of water;

c) with valves open, place the test cylinder and connecting tubing in an oven at approximately 110 °C for 1 h;

d) immediately after, connect copper tubing and the test cylinder assembly to the recovery cylinder, from which the sample is to be drawn, and to an evacuation system then evacuate the entire system to less than 0,133 kPa.

7.3 Vapour phase sample

At least one vapour phase sample shall be obtained for determining the non-condensables. Draw samples from recovery cylinders identified in 6.5.2. Store the cylinders for at least 24 h at 21 °C before taking the samples. The sample content shall be the minimum required for analysis. Non-condensable determination is not required for refrigerants R-11 and R-113 because they have normal boiling points at or above room temperature.

7.4 Liquid phase sample

A liquid phase sample is required for all tests except the test for non-condensables. The test cylinder shall not be loaded over 80 % capacity at room temperature. This can be accomplished by weighing the empty test cylinder and then the cylinder with refrigerant. The test cylinder shall not become completely full of liquid below 55 °C. Prior to drawing the liquid phase sample, agitate the storage container to thoroughly mix the contaminants. When the desired amount of refrigerant has been collected, close the valves and the sample cylinder immediately. Record the gross mass.

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