

**7.4.1.2 Vapor Refrigerant Recovery Rate.** If elected, the average vapor flow rate shall be measured to accuracy requirements in clause 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 vapor at the higher of 24°C or the boiling temperature (100 kPa absolute pressure), the weight of the mixing chamber and the pressure shall be recorded. At final conditions representing pressure in the mixing chamber of 10% of the initial condition, but not less than the final recovery vacuum (see 9.6) nor more than 100 kPa, measure the weight of the mixing chamber and the elapsed time.

**7.4.1.3 High Temperature Vapor Recovery Rate.** Applicable for equipment having at least one designated refrigerant (see 11.2) with a boiling point between -50°C and +10°C. Measure the rate for R-22, or the refrigerant with the lowest boiling point if R-22 is not a designated refrigerant. Repeat the test in 7.4.1.2 at saturated conditions at 40°C and continue to operate equipment to assure it will achieve the final recovery vacuum (see 7.4.3).

**7.4.2 Recovery Operation.** This test is for determining the final recovery vacuum and the ability to remove contaminants as appropriate. If equipment is rated for liquid recovery (see 7.4.1.3), liquid recovery feed means described in 6.2.5 shall be used. If not, vapor recovery means described in 6.2.3 or 6.2.4 shall be used. Continue recovery operation until all liquid is removed from the test apparatus and vapor is removed to the point where equipment shuts down by automatic means or is manually shut off per operating instructions.

**7.4.2.1 Oil Draining.** Capture oil from the equipment at intervals as required in the instructions. Record the weight of the container. Completely remove refrigerant from oil by evacuation or other appropriate means. The weight difference shall be used in 9.5.2.

**7.4.3 Final Recovery Vacuum.** At the end of the first test batch for each refrigerant, the liquid valve and vapor valve of the apparatus shall be closed. After waiting 1 minute, the mixing chamber pressure shall be recorded (see 9.6).

**7.4.4 Residual Refrigerant.** This test will measure the mass of remaining refrigerant in the equipment after clearing and therefore the potential for mixing refrigerants (see 4.6).

**7.4.4.1 Initial Conditions.** At the end of the last test for each batch for each refrigerant, the equipment shall be disconnected from the test apparatus (Figure 1). Recycle per 7.5, if appropriate. Perform refrigerant clearing operations as called for in the instruction manual. Capture and record the weight of any refrigerant which would have been emitted to the atmosphere during the clearing process for use in 9.5. If two loops are used for recycling, trapped refrigerant shall be measured for both.

**7.4.4.2 Residual Trapped Refrigerant.** Evacuate an empty test cylinder to 1.0 kPa absolute. Record the empty weight of the test cylinder. Open all valves to the equipment so as to provide access to all trapped refrigerant. Connect the equipment to the test cylinder and operate valves to recover the residual

refrigerant. Record the weight of the test cylinder using a recovery cylinder pressure no less than specified in 6.2.2. Place the test cylinder in liquid nitrogen for a period of 30 minutes or until a vacuum of 1000 microns is reached, whichever occurs first.

#### **7.5 Recycling Tests (Recovery/Recycle Equipment).**

**7.5.1 Recycling Operation.** As each recovery cylinder is filled in 7.4.2, recycle according to operating instructions. There will not necessarily be a separate recycling sequence. Note non-condensable purge measurement in 9.5.

**7.5.1.1 Recycle Flow Rate.** While recycling the first recovery cylinder for each refrigerant, determine the recycling flow rate by appropriate means (see 9.3) to achieve the accuracy required in 9.4.

**7.5.2 Non-Condensable Sample.** After completing 7.4.3, prepare a second test batch (7.3). Recover per 7.4.2 until the current recovery cylinder is filled to 80% level by volume. Recycle per 7.5.1. Mark this cylinder and set aside for taking the vapor sample. For equipment having both an internal tank of at least 3 kg refrigerant capacity and an external recovery cylinder, two recovery cylinders shall be marked and set aside. The first is the cylinder described above. The second cylinder is the final recovery cylinder after filling it to 80% level by volume and recycling.

**7.5.3 Liquid Sample for Analysis.** Repeat steps 7.3, 7.4.2 and 7.5.1 with further test batches until indication means in 4.2 show the filter/drier(s) need replacing.

**7.5.3.1 Multiple Pass.** 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.

**7.5.3.2 Single Pass.** For equipment with the single pass recycling circuit, draw the liquid sample (see 7.4) from the current cylinder.

**7.6 Measuring Refrigerant Loss.** Refrigerant loss due to non-condensables shall be determined by appropriate means (see 9.5.1). The loss could occur in 7.4.1, 7.4.2 and 7.5.1.

### **Section 8. Sampling and Chemical Analysis Methods**

**8.1 Chemical Analysis.** Chemical analysis methods shall be specified in appropriate standards such as ARI 700-95 and Appendix C to ARI Standard 700-95.

#### **8.2 Refrigerant Sampling.**

**8.2.1 Water Content.** The water content in refrigerant shall be measured by the Karl Fischer Analytical Method or by the Karl Fischer Coulometric techniques. Report the moisture level in parts per million by weight.

**8.2.2 Chloride Ions.** Chloride ions shall be measured by turbidity tests. At this time, quantitative results have not been defined. Report chloride content as "pass" or "fail." In the future, when quantitative results are possible, report chloride content as parts per million by weight.

**8.2.3 Acidity.** The acidity test uses the titration principle. Report the acidity in parts per million by weight (mg KOH/kg) of sample.

**8.2.4 High Boiling Residue.** High boiling residues shall use measurement of the

volume of residue after evaporating a standard volume of refrigerant. Using weight measurement and converting to volumetric units is acceptable. Report high boiling residues as percent by volume.

**8.2.5 Particulates/Solids.** The particulates/solids measurement employs visual examination. Report results as "pass" or "fail."

**8.2.6 Non-condensables.** The level of contamination by non-condensable gases in the base refrigerant being recycled shall be determined by gas chromatography. Report results as percent by volume.

### **Section 9. Performance Calculation and Rating**

**9.1 Vapor Refrigerant Recovery Rate.** This rate shall be measured by weight change of the mixing chamber divided by elapsed time (see 7.4.1.2). The units shall be kg/min and the accuracy shall be per 9.4.

**9.1.1 High Temperature Vapor Recovery Rate.**

**9.2 Liquid Refrigerant Recovery Rate.** This rate shall be measured by weight change of the mixing chamber divided by elapsed time (see 7.4.1.3). The units shall be kg/min and the accuracy shall be per 9.4.

**9.3 Recycle Flow Rate.** The recycle flow rate shall be as defined in 3.10, expressed in kg/min, and the accuracy shall be per 9.4.

**9.3.1** For equipment using multi-pass recycling or a separate sequence, the recycle rate shall be determined by dividing the net weight W of the refrigerant to be recycled by the actual time T required to recycle. Any set-up or operator interruptions shall not be included in the time T.

**9.3.2** If no separate recycling sequence is used, the recycle rate shall be the higher of the vapor refrigerant recovery rate or the liquid refrigerant recovery rate. The recycle rate shall match a process which leads to contaminant levels in 9.9. Specifically, a recovery rate determined from bypassing a contaminant removal device cannot be used as a recycle rate when the contaminant levels in 9.9 are determined by passing the refrigerant through the contaminant removal device.

**9.4 Accuracy of Flow Rates.** The accuracy of test measurements in 9.1, 9.2 and 9.3 shall be  $\pm 0.08$  kg/min or flow rates up to .42 kg/min and  $\pm 2.0\%$  for flow rates larger than .42 kg/min. Ratings shall be expressed to the nearest .02 kg/min.

**9.5 Refrigerant Loss.** This calculation will be based upon the net loss of refrigerant which would have been eliminated in the non-condensable purge process (see 7.5.1), the oil draining process (see 7.4.2.1) and the refrigerant clearing process (see 7.4.4.1), all divided by the net refrigerant content of the test batches. The refrigerant loss shall not exceed 3% by weight.

**9.5.1 Non-Condensable Purge.** Evacuate an empty container to 2 kPa absolute. Record the empty weight of the container. Place the container in a dry ice bath. Connect the equipment purge connection to the container and operate purge according to operating instructions so as to capture the non-condensables and lost refrigerant. Weigh the cylinder after the recycling is complete. Equivalent means are permissible.