SAE International™

SURFACE VEHICLE STANDARD

SAE J2727

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R134a Mobile Air Conditioning System Leakage Chart

1. Scope

Current industry standards do not exist for determining refrigerant emissions from mobile air conditioning systems. Test procedures are not common between production component suppliers in establishing leakage values. This "System Leakage Chart" has been developed from industry experience of expected refrigerant leakage gains from system design resulting from technology changes. It provides a rating value of various technologies that are currently available. The "Leakage Chart" can be expanded as new technologies are offered and/or developed. This document provides the information to develop an Excel file template "Leakage Chart" for making system analysis. It is not the intent of this Standard to define the refrigerant emissions from a mobile air conditioning system. It is to only define a system rating based upon the technology used. Future development of SAE Standards for determining mobile air conditioning refrigerant emissions such as system static and dynamic min-shed test procedures will provide a procedure for determining system emissions.

1.1 Rationale

Not applicable.

2. References

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

SAE J2064—R134a Refrigerant Automotive Air-Conditioning Hose

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3. Assumptions for R134a Leakage Chart Spreadsheet

3.1 General Assumptions

3.1.1 Real world permeation rates will not be universally consistent due to: Assembly Variation, Wear and Degradation, effects of vibration, and localized temperatures.

3.1.2 The values in this spreadsheet apply to new systems as assembled in the vehicle.

3.1.3 Due to lack of standard tests, reference values used here represent agreed upon placeholders until tests are defined and evaluations are completed.

3.2 Rigid Pipe Connections

3.2.1 Fitting reference values are a function of leakage and "assembly robustness".

3.2.2 Rigid pipe connections are those tube and pipe assemblies with no hose joints. Leakage occurs only at the two fitting connections at either end.

3.3 Service Ports

Service fittings are tested with sealing caps in place.

3.4 PRV, Switches, Transducers

These devices include o-ring seals.

3.5 Flexible Hose

3.5.1 It is assumed that high-side pressure hoses permeate at twice the rate of low-side pressure hoses due to higher temperatures and pressures when in operation, but leakage is the same when the vehicle is static. Selection of hose material and construction can change the permeation rate.

3.5.1.1 The System Assumption table requires that the high-side and low-side pressure hose size and hose construction type be identified for rating the system.

3.5.2 Hose permeation rates include leakage from the tube/hose crimps.

3.5.3 SAE J2064 R134a Refrigerant Automotive Air-Conditioning Hose [published Jan 2005] identifies current industry standards.

3.5.3.1 It is assumed veneer hoses use an adhesive or O-rings or similar sealing element for crimps.

3.5.4 Flexible hose assemblies include tube, hose and crimping. Leakage occurs through the hose and at the crimps. The leakage at the tube fitting connections at either end is included in the “System Component Connection” category.

3.5.5 Hose permeation rate is a function of location, internal refrigerant temperature and pressure, material, and inner surface area.

3.6 Heat Exchangers, Mufflers and Receiver/Driers and Accumulators

3.6.1 These components are considered as robust and the Leakage Chart assigns a value of .001 for their emissions.

3.6.1.1 Refrigerant heat exchanger coupling(s) (threaded surfaces) shall meet the OEM requirements and be free of manufacturing process residue.

3.7 Compressor

3.7.1 The compressor major permeation paths are shaft seal and housing seals.

3.7.2 It is assumed that multiple lip shaft seals are better than single lip seals. Dust seals shall not count as secondary refrigerant seals unless shown to reduce leakage levels. It is assumed that gasket-housing seals are better than O-rings.

4. System Rating Values (SRV)

4.1 Five < SRV Standard Leakage

4.2 Four < SRV < Five: Leakage Enhancement I

4.3 Three < SRV < Four: Leakage Enhancement II

4.4 Two < SRV < Three: Leakage Enhancement III

4.5 One < SRV < Two: Leakage Enhancement IV

4.6 Zero < SRV < One: Leakage Enhancement V

5. Sample Sheet for R134a Leakage Chart Spreadsheet Figure 1

5.1 This provides an example rating for a refrigerant system having the following:

5.2 Rigid Pipe Connections and Flexible Hose Connections

9 single o-rings
1 single captured o-ring
2 seal washer

5.3 Service Ports

1 high side single o-ring
1 low side single o-ring

5.4 PRV, Switches, Transducers

2 single o-ring
1 single captured o-ring

5.5 Flexible Hose

1 high pressure line 650 mm length 10 mm diameter standard barrier material
1 low pressure line 650 mm length 16 mm diameter rubber hose

5.6 Compressor

Single lip shaft seal and body o-rings

5.7 This system configuration has a rating of 5.6 indicating that the expected leakage rating is slightly higher that an average system.

6. Spreadsheet Formulas

Since a spread sheet cannot be include in this document the typical layout is identified in Figure 2 and the formulas for developing the system assumption are identified in this section.

6.1 Fittings

6.1.1 Line H7 =(B6*B7+C6*C7+D6*D7+E6*E7+F6*F7 + G7*G6)/1000

6.1.2 Line H10 =(B9*B10+C9*C10+D9*D10+E9*E10+F9*F10 + G10*G9)/1000

6.1.3 Line H13 =(B12*B13+C12*C13+D12*D13+E12*E13+F12*F13 + G13*G12)/1000

6.1.4 Line H16 =(B15*B16+C15*C16+D15*D16+E15*E16+F15*F16 + G16*G15)/1000

6.1.5 H17 =SUM(H7:H16)

6.2 Flexible Hose

6.2.1 High pressure line 1 D22 =3.14159*2*C22/2*B22

H22 =(E22*0.09*D22+F22*0.0113*D22+G22*0.00225*D22)/1000

6.2.2 High pressure line 2 D23 =3.14159*2*C23/2*B23

H23 =(E23*0.09*D23+F23*0.0113*D23+G23*0.00225*D23)/1000

6.2.3 High pressure line 3 D24 =3.14159*2*C24/2*B24

H24 =(E24*0.09*D24+F24*0.0113*D24+G24*0.00225*D24)/1000

6.2.4 High pressure line 4 D25 =3.14159*2*C25/2*B25

H25 =(E25*0.09*D25+F25*0.0113*D25+G25*0.00225*D25)/1000

6.2.5 Low pressure line 1 D26 =3.14159*2*C26/2*B26

H26 =(E26*0.045*D26+F26*0.0056*D26+G26*0.00113*D26)/1000

6.2.6 Low pressure line 2 D27 =3.14159*2*C27/2*B27

H27 =(E27*0.045*D27+F27*0.0056*D27+G27*0.00113*D27)/1000

6.2.7 Low pressure line 3 D28 =3.14159*2*C28/2*B28

H28 =(E28*0.045*D28+F28*0.0056*D28+G28*0.00113*D28)/1000

6.2.8 Low pressure line 4 D29 =3.14159*2*C29/2*B29

H29 =(E29*0.045*D29+F29*0.0056*D29+G29*0.00113*D29)/1000

6.2.9 TOTAL H30 =SUM(H22:H29)

6.3 Heat Exchangers Mufflers and Receiver/Driers and Accumulators

6.3.1 Assumpiton = 0.001 H33 0.001

6.4 Compressor

6.4.1 Compressor H40 =(B39*B40+C39*C40+D39*D40+E39*E40)/1000

6.5 Summary and Pie Chart

6.5.1 Fittings B44 =H17/B51

6.5.2 Hoses B45 =H30/B51

6.5.3 Heat Exchangers B46 =H33/B51

6.5.4 Compressor B47 =H40/B51

6.5.5 Rating Value B51 =SUM(H17,H30,H33,H40)

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