



SURFACE VEHICLE STANDARD

J3094™**FEB2023**Issued 2019-02
Revised 2023-02

Superseding J3094 APR2020

Test Procedure for Internal Heat Exchangers of Mobile Air-Conditioning Systems with R-134a or R-1234yf Refrigerant

RATIONALE

This revision updates the scaling limits for IHX based on bench testing results gained with various lengths of the same cross section design from two suppliers. Results of a very short IHX of approx 206 mm revealed a linear performance scaling. Subsequently the scaling limits were modified to up to a ratio of 1.1 and down to 200 mm and the reporting template of SAE J3174 updated.

FOREWORD

This SAE Standard is developed to establish a common test procedure at the component level for internal heat exchangers (IHX) for mobile air-conditioning systems. Common procedures and test points are needed to more readily evaluate IHX designs in the industry.

1. SCOPE

The purpose of this SAE Standard is to define a common set of thermodynamic test conditions to evaluate internal heat exchangers for use with R-134a and R-1234yf refrigerants in mobile air-conditioning systems. This SAE Standard can be used to test actual vehicle IHX designs or standardized IHX samples, which can be used for comparison based on a common length and shape.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J639	Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems
SAE J2765	Procedure for Measuring System COP [Coefficient of Performance] of a Mobile Air-Conditioning System on a Test Bench
SAE J2766	Life Cycle Analysis to Estimate the CO ₂ -Equivalent Emissions from MAC Operation

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Documents

Document Sharing Hub

Seybold, L., Hill, W., Pietsch, K., and Lazaridis, I., "Comparison of Coaxial and Non-Coaxial Internal Heat Exchangers," SAE Technical Paper 2012-01-0319, 2012, <https://doi.org/10.4271/2012-01-0319>.

3. DEFINITIONS

HIGH-PRESSURE LINE (HP): Connection between the condenser outlet port and the expansion device inlet port.

INTERNAL HEAT EXCHANGER (IHX): Transfers heat from high-pressure line to low-pressure line of the A/C system. IHX can be part of the A/C suction and liquid lines, or a single component, depending on packaging and assembly requirements.

LOW-PRESSURE LINE (LP): Connection between the expansion device outlet port and the compressor inlet port.

R-1234yf: Refrigerant 2,3,3,3-Tetrafluoro-1-Propene.

R-134a: Refrigerant 1,1,1,2-Tetrafluoroethane (HFC-134a) .

REFPROP: NIST reference fluid thermodynamic and transport properties database.

4. SYMBOLS AND ABBREVIATIONS

A/C	Air conditioning
COP	Coefficient of performance
h	Enthalpy (per REFPROP Version 9 or higher)
HFC	Hydrofluorocarbons
HP	High pressure
IHX	Internal heat exchanger
LCCP	Life cycle climate performance
LP	Low pressure
OCR	Oil circulation rate
RH	Relative humidity
RT	Room temperature
TP	Test point
η_h	Effectiveness (based on enthalpies)
$\dot{Q}$	Heat transfer
$\dot{m}_R$	Refrigerant mass flow (excluding oil flow)

5. GENERAL DESCRIPTION

5.1 A typical R-134a or R-1234yf IHX assembly consists of a heat exchange section and the required line connections for the high and low side of the A/C system. It may be a standalone component & or included as part of an air-conditioning line set. This SAE Standard validates only the thermodynamic performance of the IHX design, excluding terminations and/or transitions to other components.

5.2 Coaxial Tube IHX

A typical coaxial tube IHX consists of an inner tube, referred to as the low-pressure suction line, and outer tubes, referred to as part of the high-pressure liquid line. Figure 1 shows a cross section of a typical coaxial tube IHX.

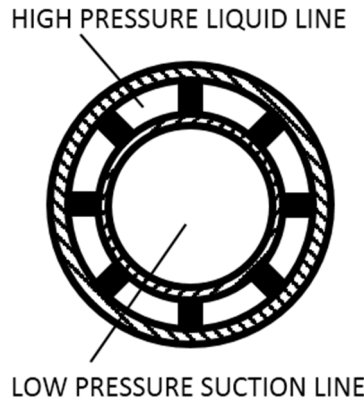


Figure 1

5.2.1 Line Separator Blocks

The shape and size of the line separator blocks (the features used to separate the high- and low-pressure portions of the IHX back into their respective lines) are not specified in this document, and generally should represent the supplier's design that is planned for production.

5.3 Non-Coaxial Tube IHX

The design of a non-coaxial tube IHX would have a heat transfer section that is not based on a coaxial tube, but allows for heat transfer in some other configuration. Figure 2 conceptually represents a non-coaxial tube IHX design without any design details. Examples of non-coaxial tube IHX are published in SAE technical paper "Comparison of Coaxial and Non-Coaxial Internal Heat Exchangers."

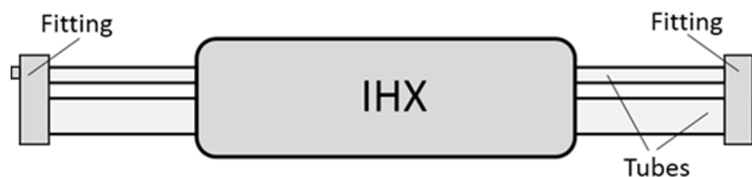


Figure 2

5.4 Test Equipment Requirements

The necessary test equipment shall be set up in accordance with SAE J2765. Instruments and sensors used for measurements shall be accurate as given in Table 1.

Table 1 - Test equipment requirements

Test Value	Allowed Measurement Uncertainty
Refrigerant temperature	± 0.2 K
Refrigerant pressure	$\leq 1.0\%$ of the reading
Refrigerant differential pressure	$\leq 1.0\%$ of the reading
Refrigerant mass flow	$\leq 1.0\%$ of the reading
Oil circulation rate	$\pm 0.2\%$ OCR

5.5 Test Sample

The IHX performance tests shall be performed at least with one test sample of the following three options: A, B, or C.

Option A: Standardized test sample for coaxial tube in tube IHX (see Figure 3). As an exception, a radius of R50 is allowed, if desired by the supplier. This deviation of the standard geometry shall be documented in the test report.

Option B: Standardized test sample for non-coaxial tube IHX (see Figure 4).

Option C: Non-standardized test sample for IHX plumbing configuration of a vehicle A/C line set assembly (production or production intent) (see Figure 5).

When using option C, the dimensions of the test sample (outer diameters, inner diameters, IHX center line length) and the location of the test points (TP) shall be documented in the test report. Depending on the IHX assembly configuration in a vehicle A/C line set, hoses and lines should be disassembled before testing. Figure 6 shows the addition of adapters to ensure correct pressure drop and temperature measurement with the IHX. Testing the entire A/C line assembly is also allowed with the understanding that additional line length and bends will reduce IHX effectiveness and increase pressure drop in comparison to other IHX only test samples. In this case, pressure and temperature points have to be placed 50 mm before inlet fittings, or after outlet fittings.