



SURFACE VEHICLE STANDARD

J3112™**JUL2019**Issued 2017-03
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Superseding J3112 MAR2017

(R) A/C Compressor Oil Separator Effectiveness Test Standard

RATIONALE

Latest revision issued to address oil separator reservoir flooding condition described in 5.2, and to establish range of applicability criteria in 5.3.1. In addition, the phrase "OCR Reduction Effectiveness" is replaced with the abbreviation "OCR.RE" throughout the document for brevity.

FOREWORD

Circulation of a refrigerant-miscible oil in the refrigerant circuit of a mobile air conditioning system is the conventional means of returning oil to the compressor for lubrication purposes. However, circulating oil will slightly reduce the effectiveness of the heat exchangers in the refrigerant circuit by leaving a thin film of oil on the inside heat exchanger surface, which will slightly add to the total resistance to heat transfer between the refrigerant and the air flowing over the outside of the heat exchanger. Therefore, a compressor that can reduce the amount of oil circulating through the refrigerant circuit, through the use of an oil separator and/or other means, can improve the overall energy efficiency of the A/C system, as expressed by COP. This SAE Standard establishes the test procedure and reporting method for quantifying oil circulation rate reduction of compressors with oil separators and/or other means of reducing the amount of oil circulation in the refrigerant circuit of mobile air-conditioning systems. Establishment of this standard ensures that oil circulation rate reduction test results for such compressors will produce comparable results.

1. SCOPE

This SAE Standard establishes the test conditions and reporting method for quantifying refrigerant circuit oil circulation rate (OCR) reduction effectiveness of mobile air conditioning compressors using R-134a and R-1234yf refrigerants that include oil separators and/or other design features for the purpose of reducing the OCR in the refrigerant circuit.

This standard and the OCR values it produces are not intended to make judgement on suitability of OCR values with regard to compressor durability.

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.

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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

2.1.2 ANSI/ASHRAE Standards

Available from ASHRAE Headquarters, 1791 Tullie Circle, NE, Atlanta GA 30329, Tel: 800-527-4723 (U.S. and Canada only) or 404-636-8400, www.ashrae.org.

ANSI/ASHRAE Standard 41.4 Standard Method for Measurement of Proportion of Lubricant in Liquid Refrigerant

ANSI/ASHRAE Standard 34 Designation and Classification of Refrigerants

3. GENERAL DESCRIPTION AND DEFINITIONS

3.1 MOBILE AIR CONDITIONING REFRIGERANT CIRCUIT

The refrigerant circuit of typical R-134a or R-1234yf mobile air conditioning system consists of the following components: compressor, discharge line, condenser (which usually includes a gas condensing heat exchanger portion, an integrated receiver/dryer, and subcooling heat exchanger portion), a liquid line, an expansion device, an evaporator, and a suction line. Variations may include dual (e.g., front and rear) evaporator systems, etc. The circuit typically includes a refrigerant-miscible oil circulating along with the refrigerant to ensure proper lubrication of the compressor. The typical mobile air conditioning refrigeration circuit is shown in Figure 1 for reference.

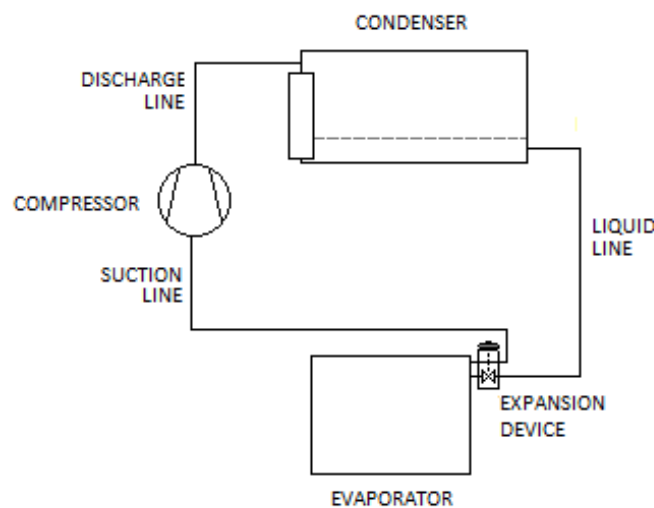


Figure 1

3.2 OIL CIRCULATION RATE (OCR)

OCR is the percentage by mass flow rate of oil to the total mass flow rate of refrigerant and oil circulating through the refrigerant circuit at a specified test condition. OCR is expressed in equation form as shown in Equation 1.

$$\text{OCR} = (\dot{m}_{\text{oil}} / (\dot{m}_{\text{ref}} + \dot{m}_{\text{oil}})) \times 100\% \quad (\text{Eq. 1})$$

3.3 COMPRESSOR WITH OIL SEPARATOR

A compressor with oil separator will include design feature(s) for separating some portion of the oil from the refrigerant either inside the compressor or as the mixture is leaving the compressor and returning the oil to the inlet of the compressor, thus maintaining the oil amount necessary in the compressor for proper operation and durability, while preventing the oil from circulating through the refrigerant circuit and compromising system COP.

3.4 COMPRESSOR WITH OTHER MEANS OF REDUCING OCR

Although an oil separator is usually the most common and effective means of reducing OCR for COP improvement, other means of reducing the initial oil charge amount needed by the compressor can also be employed which will also reduce OCR, since there is less oil in the system to begin with. Reducing the initial charge amount of oil can be accomplished through advanced design techniques such as use of high strength and/or low-friction materials, modifying internal component geometry to reduce the amount of force between components at sliding interfaces, etc. This measurement standard can be used to evaluate the effectiveness of these features for reducing OCR, regardless if they are used in conjunction with, or independent of, an oil separator.

3.5 COMPRESSOR SERIES/COMPRESSOR MODEL

A compressor series is a family of compressors using identical or highly similar construction and components, where testing of one compressor model in the series will be representative of other models in the compressor series in terms of OCR.RE results. Compressor models within a compressor series typically differ in terms of displacement only, though other minor differences may exist as well. For example, compressor mounting features will drive different compressor part numbers for what are otherwise essentially the same compressor.

4. ACRONYMS, ABBREVIATIONS, AND SYMBOLS

The following symbols and abberivations are used throughout this standard. For additional symbols used for the optional R_{FOT} analysis, see 5.2.

A/C	Air conditioning.
COP	Coefficient of performance (i.e., system energy efficiency). COP is the ratio of energy (heat) removed from the air being cooled at the evaporator to the energy (work) put into the refrigerant by the compressor. Refer to SAE J2765 for additional details.
OCR	Oil circulation rate. See 3.2 of this standard for additional details.
OCR _{BASE}	Baseline OCR of a system without OCR reducing technology.
OCR _{NEW}	OCR of a system with an OCR reducing technology installed .
OCR.RE	Oil circulation rate reduction effectiveness. See Equation 2.
OEM	Original equipment manufacturer.
$\dot{m}_{ref}$	Refrigerant mass flow rate.
$\dot{m}_{oil}$	Oil mass flow rate.
R-1234yf	Refrigerant 2,3,3,3-Tetrafluoro-1-Propene (HFO-1234yf). (Refer to ANSI/ASHRAE 34.)
R-134a	Refrigerant 1,1,1,2-Tetrafluoroethane, (HFC-134a). (Refer to ANSI/ASHRAE 34.)

5. METHODS AND PROCEDURES

5.1 OCR Reduction Effectiveness Calculation

OCR Reduction Effectiveness for a compressor with an oil separator and/or alternate means shall be accomplished by measuring the OCR in a system in a bench test using the procedure detailed in 5.3 and calculating the ratio of the OCR with the new technology to the OCR with the baseline technology. The resulting ratio is defined by this standard as the OCR Reduction Effectiveness (OCR.RE), and shall be expressed as a percentage, as shown in Equation 2:

$$\text{OCR.RE} = (1 - (\text{OCR}_{\text{NEW}} / \text{OCR}_{\text{BASE}})) * 100\% \quad (\text{Eq. 2})$$

The OCR_{BASE} and OCR_{NEW} values to be used in Equation 2 shall be the average of the I45 and M45 OCR values for the baseline and new systems respectively.

Two methods for determining OCR_{BASE} are available to users of this standard as detailed in 5.1.1 and 5.1.2.

5.1.1 Method 1

Method 1 uses a default value for OCR_{BASE} , which was established based on OEM and supplier data of OCR for systems using compressors without oil separators provided during development of this standard. See Table 1.

Table 1 - Method 1 default baseline OCR value

Typical OCR for Compressors Without Oil Separators (SAE J2765 I45 & M45 Test Conditions)		OCR_{BASE} Value for Eq. 2
I45	M45	I45/M45 Average
7.5%	8.5%	8.0%

5.1.2 Method 2

Method 1 is the preferred method of calculating OCR.RE, since it uses a common baseline OCR, and can therefore be used for making direct comparisons of OCR.RE results between different sources. However, in some situations, it may be preferable to use a measured value for the baseline system OCR to calculate OCR.RE. The baseline system OCR shall be measured using the same procedure as the improved system OCR, as detailed in 5.3. The baseline system selected in Method 2 shall be a comparable system from series production (past or present), to the system where the compressor to be evaluated is applied, except the baseline compressor will not include an oil separator or other advanced features for reducing OCR (see 3.4). The equation to be used to calculate OCR.RE for Method 2 is also Equation 2; the only difference in the application of Equation 2 with Method 2 versus Method 1 is that the value of OCR_{BASE} will be a measured value when using Method 2, rather than the default value from 5.1.1 when using Method 1.

Details of the baseline system will also be included in reporting OCR.RE using Method 2, including descriptions of the major system components used, refrigerant and oil charge amounts, oil type, and model year and vehicle name that the baseline system was applied to.