4E

Energy Efficient End-use Equipment
International Energy Agency

ENERGY EFFICIENCY POLICY BRIEF

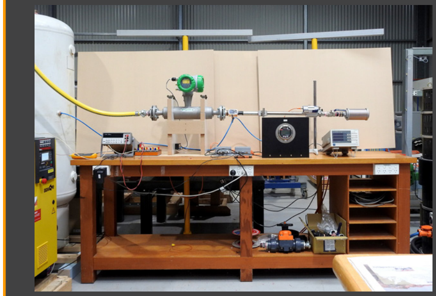
Improving the Measurement of Air Compressor Efficiency – Learnings from the EMSA Round Robin

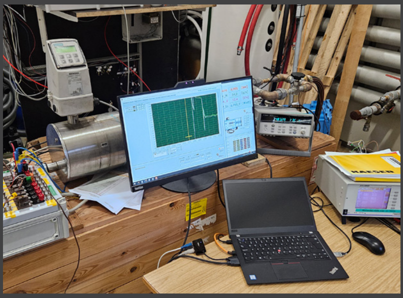
EMSA10

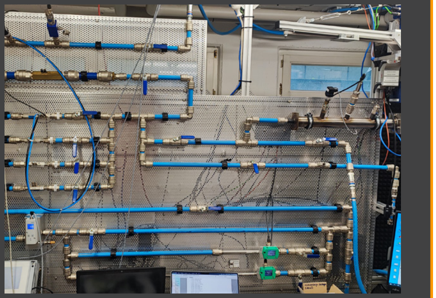
Statement of platform objectives and scope of policy brief

The IEA 4E Electric Motor Systems Platform (EMSA) promotes the opportunities for energy efficiency in electric motor systems by disseminating best practice information worldwide. It supports the development of internationally aligned test standards and policies to improve the energy performance of new and existing electric motors and motor systems. Electric motors are used in a wide range of industrial applications, but also in many types of applications in the commercial, residential, agricultural and transportation sectors. They typically operate as part of a motor system, converting electrical energy into mechanical power, driving applications like pumps, fans, compressors and machines.

This Policy Brief highlights the results of an international interlaboratory test programme (Round Robin) of small, packaged air compressors, organised by EMSA, and outlines its implications.


CalTest, Australia, 2025


Danish Technological Institute, Denmark, 2025


IER, University of Stuttgart, Germany, 2025

Observations for Policy Makers

- This Round Robin (2022–2025) involved three laboratories in Australia, Denmark and Germany testing two compact oil-injected screw compressors (4 kW and 5.5 kW) under varying environmental conditions.
- The current acceptance test standard ISO 1217:2009 (Edition 4) lacks a straightforward unambiguous, step-by-step procedure resulting in inconsistencies in measured efficiency across laboratories.
- Testing under different ambient conditions showed that variations—particularly in inlet pressure—are not fully compensated by existing correction methods. In addition, air flow measurement remains a key source of uncertainty, implicating a need for further addressing requirements or limitations e.g. for ambient conditions.
- To improve the reproducibility and consistency of test results, the project team developed a practical **Guide** for measuring air compressor isentropic efficiency. The Guide provides a structured, step-by-step procedure aligned with ISO 1217:2009 and its 2016 Amendment.
- Ambiguities in the set of standards allow for different isentropic efficiency values to be derived from identical test data. A common spreadsheet has been developed, the **EMSA CompressorCalc** tool, where two calculation approaches are included:
  - Method “A”: based on corrected values for isentropic power and input power
  - Method “B”: based on uncorrected measured values

  Both methods are calculated from the same raw data, illustrating the impact of methodological choices.
- Overall, the Round Robin results highlight the need for clearer and unambiguous measurement and calculation methods. Addressing these gaps would be important in the ongoing revision of ISO 1217.

MORE INFORMATION

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Report with **Round Robin results and Guide**, and a separate **EMSA CompressorCalc** tool. For further information contact **emsa@iea-4e.org.**

Key Findings

Ambiguity in measurement and calculation methods leads to variable results

Testing of identical compressors across three laboratories showed both good agreement and notable variation, demonstrating that the current standard ISO 1217 lacks clarity and does not consistently ensure reproducible results.

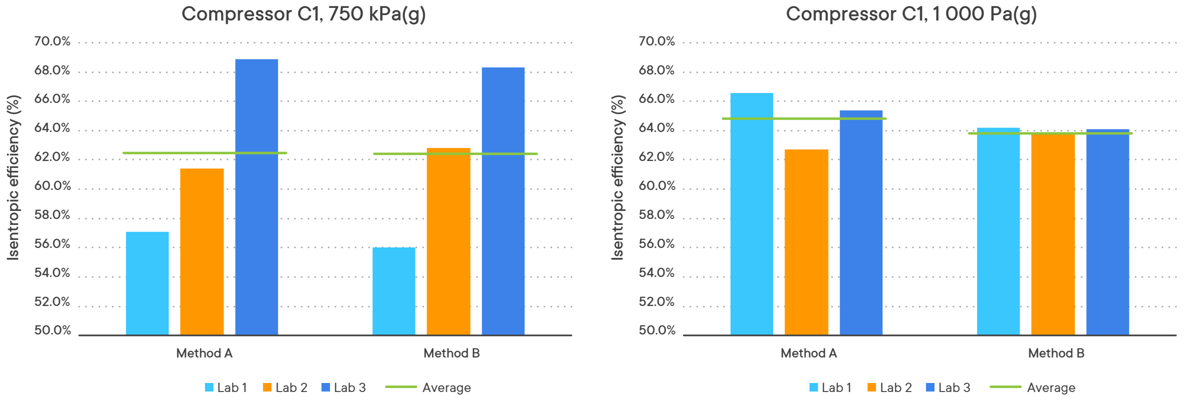


Figure 1: Calculated isentropic efficiencies for the tested C1 and C2 compressors by 3 labs

For Compressor C2, the calculated isentropic efficiencies show good agreement across laboratories when applying the same calculation method. In particular, the uncorrected approach (Method "B") produces very similar results across all three labs.

However, when ambient corrections are applied (Method "A"), differences become more pronounced. Results from one laboratory (Lab 2), characterised by relatively low barometric pressure and higher ambient temperatures, indicate a negative impact on calculated efficiency. While Method "A" generally yields higher efficiency values than Method "B" in the other laboratories, this trend is reversed in Lab 2, where the corrected value is lower.

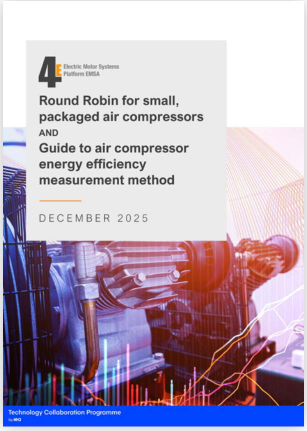
For Compressor C1, the calculated isentropic efficiencies show a wider spread of results, although the average efficiency remains consistent. The project team has not been able to identify a definitive cause for this spread, but reduced accuracy in flow measurement at lower absolute flow rates may contribute to the observed differences.

These findings suggest that current correction methods do not fully account for variations in ambient conditions, contributing to inconsistencies in reported efficiency values.

EMSA guidance improves consistency and supports policy implementation

The project team developed a practical, step-by-step measurement guide and the EMSA CompressorCalc tool to improve the consistency of test results and support the ongoing revision of ISO 1217.

Reliable and reproducible measurements ensure that isentropic efficiency values are comparable across products and test conditions. This is essential for setting robust standards, enforcing compliance, ensuring fair competition, and enabling informed market decisions—making them a cornerstone of effective energy efficiency policy.



4E Electric Motor Systems Platform EMSA

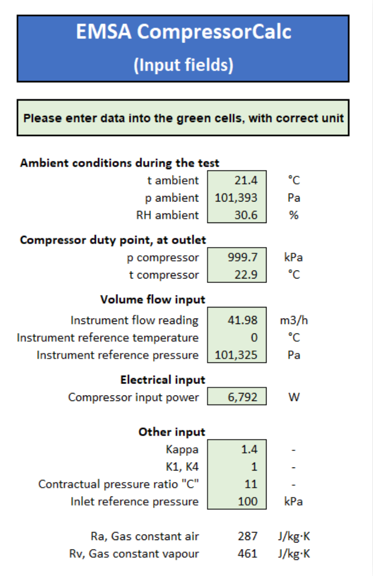
Round Robin for small, packaged air compressors

AND

Guide to air compressor energy efficiency measurement method

DECEMBER 2025

Technology Collaboration Programme by iea



EMSA CompressorCalc
(Input fields)

Please enter data into the green cells, with correct unit

Ambient conditions during the test		
t ambient	21.4	°C
p ambient	101,393	Pa
RH ambient	30.6	%
Compressor duty point, at outlet		
p compressor	999.7	kPa
t compressor	22.9	°C
Volume flow input		
Instrument flow reading	41.98	m3/h
Instrument reference temperature	0	°C
Instrument reference pressure	101,325	Pa
Electrical input		
Compressor input power	6,792	W
Other input		
Kappa	1.4	-
K1, K4	1	-
Contractual pressure ratio "C"	11	-
Inlet reference pressure	100	kPa
Ra, Gas constant air	287	J/kg·K
Rv, Gas constant vapour	461	J/kg·K