ISO/FDIS 4376<del>:2024(en)</del>

ISO-<u>/TC-118/SC-06</u>

Secretariat:-SIS

Date: 2024-<del>07-13</del>xx

Cycle energy requirement—— Test method

Exigence d'énergie de cycle- \_\_ Essais de réception

iTeh Standards

FDIS stage

ISO/FDIS 4376

https://standards.iteh.ai/catalog/standards/iso/6e0b6927-ffe7-495f-bb94

Formatted	
Style Definition	
Style Definition	<u> </u>
Style Definition	<u> </u>
Style Definition	
Style Definition	<u> </u>
Style Definition	
Style Definition	<u> </u>
Style Definition	
Style Definition	<u> </u>
Style Definition	

Style Definition
Style Definition
Style Definition

# ISO/FDIS 4376:2024(<u>Een</u>)

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office CP 401 • Ch. de Blandonnet 8 CH-1214 Vernier, Geneva Phone: + 41 22 749 01 11 EmailE-mail; copyright@iso.org

Website: www.iso.orgwww.iso.org

Published in Switzerland

Formatted: Font: 11 pt

Formatted: Font: 11 pt

**Formatted:** HeaderCentered, Space After: 0 pt, Line spacing: single

**Formatted:** Right: 1.5 cm, Bottom: 1 cm, Gutter: 0 cm, Header distance from edge: 1.27 cm, Footer distance from edge: 0.5 cm

**Commented [eXtyles1]:** The reference "ISO 2024" is to a withdrawn standard

Formatted: Default Paragraph Font

Formatted: Default Paragraph Font

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: French (France)
Formatted: French (France)

Formatted: French (France)

# iTeh Standards (https://standards.iteh.ai) Document Preview

ISO/FDIS 4376

https://standards.iteh.ai/catalog/standards/iso/6e0b6927-ffe7-495f-bb95-99817a289cad/iso-fdis-4376

Formatted: FooterPageRomanNumber

# **Contents**

Introduction	<b>Forew</b>	vord	<u></u> v
2         Normative references         1           3         Terms and definitions         1           4         Symbols, abbreviations and subscripts         3           4.1         Symbols and abbreviations         3           4.2         Subscripts         3           5         Measuring equipment, methods and accuracy         4           5.1         General         4           5.2         Measurement of compressor package actual flow rate         4           5.4         Measurement of compressor package power input         4           5.4         Measurement logging frequency         5           5.5         Measurement logging frequency         5           5.6         Throttle valve         5           5.7         Non-return valve         5           6         Test procedure         5           6.1         CER test conditions and limitations         6           6.2         Cycle energy requirement test method         6           6.2.1         (Optional) Full load actual volume flow and package power input         7           6.2.2         Minimum actual volume flow and package power input         7           6.2.3         Calculation of cycle energy requirement         7	Introd	duction	_vi
3         Terms and definitions         1           4         Symbols, abbreviations and subscripts         3           4.1         Symbols and abbreviations         3           4.2         Subscripts         3           5         Measuring equipment, methods and accuracy         4           5.1         General         4           5.2         Measurement of pressure and temperature         4           5.3         Measurement of compressor package actual flow rate         4           5.4         Measurement of compressor package actual flow rate         4           5.4         Measurement logging frequency         5           5.5         Measurement logging frequency         5           5.6         Throttle valve         5           5.7         Non-return valve         5           6.1         Test procedure         5           6.2         Trottle valve         5           6.1         Test procedure         5           6.2         Cycle energy requirement test method         6           6.2         Test procedure         7           6.2.1         (Optional) Full load actual volume flow and package power input         7           6.2.2         Minimum actual volu	1	Scope	<u></u> 1
4         Symbols, abbreviations and subscripts         3           4.1         Symbols and abbreviations         3           4.2         Subscripts         3           5         Measuring equipment, methods and accuracy         4           5.1         General         4           5.2         Measurement of pressure and temperature         4           5.3         Measurement of compressor package actual flow rate         4           5.4         Measurement logging frequency         5           5.5         Measurement logging frequency         5           5.6         Throttle valve         5           6.         Test procedure         6           6.2.1         (Optional) Full load actual volume flow and package power input         7           6.2.2         M	2	Normative references	<u></u> 1
4.1       Symbols and abbreviations       3         4.2       Subscripts       3         5       Measuring equipment, methods and accuracy       4         5.1       General       4         5.2       Measurement of pressure and temperature       4         5.3       Measurement of compressor package actual flow rate       4         5.4       Measurement logging frequency       5         5.6       Throttle valve       5         5.7       Non-return valve       5         6       Test procedure       5         6.1       CER test conditions and limitations       6         6.2       Cycle energy requirement test method       6         6.2       Cycle energy requirement test method       6         6.2       Cycle energy requirement test method       6         6.2       Cycle energy requirement flow and package power input       7         6.2.2       Minimum actual volume flow and package power input       7         6.2.3       Ide power       7         6.4       Logging data       7         6.2.5       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement — Simplified estimation       11 </td <td>3</td> <td>Terms and definitions</td> <td><u></u>1</td>	3	Terms and definitions	<u></u> 1
4.2         Subscripts         3           5         Measuring equipment, methods and accuracy         4           5.1         General.         4           5.2         Measurement of pressure and temperature.         4           5.3         Measurement of compressor package actual flow rate.         4           5.4         Measurement of compressor package power input.         4           5.5         Measurement logging frequency.         5           5.6         Throttle valve.         5           5.7         Non-return valve.         5           6         Test procedure.         5           6.1         CER test conditions and limitations.         6           6.2         Cycle energy requirement test method.         6           6.2.1         Optional) Full load actual volume flow and package power input.         7           6.2.1         Optional) Full load actual volume flow and package power input.         7           6.2.2         Uninimum actual volume flow and package power input.         7           6.2.3         Idle power.         7           6.2.4         Logging data.         7           6.2.5         Cycling modes and determination of cycle.         7           6.3         Calculation of cycl	4	Symbols, abbreviations and subscripts	<u></u> 3
5         Measuring equipment, methods and accuracy         4           5.1         General	4.1	Symbols and abbreviations	3
5.1       General       4         5.2       Measurement of pressure and temperature       4         5.3       Measurement of compressor package actual flow rate       4         5.4       Measurement logging frequency       5         5.6       Throttle valve       5         5.7       Non-return valve       5         6       Test procedure       5         6.1       CER test conditions and limitations       6         6.2       Cycle energy requirement test method       6         6.2.1       (Optional) Full load actual volume flow and package power input       7         6.2.2       Iniminum actual volume flow and package power input       7         6.2.3       Ide power       7         6.2.4       Logging data       7         6.2.5       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       1         Scope	4.2	Subscripts	<u></u> 3
5.2         Measurement of pressure and temperature.         4           5.3         Measurement of compressor package actual flow rate.         4           5.4         Measurement of compressor package power input.         4           5.5         Measurement logging frequency.         5           5.6         Throttle valve.         5           5.7         Non-return valve.         5           6         Test procedure.         5           6.1         CRR test conditions and limitations.         6           6.2         Cycle energy requirement test method.         6           6.2.1         Optional) Full load actual volume flow and package power input.         7           6.2.2         Minimum actual volume flow and package power input.         7           6.2.3         Idle power.         7           6.2.4         Logging data.         7           6.2.5         Cycling modes and determination of cycle.         7           6.3         Calculation of cycle energy requirement.         9           6.4         Test report.         10           Annex B (informative) Cycle energy requirement.         Simplified estimation.         11           Annex B (informative) Cycle energy requirement.         Compressor control strategies.         12		Measuring equipment, methods and accuracy	<u></u> 4
5.3       Measurement of compressor package actual flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       5         5.6       Throttle valve       5         5.7       Non-return valve       5         6       Test procedure       5         6.1       CFR test conditions and limitations       6         6.2       Cycle energy requirement test method       6         6.2.1       (Optional) Full load actual volume flow and package power input       7         6.2.2       Minimum actual volume flow and package power input       7         6.2.3       Idle power       7         6.4       Logging data       7         6.2       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         1       Scope       1         2       Normative r	5.1	General	<u></u> 4
5.4       Measurement of compressor package power input	5.2		
5.5         Measurement logging frequency.         5           5.6         Throttle valve.         5           5.7         Non-return valve.         5           6         Test procedure.         5           6.1         CER test conditions and limitations.         6           6.2         Cycle energy requirement test method.         6           6.2.1         (Optional) Full load actual volume flow and package power input.         7           6.2.2         Minimum actual volume flow and package power input.         7           6.2.3         Idle power.         7           6.2.4         Logging data.         7           6.2.5         Cycling modes and determination of cycle.         7           6.3         Calculation of cycle energy requirement.         9           6.4         Test report.         10           Annex A (informative) Cycle energy requirement.         Simplified estimation.         11           Annex B (informative) Cycle energy requirement.         Compressor control strategies.         12           Foreword.         iv           Introduction.         v           1         Scope.         1           2         Normative references.         1           3         Term	5.3	Measurement of compressor package actual flow rate	<u></u> 4
5.6         Throttle valve         5           5.7         Non-return valve         5           6         Test procedure         5           6.1         CER test conditions and limitations         6           6.2         Cycle energy requirement test method         6           6.2.1         (Optional) Full load actual volume flow and package power input         7           6.2.2         Minimum actual volume flow and package power input         7           6.2.3         Idle power         7           6.2.4         Logging data         7           6.2.5         Cycling modes and determination of cycle         7           6.3         Calculation of cycle energy requirement         9           6.4         Test report         10           Annex A (informative) Cycle energy requirement — Simplified estimation         11           Annex B (informative) Cycle energy requirement — Compressor control strategies         12           Foreword         iv           Introduction         v           Introduction         v           Introduction         v           Introduction         v           Introduction         v           Introduction         v           Introduction <td>5.4</td> <td></td> <td></td>	5.4		
5.7         Non-return valve         5           6         Test procedure         5           6.1         CER test conditions and limitations         6           6.2         Cycle energy requirement test method         6           6.2.1         (Optional) Full load actual volume flow and package power input         7           6.2.2         Minimum actual volume flow and package power input         7           6.2.3         Idle power         7           6.2.4         Logging data         7           6.2.5         Cycling modes and determination of cycle         7           6.3         Calculation of cycle energy requirement         9           6.4         Test report         10           Annex A (informative) Cycle energy requirement — Simplified estimation         11           Annex B (informative) Cycle energy requirement — Compressor control strategies         12           Foreword         iv           Introduction         v           1         Scope         1           2         Normative references         1           3         Terms and definitions         1           4         Symbols and subscripts         3           4.1         Symbols and subscripts         3	5.5	Measurement logging frequency	<u></u> 5
6         Test procedure	5.6	Throttle valve	<u></u> 5
6.1       CER test conditions and limitations       6         6.2       Cycle energy requirement test method       6         6.2.1       (Optional) Full load actual volume flow and package power input       7         6.2.2       Minimum actual volume flow and package power input       7         6.2.3       Idle power       7         6.2.4       Logging data       7         6.2.5       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative)       Cycle energy requirement — Simplified estimation       11         Annex B (informative)       Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of flow rate	5.7		
6.1       CER test conditions and limitations       6         6.2       Cycle energy requirement test method       6         6.2.1       (Optional) Full load actual volume flow and package power input       7         6.2.2       Minimum actual volume flow and package power input       7         6.2.3       Idle power       7         6.2.4       Logging data       7         6.2.5       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative)       Cycle energy requirement — Simplified estimation       11         Annex B (informative)       Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of flow rate	6	Test procedure	<u></u> 5
6.2       Cycle energy requirement test method       6         6.2.1       (Optional) Full load actual volume flow and package power input       7         6.2.2       Minimum actual volume flow and package power input       7         6.2.3       Idle power       7         6.2.4       Logging data       7         6.2.5       Cycling modes and determination of cycle       7         6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         Introduction	6.1		
6.2.1 (Optional) Full load actual volume flow and package power input       7         6.2.2 Minimum actual volume flow and package power input       7         6.2.3 Idle power       7         6.2.4 Logging data       7         6.2.5 Cycling modes and determination of cycle       7         6.3 Calculation of cycle energy requirement       9         6.4 Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         4 Scope       1         2 Normative references       1         3 Terms and definitions       1         4 Symbols and subscripts       3         4.1 Symbols       3         5 Measuring equipment, methods, and accuracy       3         5.1 General       3         5.2 Measurement of pressure and temperature       3         5.3 Measurement of flow rate       4         5.4 Measurement of gow rate       4         5.5 Measurement logging frequency       4		Cycle energy requirement test method	6
6.2.2 Minimum actual volume flow and package power input       7         6.2.3 Idle power       7         6.2.4 Logging data       7         6.2.5 Cycling modes and determination of cycle       7         6.3 Calculation of cycle energy requirement       9         6.4 Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       2         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of compressor package power input       4         5.4       Measurement logging frequency       4	6.2.1		
6.2.3 Idle power	6.2.2		
6.2.4 Logging data       7         6.2.5 Cycling modes and determination of cycle       7         6.3 Calculation of cycle energy requirement       9         6.4 Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         4 Scope       1         2 Normative references       1         3 Terms and definitions       1         4 Symbols and subscripts       3         4.1 Symbols       3         5 Measuring equipment, methods, and accuracy       3         5.1 General       3         5.2 Measurement of pressure and temperature       3         5.3 Measurement of flow rate       4         5.4 Measurement logging frequency       4	6.2.3		
6.2.5 Cycling modes and determination of cycle       7         6.3 Calculation of cycle energy requirement       9         6.4 Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         4 Scope       1         2 Normative references       1         3 Terms and definitions       1         4 Symbols and subscripts       3         4.1 Symbols       3         5 Measuring equipment, methods, and accuracy       3         5.1 General       3         5.2 Measurement of pressure and temperature       3         5.3 Measurement of flow rate       4         5.4 Measurement of compressor package power input       4         5.5 Measurement logging frequency       4	6.2.4		
6.3       Calculation of cycle energy requirement       9         6.4       Test report       10         Annex A (informative) Cycle energy requirement — Simplified estimation       11         Annex B (informative) Cycle energy requirement — Compressor control strategies       12         Foreword       iv         Introduction       v         1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4		Cycling modes and determination of cycle	7
6.4 Test report	6.3	Calculation of cycle energy requirement	9
Annex B (informative) Cycle energy requirement — Compressor control strategies	6.4		
Annex B (informative) Cycle energy requirement — Compressor control strategies	Annex	x A (informative) Cycle energy requirement — Simplified estimation	11
Introduction		https://standards.itah.al/catalog/standards/iso/ballhhu///tta///lust	
Introduction	Annex	x B (informative) Cycle energy requirement — Compressor control strategies	12
Introduction			
1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4	Forew	vord	. iv
1       Scope       1         2       Normative references       1         3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4			
2       Normative references	Introd	luction	V
2       Normative references	1	Scope	_1
3       Terms and definitions       1         4       Symbols and subscripts       3         4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4	2	•	
4 Symbols and subscripts 3 4.1 Symbols 3 5 Measuring equipment, methods, and accuracy 3 5.1 General 3 5.2 Measurement of pressure and temperature 3 5.3 Measurement of flow rate 4 5.4 Measurement of compressor package power input 4 5.5 Measurement logging frequency 4	2		
4.1       Symbols       3         5       Measuring equipment, methods, and accuracy       3         5.1       General       3         5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4	•		
5 Measuring equipment, methods, and accuracy			
5.1 General 3 5.2 Measurement of pressure and temperature 3 5.3 Measurement of flow rate 4 5.4 Measurement of compressor package power input 4 5.5 Measurement logging frequency 4			
5.2       Measurement of pressure and temperature       3         5.3       Measurement of flow rate       4         5.4       Measurement of compressor package power input       4         5.5       Measurement logging frequency       4			
5.3 Measurement of flow rate			
5.4 Measurement of compressor package power input	U. <u> </u>		
5.5 Measurement logging frequency			
	5.5		4

Formatted: Font: 11 pt, Font color: Auto

Formatted: Font: 11 pt

Formatted: HeaderCentered, Left, Space After: 0 pt,

Line spacing: single

-99817a289cad/iso-fdis-4376

Formatted: Font: 10 pt

Formatted: Font: 10 pt

Formatted: Font: 10 pt

Formatted: FooterCentered, Left, Space Before: 0 pt,

Tab stops: Not at 17.2 cm

Formatted: Font: 11 pt

Formatted: FooterPageRomanNumber, Left, Space

After: 0 pt, Tab stops: Not at 17.2 cm

© ISO-2024 - All rights reserved

iii

# ISO/FDIS 4376:2024(<u>Een</u>)

5.6 Throttle Valve
5.7 Non-Poturn Valvo
S., Non Return valve
6 Test Procedure
6.1 CER test conditions and limitations
6.2 Cycle Energy Requirement Test method
6.2.1 (Ontional) Full load Actual Volume Flow and Package Power Input
6.2.1 (Optionar) run toda fictual votame row and rackage rower input
6.2.2 Minimum Actual Volume Flow and Package Power Input
6.2.3 Idle Power
6.2.4 Logging data
6.2.5 Cycling modes and determination of cycle
6.2 Calculation of Cycle Energy requirement
Calculation of cycle Energy requirement
6.4 Test Report
Annex A (informative) Cycle Energy Requirement - Simplified estimation
Attities A (timor mative) cycle Energy Requirement – Simplified estimation
Annex B (informative) Cycle Energy Requirement - Compressor Control Strategies1
Bibliography2

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: HeaderCentered, Space After: 0 pt, Line

spacing: single

# iTeh Standards (https://standards.iteh.ai) Document Preview

ISO/FDIS 4376

https://standards.iteh.ai/catalog/standards/iso/6e0b692/-ffe/-4951-bb95-9<mark>981/a289cad/iso-fdis-43/6</mark>

© ISO 2024 – All rights reserved

Formatted: FooterPageRomanNumber

#### **Foreword**

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see <a href="www.iso.org/directives">www.iso.org/directives</a>).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <a href="https://www.iso.org/patents.www.iso.org/patents.">www.iso.org/patents.www.iso.org/patents.</a>. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see <a href="https://www.iso.org/iso/foreword.html">www.iso.org/iso/foreword.html</a>.

This document was prepared by Technical Committee ISO/TC 118, Compressors and pneumatic tools, machines and equipment, Subcommittee SC 6, Air compressors and compressed air systems.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at <a href="https://www.iso.org/members.html">www.iso.org/members.html</a> www.iso.org/members.html.

Formatted: Font: 11 pt, Font color: Auto

Formatted: Font: 11 pt

Formatted: HeaderCentered, Left, Space After: 0 pt,

Line spacing: single

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: English (United Kingdom)

Commented [eXtyles2]: The URL

https://www.iso.org/members.html has been redirected to http://www.iso.org/about/members. Please verify the URL

Formatted: Font: 10 pt

Formatted: Font: 10 pt

Formatted: Font: 10 pt

**Formatted:** FooterCentered, Left, Space Before: 0 pt, Tab stops: Not at 17.2 cm

Formatted: Font: 11 pt

Formatted: FooterPageRomanNumber, Left, Space

After: 0 pt, Tab stops: Not at 17.2 cm

© ISO-2024- - All rights reserved

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: HeaderCentered, Space After: 0 pt, Line

spacing: single

#### Introduction

This document was developed to provide guidance to determine the cycle energy requirement for all types of compressors. The types of compressors included in the consideration include dynamic and positive displacement designs. Applicable pressures include low pressure (e.g. blowers), typical air network pressures in industry and higher pressures needed for special application. Applications covered include but are not limited to standard industrial air production and gas compression for industrial and other purposes.

Compressors are used in almost all types of industries and in processes such as energy production and water treatment. In most industrial facilities, small and large, compressed air is an expected utility. In industry and elsewhere many processes demand gases to be compressed to certain pressures.

Compressing a gas is energy intensive and growing attention to the environmental impact has encouraged manufacturers of compressors to continuously raise the energy efficiency of its products.

The need for compressed gas usually varies with time. While some types of compressor can adapt to changes of demand by delivering variable amounts of gas all compressors will at some point change from gas delivery to no delivery and back. Such a no delivery mode, called idle mode, usually means the compressor is left running being ready to resume delivery on short notice while still consuming energy.

Until now performance data is typically given and evaluated for a steady state design point. It is also customary to provide data for the idle mode when the delivered amount of gas is zero. What is not provided at present time is the energy consumed in switching from idle mode to delivery and vice versa. Taken together the energy required for these two events combined can be referred to as the cycle energy requirement (CER).

(https://standards.iteh.ai)
Document Preview

ISO/FDIS 4376

https://standards.iteh.ai/catalog/standards/iso/6e0b6927-ffe7-495f-bb95-99817a289cad/iso-fdis-4376

 $\textbf{Formatted:} \ \mathsf{FooterPageRomanNumber}$ 

# Cycle energy requirement—\_\_ Test method

#### 1 Scope

This document applies to electrically driven positive displacement and dynamic compressors.

This document defines and describes the test method to evaluate the cycle energy requirement.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

<std>ISO 5167-ISO 5167-I, Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements</sd>

<std>ISO 9300, Measurement of gas flow by means of critical flow nozzles</std>

ISO 9300, Measurement of gas flow by means of critical flow nozzles

#### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ——ISO Online browsing platform: available at <a href="https://www.iso.org/obp">https://www.iso.org/obp</a>
- —IEC Electropedia: available at <a href="https://www.electropedia.org/">https://www.electropedia.org/</a>

standards.iteh.ai/catalog/standards/iso/6e0b6927-ffe7-495f-bb9:

#### 3.1

#### standard inlet point

location at which gas enters the compressor package

#### 3.2

#### standard discharge point

discharge point for a packaged compressor is the terminal outlet

# 3.3

# inlet pressure

absolute pressure of the gas at the standard inlet point (3.1)

#### 3.4

# inlet temperature

total temperature at the *standard inlet point* (3.1) of the compressor

**Formatted:** Right: 1.5 cm, Bottom: 1 cm, Gutter: 0 cm, Header distance from edge: 1.27 cm, Footer distance from edge: 0.5 cm

Formatted: Default Paragraph Font

Formatted: Default Paragraph Font

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Commented [eXtyles3]:** The match came back with a different title. The original title was: Measurement of gas flow by means of critical flow Venturi nozzles

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Commented [eXtyles4]: The URL

https://www.iso.org/obp has been redirected to https://www.iso.org/obp/ui. Please verify the URL

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Font: Italic

Formatted: Font: Italic

**Formatted:** Footer, Left, Space After: 0 pt, Tab stops: Not at 17.2 cm

© ISO 2024 - All rights reserved

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: HeaderCentered, Space After: 0 pt, Line

spacing: single

#### 3.5

#### compressor package

compressor unit with prime mover, transmission, fully piped and wired and generally includes all ancillary items necessary for effective operation

#### 3.6

#### compressor package power input

sum of the electrical power inputs to the prime mover and all other ancillary and auxiliary items included in the *compressor package* (3.5)(3.5)

#### 3.7

#### compressor package actual volume flow rate

actual volume flow rate of gas, compressed and delivered at the *standard discharge point*; (3.2). referred to conditions of total temperature, total pressure and composition prevailing at the *standard inlet point* (3.1)

Note 1-to-entry:-Composition can refer to humidity, for instance.

#### 3.8

#### thermal steady state

state in which the variation in the difference between inlet and outlet temperatures is within 1 K for a period of three minutes or more

#### 3.9

#### idle power consumption

stable steady-state power consumption of the compressor at zero volume flow rate or at pressure ratio of one, the compressor shall always be able to reach this state independent of the number of load-idle cycles

Note 1-to-entry: The idle power consumption can be zero.

#### 3.10

# rated discharge pressure

total pressure at the *standard discharge point* (3.2) where performance is measured.

#### 3.11

# offload discharge pressure

total pressure at the <u>standard discharge point (3.2)</u> when the <u>compressor package (3.5)(3.5)</u> transitions to idle state

Note 1-to-entry: The offload discharge pressure shall be between 100 % and 110 % of the rated discharge pressure.

#### 3.12

### minimum actual volume flow rate

lowest actual volume flow rate at which the compressor can run stable at the specified *offload discharge* pressure (3.10)(3.10)

EXAMPLE For a centrifugal this can correspond to the surge anticipation limit at the offload discharge pressure. For a variable speed screw compressor this can correspond to the lowest speed point at the offload discharge pressure

#### 3.13

# measured power

power measured by a power meter at a specific time under specific conditions

**Commented [eXtyles5]:** The term "compressor package actual volume flow rate" has not been used anywhere in this document

Formatted: Font: Italic

Formatted: Font: Italic

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Font: Italic

Formatted: Font: Italic

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

**Formatted:** Line spacing: At least 11 pt, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: FooterPageRomanNumber

© ISO 2024 – All rights reserved

2

© ISO 2024 - All rights reserved

#### 3.14

# ideal load-idle cycle

principle of operation where the transition from load to idle and idle to load is instantaneous at the offload discharge pressure (3.10)(3.10) and minimum flow rate without consuming any additional energy

# cycle energy requirement

CER

additional energy compared to what would be consumed during the ideal load-idle cycle (3.14) during switching of states at offload discharge pressure (3.10)(3.10) and minimum flow rate

# 4 Symbols, abbreviations and subscripts

# 4.1 Symbols and abbreviations

Symbol/ abbreviation	Term	SI unit	Other practical units
CER	cycle energy requirement	J	MJ, kJ
p,	pressure	Pa	MPa, bar, mbar
P	power	W	MW, kW
T_	temperature	l e k	10 2 1-°C
V_	volume	m³	l
$q_{V_{\bullet}}$	volume flow rate	m³/s	l/s, m³/min, m³/h
f	frequency	Hz	
t,	time	ocument	Premin AW

# 4.2 Subscripts

Subscript	Term	Remark
ntips.//star	Inlet Inlet	Inlet condition / ambient
d	Discharge	
1	compressor switches to the idle state	
2	zero-flow and steady state achieved	
3	compressor switches to the load state	
4	compressor is delivering flow downstream of non-return valve	
NRV	Non-return valve	
UNRV	Upstream of Non-Return Valve	
DNRV	Downstream of Non-Return Valve	
V	Volume	
L	Load	Machine running in load
min	Minimum	
L1	Rated	
L2	Offload	Maximum allowable working pressure

© ISO-2024 - All rights reserved

Tormatteu		لِننا
Formatted		
Formatted		<u></u>
//≻──		<u> </u>
Formatted		
Formatted		<u> </u>
Formatted		<u> </u>
Formatted		[]
Formatted		
Formatted		
Formatted		[]
Formatted		
Formatted		
Formatted		<u></u>
Formatted		
Formatted		
Formatted		
Formatted		()
Formatted		
	iso-fdis-4376	<u></u>
Formatted		
Formatted		
Formatted		
		<u></u>
Formatted		<u></u>
Formatted		<u></u>
Formatted		<u> </u>
Formatted		[]
Formatted		[]
Formatted		
Formatted		<u></u>
Formatted		
Formatted		
Formatted		(
Formatted		
Formatted		
Formatted		
Formatted		()
Formatted		
Formatted		

Formatted Formatted

**Formatted** 

Subscript	Term	Remark	L
max	Maximum		¥
MEAS	Measured		¥
IDLE	Idle	Machine off-load, no compressed air delivered to customer	4
EST	Estimation		4

#### 5 Measuring equipment, methods and accuracy

#### 5.1 General

The equipment and methods given in this document are not intended to restrict the use of other equipment and methods with the same or better accuracy.

All inspection, measuring, test equipment and devices that can affect the test shall be calibrated and adjusted at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to nationally recognized standards.

#### 5.2 Measurement of pressure and temperature

Pressure measurement shall have an accuracy of ±1 % at the measured value.

Temperature measurement shall have an accuracy of ±1 K.

The following characteristics shall be measured:

- —package inlet pressure (at standard inlet point);
- -package inlet temperature (at standard inlet point);
- -package discharge pressure (at standard discharge point); LSO/I
- pressure upstream of the non-return valve;
- -pressure downstream of the non-return valve;

If the compressor package does not have an internal non-return valve, one can be installed downstream of the compressor package with the pressure measurement on both sides to allow for non-invasive measuring of cycle energy requirement.

#### 5.3 Measurement of compressor package actual flow rate

The actual delivered flow rate of the compressor shall be measured by performing a test as indicated in both ISO 5167-1 and ISO 9300.

#### 5.4 Measurement of compressor package power input

The compressor package power input measurement shall have an accuracy of  $\pm 1~\%$  at the measured value.

Formatted: Font: 11 pt

Formatted: Font: 11 pt

Formatted: HeaderCentered, Space After: 0 pt, Line

spacing: single

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Formatted: Font: Not Bold Formatted: Adjust space between Latin and Asian text,

Adjust space between Asian text and numbers Formatted: Adjust space between Latin and Asian text. Adjust space between Asian text and numbers

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Space Before: 12 pt. Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Adjust space between Latin and Asian text, Adjust space between Asjan text and numbers, Tab stops: Not at 0.71 cm

Formatted: Line spacing: single, Adjust space between Latin and Asian text, Adjust space between Asian text

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.71 cm

Formatted: Line spacing: single, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

**Formatted** 

Formatted	()
Formatted	
Formatted	
Formatted: Default Paragraph Font	
Formatted	
Formatted	

Formatted: FooterPageRomanNumber

© ISO 2024 - All rights reserved

4

#### 5.5 Measurement logging frequency

The logging frequency of the pressure and power measurements shall be at least 10 Hz.

#### 5.6 Throttle valve

An adjustable throttle valve is required downstream of the compressor package.

#### 5.7 Non-return valve

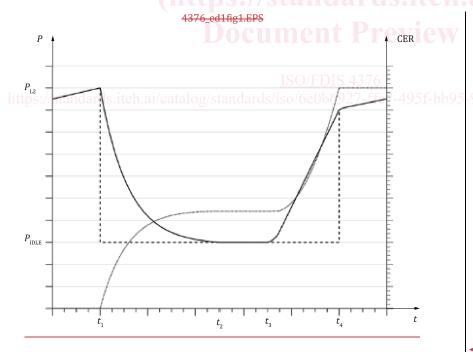
If a non-return valve (check valve) is not part of the compressor package, one shall be installed downstream for testing purposes.

#### 6 Test procedure

Cycle energy requirement (CER) is the additional energy compared to what would be consumed during the ideal load-idle cycle during switching of states at offload discharge pressure and minimum flow rate, e.g., pressurizing the internals first when switching to load until the non-return valve is opened, e.g., venting the internals when switching to idle until an idle state is reached.

Figure 1 Figure 1 shows an example of the Cycle Energy Requirement compared to an ideal load-idle cycle where at time  $t_1$  the compressor switches to idle and at time  $t_4$  the product finally delivers air back to the customer at the requested pressure.

A full compressor package cycle includes a venting phase  $(t_1 \text{ to } t_2)$ , a steady state zero flow phase  $(t_2 \text{ to } t_3)$  and a loading phase  $(t_3 \text{ to } t_4)$ 



Key

© ISO-2024- – All rights reserved

Formatted: Font: 11 pt, Font color: Auto

Formatted: Font: 11 pt

**Formatted:** HeaderCentered, Left, Space After: 0 pt, Line spacing: single

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.71 cm

**Formatted:** Line spacing: single, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.71 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.71 cm

**Formatted:** Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

495f-bb95<mark>-9</mark>9817a289cad/iso-fdis-4376

Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm

Formatted: Font: 10 pt

Formatted: Font: 10 pt

Formatted: Font: 10 pt

**Formatted:** FooterCentered, Left, Space Before: 0 pt, Tab stops: Not at 17.2 cm

Formatted: Font: 11 pt

**Formatted:** FooterPageRomanNumber, Left, Space After: 0 pt, Tab stops: Not at 17.2 cm

5