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**Cycle energy requirement —
Test method**

Exigence d'énergie de cycle — Essais de réception

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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 www.iso.org/directives).

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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 www.iso.org/iso/foreword.html.

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 www.iso.org/members.html.

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).

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.

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

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 <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

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

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)

3.7

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 *standard discharge point* (3.2) when the *compressor package* (3.5) 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)

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

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) and minimum flow rate without consuming any additional energy

3.15

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) 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	K	-°C
V	volume	m ³	l
q_V	volume flow rate	m ³ /s	l/s, m ³ /min, m ³ /h
f	frequency	Hz	
t	time	s	min

4.2 Subscripts

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

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.