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Vacuum technology — Standard methods for measuring vacuum pump performance —

Part 3: Specific parameters for mechanical booster vacuum pumps

Technique du vide — Méthodes normalisées pour mesurer les performances des pompes à vide —

Partie 3: Paramètres spécifiques aux pompes à vide intermédiaires mécaniques

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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 documents 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 112, *Vacuum technology*.

A list of all parts in the ISO 21360 series can be found on the ISO website.

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 specifies standard methods for measuring the performance characteristics of mechanical booster vacuum pumps. This document complements ISO 21360-1, which provides a general description of the measurement of performance data of vacuum pumps. This document takes precedence in the event of a conflict with ISO 21360-1.

The purpose of this document is to ensure that measurements of the performance characteristics of mechanical booster vacuum pumps are, as far as possible, carried out by identical procedures and under identical conditions. As a result, measurements conducted by different manufacturers or in different laboratories, and statements of performance quoted in manufacturers' literature, are intended to be obtained on a properly comparable basis to the benefit of both user and manufacturer.

Vacuum technology — Standard methods for measuring vacuum pump performance —

Part 3: Specific parameters for mechanical booster vacuum pumps

1 Scope

This document specifies methods and special requirements for measuring the maximum tolerable pressure difference, effective compression ratio, compression ratio with zero throughput and overflow valve pressure difference of mechanical booster vacuum pumps.

It applies to mechanical booster vacuum pumps employed for medium vacuum or rough vacuum applications including gas-cooled mechanical booster vacuum pump and multiple mechanical booster vacuum pump systems.

It covers particular characteristics of mechanical boosters that are different from those of the usual positive displacement vacuum pumps. Maximum tolerable pressure difference Δp_{max}, effective compression ratio K_{eff}, compression ratio with zero throughput K_0 and overflow valve pressure difference Δp_1 are special characteristics of the performance of mechanical booster vacuum pumps.

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 3529-1, *Vacuum technology — Vocabulary — Part 1: General terms*

ISO 3529-2, *Vacuum technology — Vocabulary — Part 2: Vacuum pumps and related terms*

ISO 3567, *Vacuum gauges — Calibration by direct comparison with a reference gauge*

ISO 21360-1:2012, *Vacuum technology — Standard methods for measuring vacuum-pump performance — Part 1: General description*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3529-1 and ISO 3529-2 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
mechanical booster vacuum pump
vacuum pump based on mechanical principles used between the backing pump and the high vacuum pump or process chamber to increase the throughput of the pumping system in medium vacuum or rough vacuum application, or to improve the compression within the system and so reduce the volume flow rate needed for the backing pump

Note 1 to entry: Several mechanical booster vacuum pumps may be cascaded for higher performance.

Note 2 to entry: In some applications, mechanical booster vacuum pumps are used for gas recirculation as well.

[SOURCE: ISO 3529-2:1981, 2.4.6, modified — The expressions "based on mechanical principles" and "or process chamber" have been added, "a medium range of pressure" has been replaced by "medium vacuum or rough vacuum application", " the pressure stages" has been replaced by "the compression".]

3.2
overflow valve pressure difference
Δp_1
pressure difference between the backing pressure p_3 and the inlet pressure p_1 immediately before the valve opens

3.3
maximum tolerable pressure difference
Δp_{max}
maximum pressure difference between the backing pressure p_3 and the inlet pressure p_1 that the test pump is able to withstand under continuous operation without any deterioration or damage

$$\Delta p_{max} = p_3 - p_1 \tag{1}$$

3.4
effective compression ratio
K_{eff}
ratio of the backing pressure p_3 to the inlet pressure p_1 of the mechanical booster vacuum pump

$$K_{eff} = \frac{p_3}{p_1} \tag{2}$$

4 Symbols

Symbol	Designation	Unit
D	inner diameter of test dome	m
D_N	nominal diameter of test dome	m
p_1	vacuum pressure on inlet	Pa (or mbar)
p_3	vacuum pressure in backing line	Pa (or mbar)
Δp_{max}	maximum tolerable pressure difference of test pump	Pa (or mbar)
K_0	compression ratio of test pump with zero throughput	—
$K_{0,max}$	maximum compression ratio of test pump with zero throughput	—
K_{eff}	effective compression ratio	—

Δp_1	overflow valve pressure difference of test pump	Pa (or mbar)
p_b	base pressure	Pa (or mbar)
u	measurement uncertainty	—

5 Measurement conditions

a) Environmental conditions shall be in accordance with ISO 21360-1.

b) Measurements are made with dry gas. Generally, test gas or air with relative humidity 65 % or below.

c) The backing pump shall provide an appropriate backing pressure and operate within normal working parameters during the measurement period.

d) There shall be no liquid in the pump housing of test pump, no medium other than the test gas shall be admitted in the housing.

e) Where cooling water is required, it shall be provided in accordance with manufacturer's specifications.

f) Rotational speed of the motor and the frequency controller system shall be in accordance with manufacturer's specifications. The rotational speed of the motor shall be within ± 3 % of the rated rotational speed.

g) It is recommended that all measurements be made with the same gas. Where different gases are used, the apparatus shall be purged with the new gas before measurement begins. In addition, it is preferable to use a gas independent vacuum gauge or a gauge calibrated for the test gases. A corresponding calibration table shall be provided for each gas species.

h) The leak rate of the experimental setup shall be less than 10^{-4} Pa·m^3/s. This shall be measured immediately before or immediately after the test.

6 Experimental setup

6.1 General

The test domes shall be clean and dry. The cleanness of the pump, seals and other components shall be appropriate for the expected base pressure. All components shall be assembled as shown in Figure 1 under clean conditions and in accordance with the manufacturer's instructions.

All measuring devices shall be calibrated either

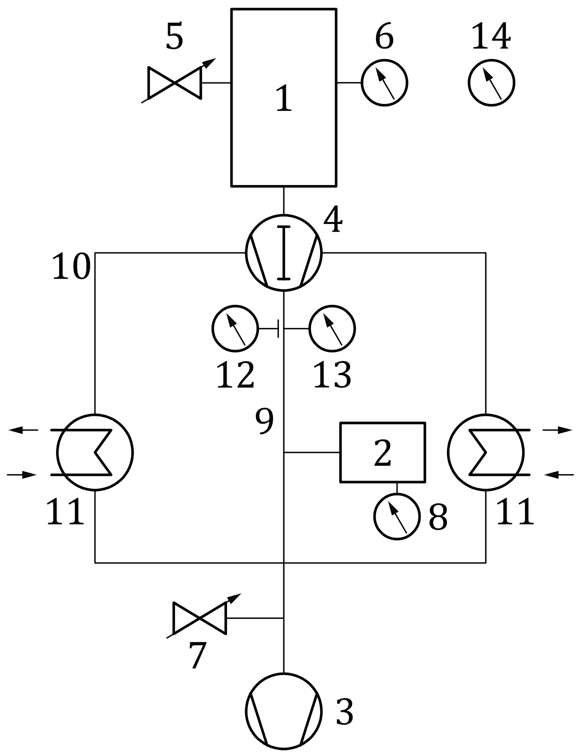
a) in a traceable way to a vacuum primary or national standard, or

b) by means of instruments of absolute measure which are traceable.

The pressure measurements are performed with total pressure vacuum gauges, which shall be calibrated as specified in ISO 3567, or by means of instruments which are traceable to SI units. In the case of calibrated measuring instruments, there should exist a calibration certificate in accordance with ISO/IEC 17025[3].

6.2 Schematic diagram

The schematic diagram of experimental setup is shown in Figure 1.



Key

1 test dome on test pump
2 buffer volume on backing line
3 backing pump
4 test pump
5 adjustable gas inlet valve A
6 vacuum gauge to measure p_1
7 adjustable gas inlet valve B
8 vacuum gauge to measure p_3
9 backing line
10 returning cooled-gas line (for gas-cooled mechanical booster vacuum pump only)
11 cooler (for gas-cooled mechanical booster vacuum pump only)
12 thermometer to measure housing temperature at outlet flange
13 thermometer to measure gas temperature at outlet
14 thermometer to measure ambient temperature

NOTE 1 The returning cooled gas line and cooler are required only if the test pump is a gas-cooled mechanical booster pump. For guidance on the design and manufacture of the measuring equipment, see Figure B.2.

NOTE 2 Adjustable gas inlet valve A (5) is not required to measure the compression ratio with zero throughput and overflow valve pressure difference.

Figure 1 — Experimental setup

For test pumps which exhaust the gas against atmospheric pressure, there is no backing pump (3) and the measurement of p_3 is replaced with a measurement of the ambient atmospheric pressure.

For gas-cooled mechanical booster pumps which exhaust the gas against atmospheric pressure, the cooling gas port should be opened to admit ambient air during measurement.

