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Pneumatic fluid power — Test methods for measuring acoustic emission pressure levels of exhaust silencers

Transmissions pneumatiques — Méthodes d'essai de mesure du niveau de pression d'émission acoustique des silencieux d'échappement

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Foreword

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This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

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 acoustic test procedure is intended to provide a common framework to industrial companies to evaluate the sound pressure levels of pneumatic exhaust silencers.

It defines two methods of measuring the level of acoustic pressure at the outlet of an exhaust silencer. These methods should be capable of being applied by pneumatic equipment manufacturers in their facilities on test benches in accordance with ISO 6358-1 and ISO 6358-2.

The first method, called "steady-state mode", is intended to evaluate the noise level under steady state flow, i.e. constant upstream pressure. This measurement is performed at 6,3 bar at least to permit comparison between silencers at the most frequently used operating pressure (or at the maximum admissible pressure if lower than 6,3 bars).

The second method, called "discharge", is intended to measure the noise level during the decrease of the pneumatic pressure (discharge test according to ISO 6358-2). To ensure the compatibility with the steady-state flow method, the pressure range includes 6,3 bar (or the maximum admissible pressure if lower than 6,3 bars).

Pneumatic fluid power — Test methods for measuring acoustic emission pressure levels of exhaust silencers

1 Scope

This document specifies two methods of measuring the level of acoustic pressure at the outlet of an exhaust silencer:

— the first method, called "steady-state mode", is intended to evaluate the noise level under steady state flow, i.e. constant upstream pressure (steady-state test according to ISO 6358-1); and

— the second method, called "discharge", is intended to measure the noise level during the decrease of the pneumatic pressure (discharge test according to ISO 6358-2).

This document is applicable to pneumatic exhaust silencers and devices designed to reduce the sound produced by discharges of compressed air, entering in the scope of application of ISO 6358-1 and ISO 6358-2.

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 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 6358-1, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 1: General rules and test methods for steady-state flow*

ISO 6358-2, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 2: Alternative test methods*

ISO 11202:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: specifications*

IEC 61260, *Electroacoustics. Octave-band and fractional-octave-band filters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11202 and ISO 6358-1 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
emission sound pressure
p
sound pressure, at a specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise as well as the effects of reflections other than those from the plane or planes permitted for the purpose of the test

Note 1 to entry: Emission sound pressure is expressed in pascals.

3.2
emission sound pressure level
Lp
ten times the logarithm to the base 10 of the ratio of the square of the emission sound pressure, p, to the square of a reference value, p_0

$$L\mathrm{p} = 10\log\left(\frac{p^2}{{p_0}^2}\right)$$

where the reference value, p_0, is equal to 20 µPa

Note 1 to entry: Emission sound pressure level is expressed in decibels.

3.3
measured equivalent continuous sound pressure level (A-weighted)
L_{Aeq}
ten times the logarithm to the base 10 of the ratio of the time average of the square of the emission sound pressure, p, during a stated time interval of duration, T (starting at t_1 and ending at t_2), to the square of a reference value, p_0

$$L_{Aeq,T} = 10\log\frac{\frac{1}{T}\int_{t_1}^{t_2} p_A^2(t)dt}{p_0^2}\,\mathrm{dB(A)}$$

where the reference value, p_0, is equal to 20 µPa and L_{Aeq} is the measured value obtained using the "L_{Aeq}" position of the sonometer

Note 1 to entry: Measured equivalent continuous sound pressure level is expressed in decibels.

Note 2 to entry: If specific frequency and time weightings as specified in IEC 61672-1 and/or specific frequency bands are applied, this is indicated by appropriate subscripts, e.g. L_{Aeq} denotes the A-weighted emission sound pressure level.

Note 3 to entry: The formula in 3.3 is equivalent to that for the environmental noise descriptor "equivalent continuous sound pressure level". However, the emission quantity defined above is used to characterize the noise emitted by a source under test and assumes that standardized measurement and operating conditions as well as a controlled acoustical environment are used for the measurements.

3.4
frequency range of interest
sound levels determined for frequencies from 100 Hz to 20 000 Hz

3.5
background noise
noise from all sources other than the source under test

Note 1 to entry: Background noise can include contributions from airborne sound, noise from structure-borne vibration and electrical noise in instrumentation.

3.6
background noise correction
K_{1A}
correction applied to the measured sound pressure levels to account for the influence of background noise

3.7
environmental correction
K_{2A}
term to account for the influence of reflected sound on the mean sound pressure level on the reference measurement surface

Note 1 to entry: Environmental correction is expressed in decibels.

4 Symbols and abbreviated terms

Symbols and units are in accordance with those defined in ISO 6358 and ISO 11202.

5 Test set-up

5.1 Test bench

According to the test method chosen, the test bench shall be in accordance with ISO 6358-1 (steady-state mode) or ISO 6358-2 (discharge mode). In particular, the size of the upstream measurement tube shall be in accordance with ISO 6358-1 specifications.

Relevant for the comparison of the sound emission is the pressure and the flow rate (flow rate is in this case a functional value to ensure that the silencer fits to the application). Therefore, it is recommended to use the test bench from ISO 6358-1 if possible as the measured flow rate is based on a stable pressure. If part two is chosen, the values of pressure and flow change significantly within the test due to the nature of the discharge method. Therefore, the value of the flow rate shows a wider tolerance range

5.2 Pneumatic pressure measurement

Only the pressure in the upstream pressure-measuring tube shall be measured. The instrumentation shall be in accordance with ISO 6358-1.

5.3 Flow measurement

The flow during the sound pressure measurement shall be recorded. The test set-up shall be strictly in accordance with ISO 6358-1.

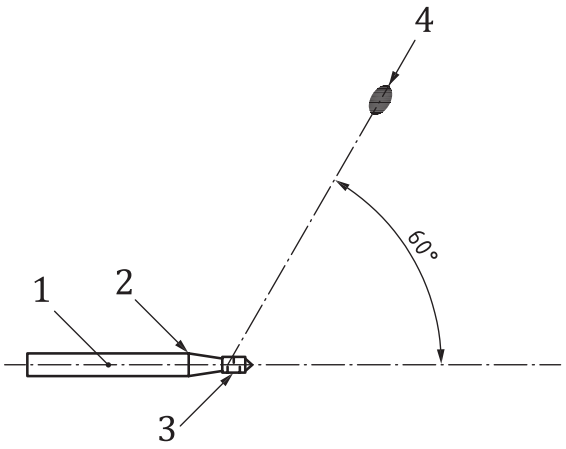
NOTE Correlative flow characteristic values are also recorded according to ISO 6358-1 or ISO 6358-2.

5.4 Sound pressure measurement

The measurement of sound pressure can be done at one or three positions. Measurement at three positions increases the precision of the result and reduces the uncertainty of the measurement. Direct incident flow on microphones should be avoided, due to noise generation by the microphones.

5.4.1 Measurement at one position

In this case, sound pressure shall be measured at one point positioned at 60° from the axis of the measurement tube, at 1 m from the centre of the end of the transition connector and at a height of 1 m, as shown in Figure 1.



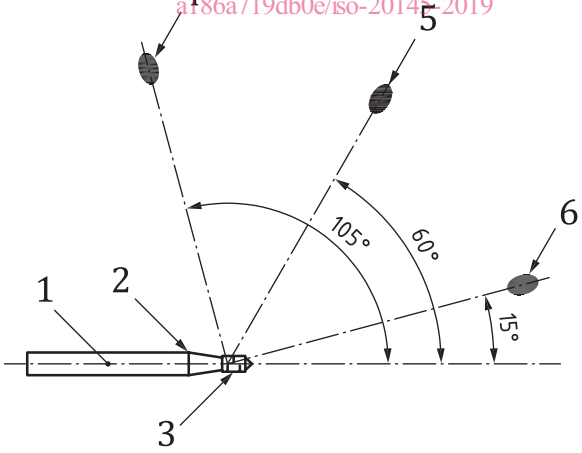
Key

1 upstream pressure measurement tube
2 upstream transition adapter
3 silencer under test
4 measurement point

Figure 1 — Arrangement of sound pressure measurement point (1 microphone)

5.4.2 Measurement at three positions

In this case, sound pressures shall be measured at three positions distributed around the arc of a circle 1m in radius and from the centre of the end of the pressure measurement tube and at a height of 1 m. The points shall be positioned at 15°, 60° and 105° from the axis of the tube, as shown in Figure 2.



Key

1 upstream pressure measurement tube
2 upstream transition adapter
3 silencer under test
4 measurement point n°3
5 measurement point n°2
6 measurement point n°6

Figure 2 — Arrangement of sound pressure measurement points (3 microphones)

5.5 Acoustic instrumentation

The entire measurement line, including the microphone and the cable, shall be in accordance with the instructions relating to instruments of class 1 specified in IEC 61672-1, and the filters shall, in this case, comply with class 1 requirements specified in IEC 61260. The microphones shall be equipped with windscreens. For the measurement in "steady-state mode", a class 1 integrating sound meter shall be used. Measurements in "discharge mode" demand the simultaneous acquisition of pneumatic pressure and sound pressure and shall therefore only be performed with an acquisition system having at least two measurement channels.

Before and after each series of measurements, the entire measuring system shall be checked by means of a sound calibrator, which shall fulfil the requirements for sound calibrators of at least precision class 1 according to IEC 60942, on one or more frequencies of the range of frequencies of interest. The difference between the two calibration series shall not exceed 0,5 dB. If the difference is over 0,5 dB, the results shall be rejected.

The acoustic calibrator shall be calibrated every year by a laboratory that performs calibrations under traceability conditions in conformity with appropriate standards. The measurement channel (sound meter or other) shall be verified at least every two years by a laboratory that can issue at least a verification certificate as per appropriate standards.

The dynamics of the measurement channel shall be adapted.

The pneumatic pressure sensor shall be in accordance with the recommendations of ISO 6358 and permit acquisition at a minimum sampling frequency of 10 Hz for working in discharge mode.

NOTE The reverberation time option for the sonometer is an advantage for qualifying the facilities.

6 Test procedure

6.1 Characterization and validation of the test facilities

The acoustic quality of the test facilities shall be characterised by determining its environmental correction K_{2A}.

This environmental correction can be obtained either from measuring the reverberation time, or through knowledge of the absorbent surfaces. The methods for determining factor K_{2A} are described in Annex A.

The measurements can only be made in an environment conforming to $K_{2A} < 4$ dB(A). Suggestions to improve the K_{2A} are given in Annex B.

In addition, the facilities shall permit a minimum distance between the microphones with respect to any reflecting object and component tested, i.e. at least 1 m (excluding the measurement tube and tank, if any). If the walls or ceilings are within 2 m of the microphone, they shall be covered with an absorbent material of class A, according to ISO 11654. In the case where the space is limited, the measurement points shall be positioned on the side with the most clearance.

The floor shall be acoustically reflective within the frequency range of interest.

6.2 Quantities to be measured

6.2.1 Basic quantities to be measured

The basic quantities that shall be measured are the pneumatic pressure in the upstream measuring tube and the equivalent continuous A-weighted sound pressure level L_{Aeq} at the positions specified in 5.4.