DRAFT INTERNATIONAL STANDARD ISO/DIS 10816-8

ISO/TC **108**/SC **2** Secretariat: **DIN**

Voting begins on **2012-12-15** Voting terminates on **2013-03-15**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts —

Part 8: Reciprocating compressor systems

Vibrations mécaniques — Évaluation des vibrations des machines par mesurages sur les parties non tournantes —

Partie 8: Systèmes de compresseurs alternatifs

ICS 17.160

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10816-8 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

ISO 10816 consists of the following parts, under the general title *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts*:

— Part 1: General guidelines

— Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1500 r/min, 1800 r/min, 3000 r/min and 3600 r/min

— Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ

— Part 4: Gas turbine sets with fluid-film bearings

— Part 5: Machine sets in hydraulic power generating and pumping plants, including measurements on rotating shafts

— Part 6: Reciprocating machines with power ratings above 100 kW

— Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts

— Part 8: Reciprocating compressor systems

— Part 21: Onshore wind turbines with gearbox

Introduction

ISO 10816-1 gives general guidelines for the evaluation of machine vibration by measurements on non-rotating parts. It establishes procedures and guidelines for the measurement and classification of mechanical vibration of reciprocating compressors. In general, this part of ISO 10816 refers to vibration of the main structure of the compressor, including the foundation, pulsation dampers and attached pipe system. The guidance values given for these vibrations are defined primarily to classify the vibration and to avoid problems with auxiliary equipment mounted on these structures. Recommendations for measurements and evaluation criteria are provided in this part of ISO 10816.

Typical features of reciprocating compressors are the oscillating masses, the cyclically varying torques, cylinder stretch and the pulsating forces in the cylinders, pulsation dampers and pipe system. All these features cause alternating loads on the main supports and vibration of the compressor system. The vibration values of reciprocating compressor systems are generally higher than for rotating compressors but, since they are largely determined by the design features of the compressor, they tend to remain more constant over the life of the system than for rotating machinery.

In the case of reciprocating compressor systems, the vibration measured on the main structure of the compressor including the foundation, pulsation dampers and piping and quantified according to this part of ISO 10816 may only give a rough idea of the vibratory states of the components within the machine itself.

The damage, which can occur when exceeding the guidance values based on experience with similar compressor systems, is sustained predominantly by machine-mounted components (e.g. instrumentation, heat exchangers, filters, pumps), connecting elements of the compressor with its peripheral parts (e.g. pipelines) or monitoring instruments (e.g. pressure gauges, thermometers). The question as from which vibration values damage is to be expected largely depends on the design of these components and their fastenings. In some cases, special measurements on certain compressor system components can be required to ascertain that the vibration values do not cause damage. It also happens that even if measured values are within the guidance values of this part of ISO 10816, problems can occur owing to the great variety of components which can be attached.

Local vibration problems as described above can be, and have to be, rectified by specific “local measures” (e.g. by elimination of resonances). Experience has shown, however, that it is possible in the majority of cases to state measurable quantities characterizing the vibratory state and to give guidance values for these. This shows that the measurable variables and the guidance values for acceptable vibration in most cases permit a reliable evaluation.

The vibration values of reciprocating compressor systems are not only affected by the properties of the compressor itself but also to a large degree by the foundation. Since a reciprocating compressor can act as a vibration generator, vibration isolation between the compressor and its foundation can be necessary. The vibration response of the foundation and the vibration from adjacent equipment can have considerable effect on the vibration of the compressor system.

Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts —

Part 8:
Reciprocating compressor systems

1 Scope

This part of ISO 10816 establishes procedures and guidelines for the measurement and classification of mechanical vibration of reciprocating compressor systems. The vibration values are defined primarily to classify the vibration of the compressor system and to avoid fatigue problems with parts in the reciprocating compressor system, i.e. foundation, compressor, dampers, piping and auxiliary equipment mounted on the compressor system. The guidelines are not intended for condition monitoring purposes.

This part of ISO 10816 applies to reciprocating compressors mounted rigidly with typical speed ratings greater than 120 r/min and up to and including 1800 r/min. The general evaluation criteria which are presented relate to operational measurements. The criteria are also used to ensure that machine vibration does not adversely affect the equipment directly mounted on the machine, e.g. pulsation dampers and the pipe system.

The machinery driving the reciprocating compressor, however, is evaluated in accordance with the appropriate part of ISO 10816 or other relevant standards and classification for the intended duty.

It is recognized that the evaluation criteria may only have limited application when considering the effects of internal machine components, e.g. problems associated with valves, pistons, piston rings may be unlikely to be detected in the measurements. Identification of such problems may require investigative diagnostic techniques which are outside the scope of this part of ISO 10816.

Noise is also outside the scope of this part of ISO 10816.

Examples of reciprocating compressor systems covered by this part of ISO 10816 are:

— horizontal, vertical, V-, W- and L-type compressor systems,

— constant and variable speed compressors,

— compressors driven by electric motors, gas and diesel engines, steam turbines, with or without a gearbox, flexible or rigid coupling,

— dry running and lubricated reciprocating compressors.

This part of ISO 10816 does not apply to hyper compressors.

2 Normative references

The following referenced documents are indispensable for the application 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 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 2954, *Mechanical vibration of rotating and reciprocating machinery — Requirements for instruments for measuring vibration severity*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 13373-2, *Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 2: Processing, analysis and presentation of vibration data*

ISO 18431-1, *Mechanical vibration and shock — Signal processing — Part 1: General introduction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 and the following apply.

3.1
compressor system
machinery system comprised of foundation, compressor (crankcase, crosshead guide, cylinders), pulsation dampers and piping

3.2
overall vibration value
vibration value measured in a frequency range from 2 Hz to 1000 Hz

3.3
purchaser
agency that issues the order and specification to the vendor

3.4
vendor
manufacturer or manufacturer's agent that supplies the equipment

4 Measurements

4.1 Measurement procedure

The primary measurement quantity shall be overall r.m.s. (root mean square) vibration velocity in mm/s.

If frequencies below 10 Hz are expected or observed, it is recommended additionally to measure the overall r.m.s. vibration displacement in mm (it is also common to display displacement in micrometres where 1 µm = 10^{-6} m).

If frequencies above 200 Hz are expected or observed, it is recommended additionally to measure the overall r.m.s. vibration acceleration in m/s^2 (it is still common to display acceleration in units of g where g = 9,81 m/s^2).

All values shall be within the values for acceptable overall vibration as summarized in 5.3.

Spectral data should be retrieved for each of the measured quantities if they exceed the vibration values of evaluation zone B/C as defined in 5.2 to aid in analysis and possible correction.

NOTE 1 Vibration acceleration values are often measured to carry out condition monitoring of internal compressor components. However, this part of ISO 10816 is not intended to be applied for condition monitoring purposes. For example, if the condition of the compressor valves is to be monitored, other procedures and standards with different values may apply. The vibration acceleration values given in this part of ISO 10816 should therefore only serve as a criterion to judge the overall integrity of the compressor system and attached equipment, e.g. pressure and/or temperature transmitters and valve lifting devices. When the acceleration values given in this part of ISO 10816 are exceeded this does not by definition imply that corrective actions are required. The susceptibility of components to high acceleration values (instruments, heavy components on small equipment nozzles, etc.), the presence of audible noise or knocking sounds or unusual or sudden changes should then become a point of attention and further analysis.

NOTE 2 The relationship between displacement, velocity and acceleration is given in Clause B.1.

Further on it should be kept in mind that the measured acceleration values on locations as shown in Figures 1 to 5 are not the values of the attached equipment but the values of the compressor system parts (foundation, crankcase, cylinder, dampers and piping) to which they are mounted.

4.2 Measuring instrumentation and measured quantities

Criteria for classifying vibration values for reciprocating compressor systems are specified in Clause 5. It is recognized that the main excitation frequencies for reciprocating compressor systems are generally found in the range 2 Hz to 300 Hz. However, when considering the complete compressor system, including auxiliary equipment that is a functional part of the compressor, a typical range 2 Hz to 1000 Hz is applied to characterize the overall vibration. For special purposes, a different range may be agreed between the vendor and purchaser.

Since the overall vibration signal usually contains many frequency components, there is no simple mathematical relationship between the r.m.s. and peak, or peak-to-peak overall vibration measurements, see Annex D.

Therefore the preferred measuring system should provide the r.m.s. values of displacement, velocity and acceleration with an accuracy of ±10 % over the range 10 Hz to 1000 Hz and with an accuracy of +10 % and –20 % over the range 2 Hz to 10 Hz. These values may be obtained from a single transducer whose signal is processed to derive the quantities not directly measured; preferably an accelerometer whose output is integrated once for velocity and twice for displacement. ISO 2954 gives requirements for instruments for measuring vibration severity. Guidelines on applying methods of signal processing and display, e.g. time and frequency domain, windowing and averaging, are covered in ISO 13373-2, ISO 18431-1 and common examples given in ISO 18431-2.

Care should be taken to ensure that any processing does not adversely affect the required accuracy of the measuring system. Both the frequency response and measured vibration values are affected by the method of attachment of the transducers. It is especially important to maintain a good attachment between the transducer and the compressor when the vibration velocities and frequencies are high. ISO 5348 gives guidelines on the mounting of accelerometers.

4.3 Locations and direction of measurements

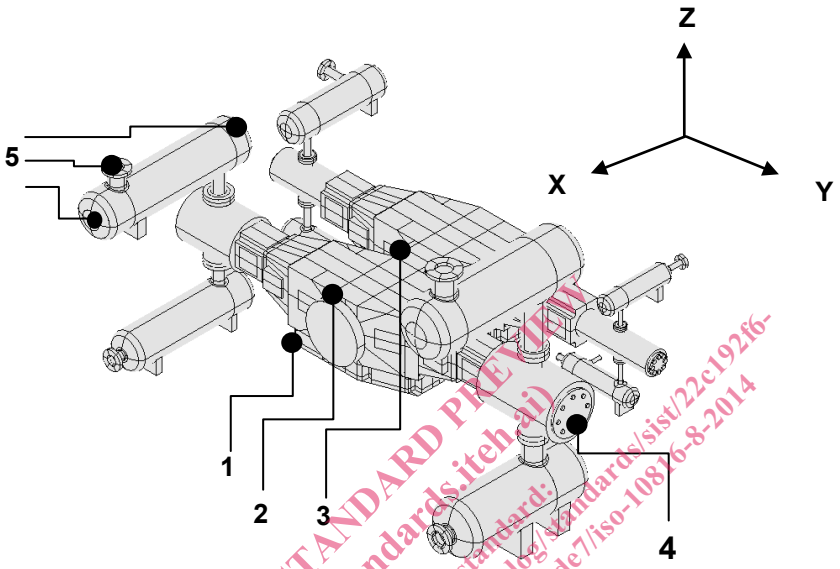
4.3.1 Locations

As a minimum, the vibration measurements shall be carried out on the locations shown in Figures 1 to 5 as follows:

- Foundation: at all compressor frame bolt locations;
- Frame (top): on each corner point and between all cylinders for a compressor with more than 2 cylinders, all at the top of the frame;
- Cylinders (lateral and rod): at the rigid part of each cylinder cover flange;
- Pulsation vessels: at the inlet and/or outlet pipeline flange and at the heads;

— Piping: at all critical parts of the system, to be determined by inspection and in agreement with the purchaser.

NOTE Accelerometers are often mounted on the crosshead guide for condition monitoring purposes of internal parts of the compressor. The vibrations are measured in the direction of the force exerted by the crosshead on this guide, which is in vertical direction of a horizontal compressor. Experience on horizontal compressors has shown that the vibration values measured on the crossheads guide can be used in addition to the vibration values of other locations to judge the integrity of the compressor. The procedure for measuring the vibration values on the crosshead guide are summarized in Annex C.



Key

1 All compressor frame foundation bolts

2 Each frame corner point

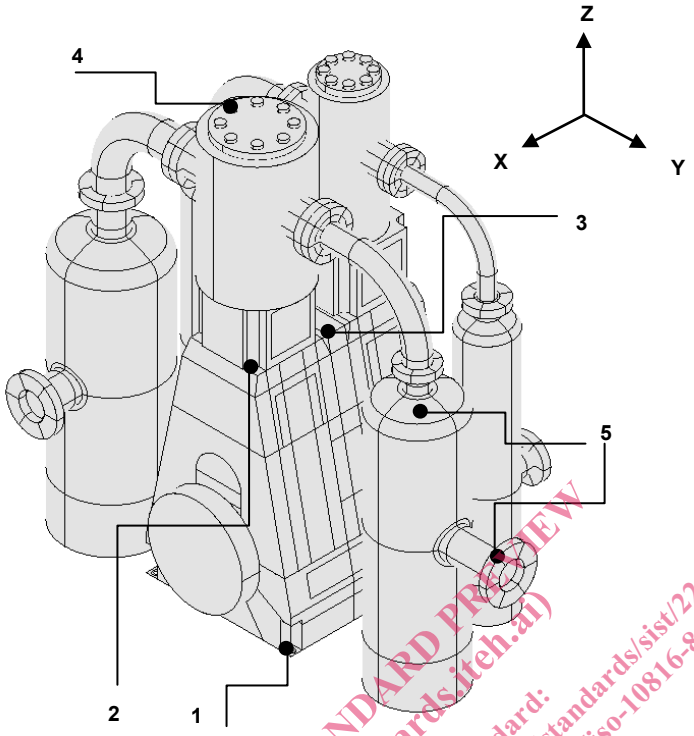
3 Each frame location between the cylinders (required for a compressor with more than one cylinder on the same side)

4 Each cylinder (cover flange at rigid location)

5 Pulsation vessels (only shown for one vessel in the figure)

NOTE For clarity, only one point is shown in the figure for most of the locations. Piping is not shown in the figure, so the measuring locations on the piping should be agreed upon with the vendor. A detailed description of the measurement directions is given in 4.3.2.

Figure 1 — Measuring locations for a horizontal compressor



Key

1 All compressor frame foundation bolts

2 Each frame corner point

3 Each frame location between the cylinders (required for a compressor with more than one cylinder on the same side)

4 Each cylinder (cover flange at rigid location)

5 Pulsation vessels (only shown for one vessel in the figure)

NOTE For clarity, only one point is shown in the figure for most of the locations. Piping is not shown in the figure, so the measuring locations on the piping should be agreed upon with the vendor. A detailed description of the measurement directions is given in 4.3.2.

Figure 2 — Measuring locations for a vertical compressor