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Sistemi za kontrolo tesnosti - 2. del: Zahteve in metode za preskušanje in ocenjevanje tlačnih in vakuumskih sistemov (vključno z dopolnilom A1)

Leak detection systems - Part 2: Requirements and test/assessment methods for pressure and vacuum systems

Leckanzeigesysteme - Teil 2: Anforderungen und Prüf-/Bewertungsmethoden für Über- und Unterdrucksysteme

Systèmes de détection de fuites - Partie 2 : Exigences et méthodes d'essai/d'évaluation des systèmes sous pression et à dépression

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23.020.01	Vsebniki za shranjevanje tekočin na splošno	Fluid storage devices in general
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Leak detection systems - Part 2: Requirements and test/assessment methods for pressure and vacuum systems

Systèmes de détection de fuites - Partie 2 : Exigences et méthodes d'essai/d'évaluation des systèmes sous pression et à dépression

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Contents

Page

European foreword

This document (EN 13160-2:2016+A1:2024) has been prepared by Technical Committee CEN/TC 393 “Equipment for tanks and filling stations”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2025, and conflicting national standards shall be withdrawn at the latest by August 2026.

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

This document includes Amendment 1 approved by CEN on 11 September 2024.

This document supersedes [A1⟩ EN 13160-2:2016 ⟨A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1].

[A1⟩ *deleted text* ⟨A1]

According to edition 2003 the following fundamental changes are given:

— requirements from EN 13160-1:2003 included, which are no longer contained in EN 13160-1:2016;

— new structure - technical requirements for the components divided; (pressure device, evaluation device, alarm device;

— technical requirements revised.

This European Standard *Leak detection systems* consists of 7 parts:

— *Part 1: General principles*

— *Part 2: Requirements and test/assessment methods for pressure and vacuum systems*

— *Part 3: Requirements and test/assessment methods for liquid systems for tanks*

— *Part 4: Requirements and test/assessment methods for sensor based leak detection systems*

— *Part 5: Requirements and test/assessment methods for in-tank gauge systems and pressurized pipework systems*

— *Part 6: Sensors in monitoring wells*

— *Part 7: Requirements and test/assessment methods for interstitial spaces, leak detection linings and leak detection jackets*

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This European Standard gives requirements and the corresponding test/assessment methods applicable to leak detection kits (leak detector) based on the measurement of pressure change. Leak detection kits are intended to be used with double skin, underground or above ground, pressurized or non-pressurized, tanks or pipework designed for water polluting liquids/fluids. The kits are usually composed of:

— measuring device;

— evaluation device;

— alarm device;

— pressure generator;

— pressure relief device;

— liquid stop device;

— condensate trap.

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.

EN 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*

EN 981:1996+A1:2008, *Safety of machinery — System of auditory and visual danger and information signals*

EN 12285-1, *Workshop fabricated steel tanks — Part 1: Horizontal cylindrical single skin and double skin tanks for the underground storage of flammable and non-flammable water polluting liquids*

EN 12285-2, *Workshop fabricated steel tanks — Part 2: Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids*

EN 13160-1:2016, *Leak detection systems — Part 1: General principles*

EN 13160-7, *Leak detection systems — Part 7: Requirements and test/assessment methods for interstitial spaces, leak detection linings and leak detection jackets*

EN 14879-4:2007, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 4: Linings on metallic components*

EN 61672-1, *Electroacoustic — Sound level meters — Part 1: Specifications (IEC 61672-1)*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13160-1:2016 and the following apply.

3.1.1
design pressure
maximum pressure expected to be applied to a system component

3.1.2
pressure full scale
full scale pressure value of the measuring device

3.1.3
working pressure
maximum pressure which is generated by a pressure/vacuum generator in the interstitial space under normal operating conditions

3.2 Symbols and abbreviated terms

F_e	is the exhaust flow rate of the pressure relief valve at p_e, in litres per hour
g	is the force of gravity, in metres per second squared
h	is the maximum filling height of the tank, in metres
h_G	is the maximum height of the groundwater related to the lowest point of the tank, in metres
h_1	is the filling height of the interstitial space due to alarm pressure p_{AE}, in metres
l	is the length of the interconnecting line, in metres
m_1	is the mass of air at T_1 and p_4
m_2	is the mass of air at T_2 and p_4
m_a	is the mass of the absorbed water per kg dry pearls, in kilograms per kilogram
m_{sch}	is the bulk weight of the dry pearls, in kilograms per cubic metre
Δm	is the difference between m_1 and m_2
p_a	is the set pressure of the pressure relief valve, in Pascal
p_{am}	is the measured set pressure of the pressure relief valve, in Pascal
p_{AA}	is the relative pressure at control point “alarm off”, in Pascal
p_{AE}	is the relative pressure at control point “alarm on”, in Pascal
p_e	is the pressure of p_{am} +5 % of the pressure relief valve, in Pascal
p_{PA}	is the working pressure of the leak detection kit and corresponds to the relative pressure at control point “pump off”, in Pascal

p_{PE} is the pressure of the leak detection kit and corresponds to the relative pressure at control point "pump on", in Pascal

p_{t2} pressure to which the interstitial space between the skins is subjected for testing, in Pascal

p_z is the closing pressure of the pressure relief valve, in Pascal

p_{zm} is the measured closing pressure of the pressure relief valve, in Pascal

p_0 is the operating pressure of the tanks and pipes, in Pascal

p_1 is p_{PA} + 100 000, in Pascal

p_2 is p_{PE} + 100 000, in Pascal

p_3 is p_{AE} + 100 000, in Pascal

p_4 is p_a + 100 000, in Pascal

Δp is the difference between p_{AE} and p_{PA}, in Pascal

Q_L is the flow rate of air due to leaks, in cubic metres per year

Q_S is the flow rate of air due to temperature variation exceeding opening pressure of the over pressure device, in cubic metres per year

Q_{gas} is the entire flow rate of air (Q_S + Q_L), in cubic metres per year

R is the general gas constant (here for air) = 287 J/(kgK)

T_0 is 15 °C = 288 K

T_1 is $T_0 + \Delta T_2$

T_2 is T_1 + 7,5 K

ΔT_1 is the temperature increase according to Formula (A.1), in Kelvins

ΔT_2 is the temperature increase according to Formula (A.2), in Kelvins

V is the proportional reduction of the interstitial space caused by ingress of liquid for assurance of the alarm, in per cent

V_A is the deflated air volume (by the pressure relief valve) in the leak detector), in cubic metres

V_k is the volume of interstitial space = 1 m^3

V_{max} is the max. volume of interstitial space, intended for this leak detector, in cubic metres

V_{TF} is the contents (volume) of the dry filter, in litres

V_0 is the entire volume of the interstitial space, in cubic metres

V_1 is the volume of the interstitial space at filling height h_1, in cubic metres

p_m is $(p_1 + p_2)/2$ average working pressure (absolute), in Pascal

ρ_G is the density of the groundwater, in kilograms per cubic metre

ρ_P is the density of the stored product in the tank, in kilograms per cubic metre

4 Requirements

4.1 Effectiveness

4.1.1 General

This type of leak detection kit is classified according to EN 13160-1:2016 as class I.

The general requirements on leak detection systems according to Clause 5 of EN 13160-1:2016 shall be met.

The interstitial space shall fulfil the requirements according to EN 13160-7, EN 12285-1 or EN 12285-2. The leak detection kit is not effective with an interstitial space volume exceeding 10 m^3.

NOTE To ensure the effectiveness of the system a vacuum leak detection kit can only serve one tank. Whereby a pipework may consist of several sections where the interstitial spaces are connected.

A complete documentation shall be provided by the manufacturer. The documentation shall contain the technical values according to 4.1.2 to 4.1.5, 4.2 and 4.3 as well as a statement about the reaction of the leak detection kit by over and under voltage and current.

The leak detection kit shall be equipped with an integrated test device for simulating a leak which shall result in an alarm.

4.1.2 Measure the pressure change

4.1.2.1 Measuring device for over pressure

Leak detection kit comprises of measuring device for over pressure to be connected to the interstitial space. The measuring device for over pressure shall fulfil the following requirements:

— pressure measuring range: given by the manufacturer;

— repeatability of the measurement according to manufacturer data;

— overload protection: at least 1,5 times of the working pressure (p_{PA});

— overpressure protection: at least 1,5 times of the pressure full scale.

The measuring device shall be connected to the interstitial space by a measuring line of the following minimum inside diameter:

— 6 mm for air based systems;

— 4 mm for inert gas based systems.

The colour of this measuring line shall be red or marked in red for indication.

4.1.2.2 Evaluation device for over pressure

The operating condition of the evaluation device shall be clearly indicated, i.e. by a “green” light.

The evaluation device shall be designed to be connected to an alarm device.

For leak detection kits with permanent connected pressure generator, the evaluation device shall provide a signal to the pressure generator that the pressure in the interstitial space does not exceed more than 90 % of p_{t2} and that a shut-off of the pressure generator is triggered.

— **For tanks**

The evaluation device shall evaluate the measuring device values. In case of a pressure drop in the interstitial space to the level before or at the value calculated in Formula (1) or Formula (2) a signal shall be sent to the alarm device.

$$p_{AE} = 3\,000 \text{ Pa} + \rho_P \cdot h \cdot g + p_0 \quad (1)$$

$$p_{AE} = 3\,000 \text{ Pa} + \rho_G \cdot h_G \cdot g \quad (2)$$

— **For pipes**

The evaluation device shall evaluate the measuring device values. In case of a pressure drop in the interstitial space to the level before or at the value calculated in Formula (3) a signal shall be sent to the alarm device.

$$p_{AE} = 0{,}1 \text{ MPa} + p_0 \quad (3)$$

4.1.2.3 Alarm device for over pressure

The alarm device shall generate an audible and visible alarm. The audible alarm shall have a sound level of ≥ 70 dB (A) in a distance of minimum 1 m with a signal according to Table 1 of EN 981:1996+A1:2008 which shall be maintained for a minimum period of 36 h. The audible alarm may be able to be switched off, but the status off should be visible.

The visible alarm shall be clearly indicated i.e. by a “red” light. The visible alarm shall have no switch off option.

The alarm device should be designed for connecting an additional alarm device, e.g. signal horn. The output parameter shall be stated.

A test possibility shall be provided to test the functionality of the audible and visible alarm.

4.1.2.4 Measuring device for vacuum

Leak detection kit comprises of measuring device for vacuum to be connected to the interstitial space. The measuring device for vacuum shall fulfil the following requirements:

— vacuum measuring range: given by the manufacturer;

— repeatability of the measurement: according to manufacturer data;

— overload protection against vacuum: minimum 1,1 times of the working vacuum (p_{PA}), at least however 60 kPa (600 mbar);

— if the measuring device is designed to be used on pressurized tanks or pipes, the measuring device shall withstand an overpressure of at least 1,1 times of the design pressure given by the manufacturer.

A condensate trap shall be provided for all lowest points of the measuring line.

The measuring device shall be connected to the interstitial space by a measuring line of 6 mm minimum diameter. The colour of this measuring line shall be red or marked in red.

4.1.2.5 Evaluation device for vacuum

4.1.2.5.1 General

The operating condition of the evaluation device shall be clearly indicated, i.e. by a "green" light.

The evaluation device shall be designed to be connected to an alarm device.

For assurance of the alarm the volume of the interstitial space has to be reduced by increasing liquid, see Formula (4):

$$V = (1 - \frac{100000\,\text{Pa} - p_{PA}}{100000\,\text{Pa} - p_{AE}}) \cdot 100 \text{ in } \% \qquad (4)$$

Due to the alarm pressure p_{AE} the interstitial space is filled (in the case of a leak) up to the height h_1 compared with the lowest point of the tank, see Formula (5):

$$h_1 = \frac{p_{AE}}{g \cdot \rho_P} \text{ or } h_1 = \frac{p_{AE}}{g \cdot \rho_G} \qquad (5)$$

Under consideration of tank geometry or geodetic differences in the levels of the double wall pipe systems the volume of the interstitial space V_1 at filling height h_1 has to be determined by calculation (or by measurement in litres), see EN 13160-7.

The alarm is considered reliable, if the following condition is fulfilled, see Formula (6):

$$V < \frac{V_1}{V_0} \qquad (6)$$

NOTE The above mentioned calculation would be carried out for tanks with a suction line down to the lowest point of the interstitial space. An analogue application is required for tanks without a suction line or for pipework, i.e. the line of reference for the height h_1 is the horizontal line through the lowest point, at which the suction line is connected with or ends in the interstitial space. For tanks with a suction line down to the lowest point of the interstitial space it is the end of the suction line on the lowest point and for tanks without a suction line down to the lowest point of the interstitial space it is the suction nozzle at the top of the tank.

4.1.2.5.2 Without integrated vacuum generator

For the application of these systems the following conditions shall be fulfilled:

— a suction line (for the vacuum pump to be installed outside) which shall be led down to the lowest point of the interstitial space;

  or

— at above-ground tanks, as an alternative, a control nozzle may be installed at the lowest point of the interstitial space.

The vacuum pressure (relative value) at p_{AE} shall be at least 35 kPa.

The vacuum pressure (relative value) of the working pressure shall be at least 70 kPa.

4.1.2.5.3 With integrated vacuum generator

The evaluation device with integrated vacuum generator for tanks and pipes shall evaluate the measuring device values. In case of a pressure rise in the interstitial space to the level before or at the value:

a) as high as the pressure calculated according to Formula (7)

$$p_{AE} = 3\ 000\ \text{Pa} + \rho \cdot g \cdot h \tag{7}$$

or

b) of 3 kPa, if the suction line in the interstitial space is led down to the lowest point

or

c) of 25 kPa for flat-bottom tanks with double bottom

an appropriate signal shall be sent to the alarm device.

For leak detection kits with permanent connected vacuum generator, the evaluation device shall provide a signal to the vacuum generator that the vacuum in the interstitial space does not exceed more than 90 % of p_{t2} and that a shut-off of the vacuum generator is triggered.

4.1.2.6 Alarm device for vacuum

The alarm device shall generate an audible and visible alarm. The audible alarm shall have a sound level of ≥ 70 dB (A) in a distance of minimum 1 m with a signal according to Table 1 of EN 981:1996+A1:2008 which shall be maintained for a minimum period of 36 h. The audible alarm may be able to be switched off but the status off should be visible.

The alarm device should be designed for connecting an additional alarm device, e.g. signal horn. The output parameter shall be stated.

The visible alarm shall be clearly indicated i.e. by a “red” light. The visible alarm shall have no switch off option.

A test possibility shall be provided to test the functionality of the audible and visible alarm.

4.1.3 Replenishment rate of the medium (only if provided)

4.1.3.1 Vacuum and pressure generators with regulated flow rate

The volume flow at the alarm pressure shall be (85 ± 15) $l \cdot h^{-1}$ if a pressure/vacuum generator is used.

The pressure/vacuum generator shall be connected to the interstitial space by an interconnecting line of the following minimum inside diameter:

— 6 mm for air based systems;

— 4 mm for inert gas based systems.

The colour of this interconnecting line shall be white or clear or marked in white for indication.

The total flow resistance of the interconnecting line between the pressure generator and the double skin tank or pipe may be not more than 1 kPa (10 mbar) at (85 ± 15) $l \cdot h^{-1}$.

NOTE This requirement is fulfilled for air-based systems, when the length of the interconnecting line is ≤ 50 m for an inner diameter of the interconnecting line of 6 mm.

4.1.3.2 Pressure / vacuum generator with time regulated flow

The average volume flow (measured over a refill and a control period) at the alarm pressure shall be (85 ± 15) $l \cdot h^{-1}$ if a pressure/vacuum generator is used.

The pressure/vacuum generator shall be connected to the interstitial space by an interconnecting line of the following minimum inside diameter:

— 6 mm for air based systems;

— 4 mm for inert gas based systems.

The colour of this interconnecting line shall be white or clear or marked in white for indication.

The total flow resistance of the interconnecting line between the pressure generator and the double skin tank or pipe may be not more than 1 kPa (10 mbar) at (85 ± 15) $l \cdot h^{-1}$.

NOTE This requirement is fulfilled for air-based systems, when the length of the interconnecting line is ≤ 50 m for an inner diameter of the interconnecting line of 6 mm.

4.1.4 Software (only if provided)

The software, where provided, shall have a facility for self-checking by fulfilling the following requirements:

— a self-diagnostic mode to test the integrity of the system at start up and periodically during use. A negative result of self-diagnostic mode shall result in an alarm condition;

— a facility to check the consistency of the input and output data, malfunction shall result in an alarm condition.

4.1.5 Function and tightness of leak detection kit

All leak detection kits shall

— be equipped with a device for simulating a leak which shall result in an alarm;

— withstand the operation pressure/vacuum as well as the pressure of tanks or pipes or the hydrostatic pressure of tanks and shall be tight under these conditions;

— have an opening and closing pressure of the pressure relief device in the range given by the manufacturer.

The devices for simulating a leak shall have clearly identified operating position.

4.2 Durability of effectiveness

4.2.1 Durability of effectiveness against temperature

The temperature ranges for leak detection kits shall be as follows:

— Type 1: −20 °C to +60 °C;

— Type 2: 0 °C to +40 °C;

— Type 3: −40 °C to +40 °C.

4.2.2 Durability of effectiveness against chemical attack

Parts of leak detection kits which may come into contact with the liquid of the stored/conveyed product or its vapour shall be resistant.

4.2.3 Durability of effectiveness against fatigue through cycling of pressure

Leak detection kits shall withstand 10 000 cycles of pressure changes.

4.2.4 Humidity measurement of the leak detection medium (only if provided)

A dry filter shall be sized so that it has not to be exchanged within one year, provided a tight system.

A device shall indicate proper function.

4.3 Additional requirement

4.3.1 Over pressure change

Each pressure relief device shall have the following parameters given by the manufacturer:

— set pressure, $p_{a;}$

— exhaust flow rate, F_e at a pressure p_e;

— closing pressure $p_{z;}$

— operational temperature range, i.e. underground, frost protected or open air.

NOTE The intention of a pressure relief device is to prevent a higher pressure in the interstitial space than p_{t2}. The higher pressure results from a temperature rise or a failure of the pump control.

4.3.2 Vacuum change

4.3.2.1 Liquid stop device

The liquid stop device shall stop the flow of liquid in the suction line of the vacuum generator under consideration of the pressures and the temperature ranges.

The liquid stop device can be

1) a mechanical device (usually called liquid stop valve), e.g. floater moving up in case of liquid. By floating up the suction line is closed;

2) a device combined of a sensor and a solenoid valve, e.g. the sensor detects the presence of liquid and by this the solenoid valve is closed.

If the sensor device is additionally connected to the evaluation device and the evaluation device is sending an alarm to the alarm device then 4.1.2.5.1 is no longer applicable.

The liquid stop device shall fulfil the following requirements:

— resist the working pressures of the evaluation device;

— resist the operating pressure of the tank or pipework;

— trigger an alarm when the sensor is wetted (only if applicable).