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Vacuum drainage systems inside buildings

Avlopp – Vacuumsystem

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EUROPÄISCHE NORM

EN 12109

April 1999

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English version

Vacuum drainage systems inside buildings

Réseau d'évacuation sous vide à l'intérieur des bâtiments

Unterdruckentwässerungssysteme innerhalb von Gebäuden

This European Standard was approved by CEN on 3 March 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 12109:1999 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165 "Waste water engineering", 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of an identical text or by endorsement, at the latest by October 1999, and conflicting national standards shall be withdrawn at the latest by October 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard is a system standard.

A vacuum drainage system is a designed system. Each system is individually designed and based upon a specification with specific design parameters for the application and the selected equipment.

This European Standard contains additional information of importance to specifiers, designers, constructors and operators.

This European Standard has three normative and three informative Annexes.

1 Scope

This European Standard specifies system requirements (performance)and the principal requirements for design and installation with related verification and test methods for vacuum drainage systems inside buildings transporting domestic wastewater from dwellings and commercial properties but excluding stormwater and rainwater.

If requirements for products used within the system are needed, Annex D (informative) provides guidance to performance requirements, design, verification and quality assurance.

The gravity system which feeds the wastewater to the vacuum drainage system is not covered by this European Standard.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1085
Waste water treatment - Vocabulary

prEN 1717
Protection against pollution of potable water in drinking water installations and general requirements of devices to prevent pollution by backflow

prEN 12056-2
Gravity drainage systems inside buildings - Part 2: Waste water systems, layout and calculation

EN 60204
Safety of machinery - Electrical equipment of machines

IEC 335-2-84
Safety of Household and Similar Electrical Appliances - Part 2-84: Particular Requirements for Toilets

3 Definitions

For the purpose of this European Standard, the definitions according to EN 1085 and the following definitions apply.

3.1 α-factor
Variable factor used to calculate probable static loss from theoretical static loss.

3.2 discharge unit
Unit of measurement for the wastewater outflow of appliances.

3.3 interface unit
Assembly with an interface valve and a buffer volume receiving wastewater.

3.4 interface valve
Valve which admits the flow of wastewater only or wastewater and air into the vacuum drainage system pipeline.

3.5 analysis
Breaking a requirement down to its constituent parts for clear evaluation.

3.6 service connection
Section of vacuum pipeline connecting an individual Interface Unit to the vacuum main.

3.7 automatic interface unit (AIU)
Assembly consisting of an interface valve, buffer volume, sensor and controller.

3.8 dynamic losses
Sum of losses caused by inertia, friction and lifts when the water is in motion.

3.9 pipe profile
Vertical elevation of the vacuum pipeline.

3.10 *K*-factor
Variable reduction factor used in design calculations to take into account the frequencies of use of sanitary appliances in different types of buildings.

3.11 air-water ratio (A/W-ratio)
Ratio of the volume of air to the volume of wastewater passed through an interface unit for each cycle of operation.

3.12 buffer volume
Storage volume of the interface unit which balances the incoming flow of wastewater to the output capacity of the discharge valve.

3.13 reforming pocket
Low point in the piping profile installed intentionally to produce a controlled slug flow.

3.14 slug
Isolated quantity of wastewater flowing full bore through the vacuum pipeline.

3.15 forwarding pump
Pump installed at the vacuum station to deliver the wastewater from the vacuum system.

3.16 inspection
Visual review of drawings, hardware or installation.

3.17 static loss
Loss of vacuum due to lifts when the system is at rest.

3.18 lift
Section of vacuum pipeline with an increase in invert level in the direction of flow.

3.19 theoretical static loss
Static loss obtained by considering every lift full of water.

3.20 vacuum
Any pressure below atmospheric.

3.21 vacuum container
Container connected to the vacuum pump, the vacuum drainage pipelines and a means of discharge.

3.22 vacuum drainage
Transportation of wastewater by vacuum.

3.23 vacuum recovery time
Time taken, after the operation of an interface valve, for the vacuum at the valve to be restored to its operational value.

3.24 vacuum generator
Equipment installed at the vacuum station to generate and maintain the vacuum within the system.

3.25 vacuum station
Installation comprising vacuum generator(s), a means of discharge and control equipment and which may also incorporate vacuum vessel/holding tank(s).

3.26 vacuum toilet
Toilet incorporating an interface unit and a means of rinsing.

3.27 controller
Device which, when activated by its level sensor, opens the interface valve and, after the passage of wastewater and normally air, closes the valve.

3.28 available vacuum differential
Difference between the vacuum level in the vacuum station and the initial vacuum needed to operate an interface unit.

3.29 availability
Operating time of a vacuum drainage system divided by its operating time plus time out of service.

3.30 data submittal
Supplying detailed information supporting compliance with the requirements of this standard.

3.31 probable static loss
Theoretical static loss multiplied by a probability factor.

3.32 water valve
Controlled valve regulating the entry of flush water of a vacuum toilet.

4 System description

A vacuum drainage system is a drainage system under sub-atmospheric pressure where:

- the wastewater is let into the pipework through interface units,
- most of the air necessary for the transportation of the wastewater enters through interface units,
- the interface units are normally operated by the pressure differential to atmosphere.

This European Standard considers the vacuum drainage system in four system elements:

- automatic interface units (AIU)
- vacuum toilets
- pipework
- vacuum station

The system is based upon the principles of intermittent transport and immediate access to vacuum.

When the interface valve is opened the difference in pressure between the atmosphere and the main pipeline pushes the volume of water and normally several times that volume of air through the service connection into the main pipeline. This creates a large local pressure differential which accelerates the water in the vicinity. As the pressure is equalized and the air is rushing through the system, it sequentially accelerates several independent masses of water that have accumulated in the low points of the pipework. This movement of water takes place in both directions, but the slope has a directional effect on the water flow.

After a number of repeated accelerations of water slugs, the air has lost most of its kinetic energy and cannot create any more pumping action. For indoor systems the transportation length is normally within the reach of every interface unit. For longer systems the interface units have to interact to provide the necessary pumping action.

For a vacuum drainage system, it is necessary to sequentially generate high acceleration and self-cleansing velocities without the use of tremendous amounts of energy.

NOTE: A vacuum drainage system is NOT a reversed pressure system where all the water would be accelerated simultaneously.

5 Principal design factors

5.1 General

The general performance of a vacuum drainage system is governed by its principal design factors:

- Safety and Health
- Availability,
- Reliability
- Maintainability
- Noise and Odour Control
- Energy Economy
- Fire Resistance

For Assessment of General Performance, see clause 12.

5.2 Health and safety

The principal objectives for health and safety are:

- There shall be no danger to public health.
- There shall be no danger to operating personnel.
- There shall be no danger to existing adjacent structures or services.

Potential hazards, identified through experience or analysis, shall be eliminated or controlled in accordance with the following order of precedence:

- Design to eliminate hazards
- Use of safety devices
- Use of warning devices
- Use of special procedures

The following safety requirements apply:

- All electrical equipment design shall be in accordance with EN 60204.
- The installation shall be in accordance with current national regulations and codes.
- All electrical equipment situated in sewage or sewage gases shall be explosion proof.
- All electrically operated vacuum toilets shall conform to IEC 335-2-84.
- Vacuum toilets shall ensure that sub-atmospheric pressures, which could cause harm to the user, cannot be generated in the bowl, if flushed when sealed from above.
- Installation instructions shall include requirements for securing the pipework.
- System Operations and Maintenance Manuals shall include detailed safety instructions. Potential safety hazards caused by component failure(s) or improper use shall be addressed.

The following health requirements apply:

- Where interface units are directly connected to a potable water system, they shall comply with prEN 1717.
- The bowl of the vacuum toilet shall have an impervious and smooth surface and shall be easily cleaned in order to provide long term hygienic performance.
- Instructions and procedures concerning handling of components contaminated by human waste shall be included in the Operations and Maintenance Manual.

5.3 Availability

Availability for a system, part of a system, or a component is expressed as:

$$\textit{availability} = \frac{\textit{operating hours}}{\textit{operating hours} + \textit{hours of service}} \tag{1}$$

System availability shall be addressed as part of system design.

High availability implies:

- High reliability
- Component failures will be of short duration and have a limited effect
- Redundancy for key components and power supply
- Rapid fault finding, isolation and repair
- Easy maintainance

The systems shall be designed such that malfunctioning branches or sub-systems can be isolated.

The maximum number of interface units per system and per sub-system can be specified.

Failure of one interface unit should not be allowed to affect the performance of adjacent interface units or toilets. If this cannot be achieved, each interface unit shall have a means of being isolated manually to stop the airflow. This procedure shall be incorporated within the operation and maintenance manuals.

No valve cycle may occupy the line for more than a short period of time, not normally exceeding 10 seconds, in order not to block other units from operating.

5.4 Reliability

System reliability expressed as the number of failures in a year, is to a large extent dependant upon the number of valve cycles performed during that period. A system reliability prediction shall be performed as part of system design and shall at least address the following:

- Number of AIUs and Vacuum Toilets to be installed
- Estimated cycles per day per AIU and vacuum toilet in the planned application
- Estimated total number of valve cycles per day for the system
- Reliability data as supplied by the manufacturers of the interface units and the vacuum station equipment.

5.5 Maintainability

System maintainability affects not only maintenance cost but also system availability. At least the following aspects shall be addressed as part of system design:

- Access to interface units, isolation valves, cleanouts etc.
- Maintenance schedules for interface units in relation to cycle frequency and endurance
- Estimated repair or replacement times of interface units
- Maintenance schedules for vacuum station equipment
- Estimated repair or replacement times for vacuum station equipment.

5.6 Noise and odour control

5.6.1 Noise

The specifier shall be responsible for specifying the permitted noise levels and test methods. The system shall be designed, constructed and installed in such a way that noise nuisance will not occur.