SLOVENSKI STANDARD
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Naprave za generiranje in doziranje biocidov za čiščenje pitne vode in vode v bazenih na kraju samem - Ozon

In-situ generating and dosing devices of biocides for drinking and swimming pool water treatment - Ozone

Anlagen zur In-Situ-Erzeugung und Dosierung von Bioziden zur Aufbereitung von Trink- und Schwimm- und Badebeckenwasser - Ozon

Dispositifs de génération et de dosage in situ de biocides pour le traitement de l’eau - Ozone

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In-situ generating and dosing devices of biocides for drinking and swimming pool water treatment - Ozone

Anlagen zur In-Situ-Erzeugung und Dosierung von Bioziden zur Aufbereitung von Trink- und Schwimm- und Badebeckenwasser - Ozon

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 164.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (prEN 17971:2023) has been prepared by Technical Committee CEN/TC 164 “Water supply”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

If devices according to this standard are to be used in other fields of application (e.g. wastewater and air treatment and surface disinfection), additional requirements shall be observed, if relevant. In particular, the requirements for feed gas can differ for other applications.

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.

1 Scope

This document is applicable to devices for the generation and dosing of the biocide ozone. The ozone is generated in these devices according to the technology of dielectric barrier discharge. According to EN 1278 and EN 15074, ozone is suited for the use of the treatment of water intended for human consumption (drinking water), respectively for the treatment of swimming pool water. Ozone can be added to the water for disinfection and for oxidative purposes. This standard may be also applied for other technologies to generate ozone, e.g. electrolysis or UV irradiation, as far as reasonable or applicable.

This standard specifies the devices construction, and test methods for the equipment used for *in situ* generation of ozone. It specifies requirements for instructions for installation, operation, maintenance, safety and for documentation to be provided with the product.

The *in situ* generation of active substances, in particular ozone, is subject to the specifications of the Biocidal Products Regulation (EU) 528/2012 (BPR) [10]. The use of ozone for the purpose of disinfection/microbiological preservation of water requires compliance with the provisions of the BPR, in particular access by the user or his device manufacturer to a data set required for the authorization of ozone under the BPR.

The *in situ* generation of ozone for the predominant purpose of oxidation of ingredients of water is subject to the specifications of the REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) [11] Regulation (EC) 1907/2006. The use for oxidative purposes requires access by the user to the data set provided for the authorization of ozone under REACH.

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 12876, *Chemicals used for treatment of water intended for human consumption - Oxygen*

EN 60529, *Degrees of protection provided by enclosures (IP Code)*

EN 10088-3, *Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN ISO 385, *Laboratory glassware - Burettes (ISO 385)*

EN ISO 648, *Laboratory glassware - Single-volume pipettes (ISO 648)*

EN ISO 4788, *Laboratory glassware - Graduated measuring cylinders (ISO 4788)*

EN ISO 7393-2, *Water quality - Determination of free chlorine and total chlorine - Part 2: Colorimetric method using N,N-dialkyl-1,4-phenylenediamine, for routine control purposes (ISO 7393-2)*

EN ISO 13849-1, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1)*

EN ISO 13849-2, *Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2)*

EN ISO 24450, *Laboratory glassware - Wide-necked boiling flasks (ISO 24450)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

NOTE In addition, the terminology contained in Article 3 of the BPR [10] is useful for the application of this document.

3.1
ozone generator
part of the ozone generation device where feed gas is carried through a dielectric barrier discharge field with the purpose of generating ozone

3.2
ozone generation device
entire device that is necessary for the generation of ozone from the feed gas, including e. g., power supply and ozone generator

3.3
ozone system
combination of devices which, in addition to the ozone generation device and ozone dosing device, both described in this document, also comprises devices for the distribution of and reaction with ozone

Note 1 to entry: All ozone exposed equipment or devices, e.g. reaction vessels, pumps, pipes, tanks or heat exchangers, are considered as part of the ozone system.

3.4
closed ozone system
ozone system where ozone does not leave the ozone system, or such that only negligible release of ozone into the building or into the environment occurs

3.5
open ozone system
any system not considered as a closed ozone system according to 3.4

3.6
feed gas
substance that is fed to the ozone generation device to generate ozone

3.7
dew point
parameter, in °C, to indicate the content of humidity in a gas

Note 1 to entry: The dew point refers to the temperature to which a gas shall be cooled to become saturated with water vapor, assuming constant air pressure and water content.

Note 2 to entry: When air is cooled below the dew point, its moisture capacity is reduced and airborne water vapor will condense to form liquid water known as dew. When this occurs via contact with a colder surface, dew will form on that surface.

3.8
residual ozone destructor
device for the destruction of residual ozone that has not been consumed in the ozone system and is accumulating in gaseous form in an off-gas flow

Note 1 to entry: The destruction takes places in the gas phase by converting the ozone (O_3) into oxygen (O_2). When the application/use of a residual ozone destructor is required, the ozone destructor shall be considered as an integral part of the ozone system.

3.9
normal temperature and pressure of gas
gas under the conditions of normal temperature t_n = 0 °C and normal pressure p_n = 101 325 Pa

3.10
normal cubic meter
$m^3{}_n$
cubic meter of gas, usually dry, referenced to 1 atmosphere (101 325 kPa) and 0 °C, i.e. to normal temperature and pressure of gas

Note 1 to entry: the unit is expressed $m^3{}_n$. In other documents the unit Nm^3 is sometimes used

[SOURCE: EN ISO 20675:2021, 3.41]

3.11
ozone systems operating at negative pressure
system whose parts and pipes, as far as they carry an ozone-containing gas, are all under negative pressure from the ozone generation device up to the mixing device

3.12
ozone systems operating at positive pressure
system whose parts and pipes, as far as they carry an ozone-containing gas, are all or partly under positive pressure from the ozone generation device up to the mixing device

3.13
expert
person who, due to their technical scientific training, work experience and knowledge of applicable standards and regulations, is able to assess an ozone system with regards to functions and safety

Note 1 to entry: This person can be from the manufacturer or an independent third-party organization (such as a test institution) without limitations, an inspector according to, EN ISO/IEC 17020 Type C, fulfils this criterion.

3.14
separate lockable installation room
lockable technical room with access for a restricted group of persons, in which the ozone generation device, and eventually other parts of the ozone system are installed, and furthermore in which other technical equipment can be installed

3.15
individual installation room
technical room in which only the ozone generation device is installed and operated

Note 1 to entry: term includes also enclosures for installation

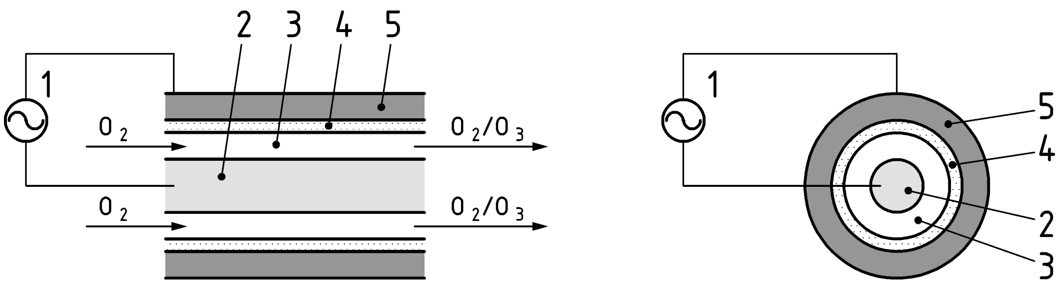
4 Technology of Dielectric Barrier Discharge to generate Ozone

Dielectric barrier discharge (DBD) is the basis for most of the commercial ozone generators. In practise, several other terms of the same meaning are in use instead of DBD: silent discharge, silent electrical discharge, silent arc discharge, corona discharge.

In dielectric barrier discharge, ozone is generated using energy from electrons in an electrical field between two electrodes. The electrodes are usually two parallel plates or concentric cylinders arranged with a certain distance to each other to form a single- or a double discharge gap. The electrodes are isolated from each other by a dielectric (non-conducting) barrier material and the discharge gap, see Figure 1.

The precursor is ambient air or oxygen gas, also called feed gas. Ozone (O_3) is generated from oxygen (O_2) of the feed gas that is piped through the discharge gap, see Figure 1. When the electrical field generated by the high voltage applied at the electrodes exceeds the insulation field strength of the feed gas in the discharge gap, the discharge in the feed gas initiates. The discharge creates a current of electric charged particles, consisting of electrons and ions. In the discharge area, the intended chemical reaction takes place: $3\ O_2 \rightarrow 2\ O_3$ (summarized). After a short time, i.e. some microseconds, the discharge current is interrupted by the dielectric being polarized by the discharge current, because the polarization of the dielectric compensates the driving electrical field. As the applied high voltage is an alternating voltage, the process repeats with opposite sign of the driving electrical field, which has consequently, the moment the new discharge initiates, the same direction as the electrical field of the dielectric. As before, the discharge is interrupted when the polarization of the dielectric is inverted and compensates the driving electrical field. Thus, the alternation of the applied high voltage enables an ongoing process generating ozone.

The alternation of the applied voltage occurs rapidly. An alternation period is much shorter than the transition time required for the gas to pass the ozone generator so that the ozone is homogeneously distributed in the gas leaving the device as ozone output. Consequently, the ozone output of DBD-devices is constant and without interruption or drops, if the feed gas supply is continuously guaranteed, if the ambient conditions, e.g. temperature or pressure, are stable, and finally if the high voltage supply runs constant.



Key

1 electric power supply — alternating voltage

2 inner electrode

3 discharge gap

4 dielectric

5 outer electrode

Figure 1 — Example for ozone generation in an alternating electrical field in a single discharge gap formed by concentric electrodes and a dielectric barrier

However, the energy of the electric power supply is only partially consumed to generate ozone. The excess of energy is converted to heat that needs to be dissipated by efficient cooling.

Details of the chemistry of the ozone generation are pointed out in clause “Chemistry”.

5 Distinguishing characteristics of ozone generation devices

5.1 General

Ozone generation devices are distinguished according to the characteristics of 5.2 to 5.5.

5.2 Design type of the ozone generation devices

Devices of compact or free design, i.e. spatially grouped or separated installation of equipment (see Clause 8).

5.3 Operating pressure

Ozone generators may be designed for operation at negative or positive pressure. The size of the ozone generating elements substantially depends on the operation frequency as well as on the pressure conditions inside the discharge compartment. Ozone systems can be constructed as ozone systems operating at negative pressure or at positive pressure according to 3.11 respectively 3.12.

5.4 Feed gas

The following types of feed gas shall be used as precursor to generate ozone, for purity requirements of the feed gas see 9.2:

a) ambient air;

b) oxygen.

5.5 Cooling of the ozone generator

Air cooling: convection or forced draft cooling.

Liquid cooling: e.g. water (cooling by direct discharge or by cooling circuit), coolant brine.

6 Technical data of the ozone generation device

The ozone generation device shall be specified by the following technical data, which shall be stated in the operating instructions:

a) manufacturer or distributor and name of device type/model;

b) type of feed gas and pressure range[1] as well as purity/quality requirements;

c) maximum allowable dew point of the feed gas inside the direct supply line to the ozone generator under normal temperature and pressure, in °C;

d) volumetric flow rate of the feed gas at the direct supply to the ozone generator at normal temperature and pressure for the nominal output of ozone generation, in m^3_n/h;

e) type, volumetric flow rate, in l/h or m^3/h, and temperature, in °C, of the cooling agent and other quality requirements of the cooling agent;

f) maximum allowable pressure of the cooling agent, in MPa;

1 in MPa [rel], stating negative pressure as a negative numerical value

g) nominal output of ozone generation, in g/h, at the nominal ozone concentration, in g/ m^3_n (the volume is related to normal temperature and pressure);

h) setting or control range of ozone generation, in g/h or in % of the nominal output, stepwise or continuously;

i) operating pressure of the ozone generator; maximum allowable negative or positive pressure, in MPa[2];

j) electrical supply data of the ozone generation device: voltage, in V; electric current, in A; apparent supply power, in VA; and frequency, in Hz;

k) Specific Energy (for high voltage power supply) (Wh or kWh) to generate 1 g or 1 kg of ozone from the supplied feed gas (not taken into account: electric power used for pre treatment of feed gas etc., for comparison reasons);

l) principal dimensions of the device, in m or mm;

m) operating weight of the device; in kg;

n) maximum and minimum allowable ambient temperature, in °C, and maximum relative humidity, in %, inside the installation room.

7 Name-plate

At least the following information shall be given clearly and permanently on a name-plate affixed to the ozone generation device:

a) manufacturer or distributor, including his address;

b) designation of model, series or type;

c) designation of device (e.g. ozone generation device);

d) year of manufacture;

e) type, batch or serial number;

f) CE label;

g) type of feed gas;

h) nominal output of ozone generation, in g/h or kg/h;

i) volumetric flow rate of the feed gas at the measuring point under normal temperature and pressure for the nominal output of ozone generation, in m^3_n /h;

j) electrical supply data, in V, A, VA, Hz;

k) allowable operating pressure of the ozone generator, in MPa[3].

2 in MPa [rel], stating negative pressure as a negative numerical value
3 in MPa [rel], stating negative pressure as a negative numerical value

8 Equipment and materials of ozone systems

8.1 General

Ozone systems can include the equipment described in 8.2 to 8.5.

8.2 Equipment for the supply of feed gas

The required equipment is specified according to the type and state of the feed gas that is to be used for the generation of ozone.

Devices operating with ambient air as feed gas may require equipment to operate with dry air. This type of equipment comprises an adsorber system, which is filled with a moisture adsorbing material and through which the feed gas is passed, incorporating upstream or downstream cooling aggregates, if necessary. The adsorption material should be regenerative. For the operation with dry feed gases (dew point at normal temperature and pressure below −45 °C) no drying device is required. Depending on the technical design of the ozone generator, this part of the device will be operated at negative or positive pressure; the equipment for the gas transport shall be implemented according to this condition.

For devices that are operated with oxygen, additional nitrogen-feeding components can be applied.

8.3 Equipment for cooling of the ozone generator

To dissipate the heat that is produced inside the ozone generator during the generation of ozone, cooling devices are necessary where the heat can be dissipated by means of gases, liquids or heat radiation.

8.4 Materials

8.4.1 Materials for parts in contact with feed gas

The materials of the equipment shall be suitable for the supply of feed gas. The materials shall be grease- and oil-free if oxygen is used as the feed gas.

8.4.2 Materials for parts in contact with ozone

Stainless steels, e.g. material numbers 1.4571, 1.4404, 1.4307 (also called SS 316L and SS 304L respectively); aluminium, e.g. Al 99,8; ceramics or glass, appropriate plastics, e.g. polytetrafluoroethylene (PTFE) and, for the generation of ozone from air, polyvinylidene fluoride (PVDF) or unplasticized poly(vinyl chloride) (PVC-U)[4]. Concerning sealing materials, ozone-resistant polymers can be used, e.g. polytetrafluoroethylene (PTFE) and, when taking into account the conditions of use, also chlorosulphonyl polyethylene (CSM), fluororubber (FPM or FKM), perfluoroelastomer (FFPM or FFKM), ozone resistant ethylene propylene diene monomer rubber (EPDM) and ozone resistant silicones.

8.5 Electrical equipment

Electric devices and machinery shall be designed with the minimum degree of protection IP21 according to EN 60529 if no higher degree of protection is required by the installation site, e.g. IP53. If these devices and machinery do not provide direct access, IP00 according to EN 60529 is sufficient as long as the electro-technical safety standard for this type of room is observed.

4 PVC-U material used for ozone gas piping is suited only for ozone systems operating at negative pressure to avoid exhaust of ozone in case of a leakage in the piping. When using PVC-U piping for ozone gas at positive pressures, additional safety requirements such as leak monitoring may be required.