

# ***Geregistreeerde Belgische norm***

**NBN EN 15219+A1**

2e uitg., januari 2008

**Normklasse: S 29**

## **Waterbehandelingsinstallaties in gebouwen - Nitraatverwijderingstoestellen - Eisen voor prestatie, veiligheid en beproeving**

Appareils de traitement d'eau à l'intérieur des bâtiments - Dispositifs de dénitratisation - Exigences de performances, de sécurité et d'essais

Water conditioning equipment inside buildings - Nitrate removal devices - Requirements for performance, safety and testing

**Toelating tot publicatie: 29 januari 2008**

Vervangt NBN EN 15219 (2007).

Deze Europese norm EN 15219+A1:2007 heeft de status van een Belgische norm.

Deze Europese norm bestaat in drie officiële versies (Duits, Engels, Frans).

***norme belge  
enregistrée***

**NBN EN 15219+A1**

2e éd., janvier 2008

**Indice de classement: S 29**

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**Autorisation de publication: 29 janvier 2008**

Remplace NBN EN 15219 (2007).

La présente norme européenne EN 15219+A1:2007 a le statut d'une norme belge.

La présente norme européenne existe en trois versions officielles (allemand, anglais, français).

English Version

**Water conditioning equipment inside buildings - Nitrate removal  
devices - Requirements for performance, safety and testing**

Appareils de traitement d'eau à l'intérieur des bâtiments -  
Dispositifs de dénitrification - Exigences de performances,  
de sécurité et d'essais

Anlagen zur Behandlung von Trinkwasser innerhalb von  
Gebäuden - Nitrattentfernungsanlagen - Anforderungen an  
Ausführung, Sicherheit und Prüfung

This European Standard was approved by CEN on 4 November 2006 and includes Amendment 1 approved by CEN on 21 October 2007.

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 CEN Management Centre 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 CEN Management Centre has the same status as the official versions.

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## Foreword

This document (EN 15219:2006+A1:2007) has been prepared by Technical Committee CEN/TC 164 "Water supply", the secretariat of which is held by AFNOR.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2008 and conflicting national standards shall be withdrawn at the latest by May 2008.

This document includes Amendment 1, approved by CEN on 2007-10-21.

This document supersedes EN 15219:2006.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** and **A1**.

With respect of potential adverse effects on the quality of water intended for human consumption caused by the product covered by this European Standard, the following is pointed out to the user:

- 1) this European Standard provides no information as to whether the product may be used without restriction in any of the Member States;
- 2) it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## 1 Scope

This European Standard specifies requirements relating to the construction and mode of operation and relevant methods for testing automatic, salt-regenerated, anion exchange nitrate removal devices for drinking water installations inside buildings, which are permanently connected to the mains supply.

**NOTE** Products intended for use in water supply systems are to comply, when existing, with national regulations and testing arrangements that ensure fitness for contact with drinking water. The Member State's relevant regulators and the EC Commission agreed on the principle for a future unique European Acceptance Scheme (EAS) which would provide a common testing and approval arrangement at European level.

If and when the EAS is adopted, European Standards on products will be amended by the addition of an Annex Z/EAS under Mandate M/136, which will contain formal references to the testing, certification and product marking requirements of the EAS. Until the EAS comes into force, the current national regulations remain applicable.

## 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.

EN 973, *Chemicals used for treatment of water intended for human consumption — Sodium chloride for regeneration of ion exchangers*

EN 1717, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow*

EN 14743, *Water conditioning equipment inside buildings — Softeners — Requirements for performance, safety and testing*

EN 15161, *Water conditioning equipment inside buildings — Installation, operation, maintenance and repair*

EN 60335-1, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2001, modified)*

EN ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

EN ISO 3822-1, *Acoustics — Laboratory tests on noise emission from appliances and equipment used in water supply installations — Part 1: Method of measurement (ISO 3822-1:1999)*

EN ISO 3822-3, *Acoustics — Laboratory tests on noise emission from appliances and equipment used in water supply installations — Part 3: Mounting and operating conditions for in-line valves and appliances (ISO 3822-3:1984)*

EN ISO 10304-1, *Water quality — Determination of dissolved fluoride, chloride, nitrite, orthophosphate, bromide, nitrate and sulphate ions, using liquid chromatography of ions — Part 1: Method for water with low contamination (ISO 10304-1:1992)*

EN ISO 11885, *Water quality — Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy (ISO 11885:1996)*

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

### 3 Terms and definitions

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

#### 3.1

##### **blending device**

internal or external device used to blend treated with untreated water

#### 3.2

##### **brining**

main phase of the regeneration process, during the course of which the brine flows through the bed of resin for the purpose of exchanging the nitrate ions fixed during the service run by chloride ions, and thereby recovering the exchange capacity of the resin bed

#### 3.3

##### **brining efficiency**

link, expressed in grams of nitrate ion ( $\text{NO}_3^-$ ) per kilogram of salt, between the exchange capacity and the salt consumption

#### 3.4

##### **anion exchange resin**

synthetic material that has the capability to exchange anions reversibly

#### 3.5

##### **continuous flow rate**

maximum flow rate at which a duplex appliance can operate continuously (24 h a day) without a premature breakthrough of nitrate

#### 3.6

##### **duplex appliance**

system employing two resin tanks, enabling the production of uninterrupted treated water supply

#### 3.7

##### **exchange capacity of the nitrate removal unit**

quantity of nitrate, expressed in grams of nitrate ion, fixed by the device between the end of the last regeneration and the beginning of the exhaustion of the resin

NOTE 1 The end of the regeneration is defined as the moment when the unit is available for service.

NOTE 2 The resin is considered to be exhausted when the residual nitrate concentration of the treated water increases above a defined value.

#### 3.8

##### **monitoring device**

time controller, flow integrator, resin exhaustion sensor or a combination of these, used to determine the appropriate moment in the operating cycle for regeneration to begin and to initiate that regeneration

#### 3.9

##### **nominal flow rate**

flow rate of water, expressed in cubic metres per hour, at which a pressure drop of maximum 100 kPa is established

#### 3.10

##### **operating cycle**

two successive and repetitive runs: the treated water run (or service) and the regeneration run

**EN 15219:2006+A1:2007 (E)****3.11****operating range**

physical and chemical conditions (temperature, pressure, flow rate, chemical water composition) within which a nitrate removal unit can operate and meet its performance guarantees

**3.12****pressure drop**

decrease in pressure between the inlet and outlet of the unit, expressed in kilopascals, at nominal flow rate

**3.13****regeneration process**

part of operating cycle, during which all the operations needed to restore the ion exchange capacity of a resin bed are carried out

**3.14****regeneration water**

quantity of water, expressed in litres (or in cubic meters), necessary for a complete regeneration process, including water used for the preparation of the brine

**3.15****residual nitrate concentration**

nitrate concentration of water sampled at the outlet of a unit during the service run

**3.16****salt consumption**

quantity of salt, expressed in kilograms, used for each regeneration

**3.17****salt tank**

tank containing the regenerating salt and the brine production device

**3.18****nitrate removal device**

complete installation necessary for the production of treated water

**3.19****nitrate removal unit**

appliance employing the anion exchange principle and which generally comprises the following constituent parts:

- pressure vessel containing the anionic ion exchange resin and devices for distributing and collecting hydraulic flows;
- devices for monitoring hydraulic flows (water and brine) through a multi-way valve or a set of pipes and multiple valves;
- tank (called salt-tank) for storage of the regeneration salt and production of the brine

**3.20****volume of resin**

quantity of anion exchange resin, expressed in litres, indicated on the rating plate or in the technical documentation

## 4 Requirements

### 4.1 Nitrate removal devices specification

Nitrate removal devices shall include all of following features and equipment:

- a) resin tank, control valve, brine tank, monitoring device;
- b) automatic regeneration;
- c) continuity of supply during regeneration;
- d) manual override facility;
- e) protection against backflows.

Some devices in the market are intended to remove nitrates and to soften water simultaneously (see Annex A). These are commonly known as “mixed beds” and include a mixture of anionic and cationic resin that regenerates simultaneously. These devices shall comply with this European Standard and also with EN 14743, except for the items stated in 4.3.8 and 4.4.4 and relevant tests that are specifically covered in this European Standard for this kind of devices.

NOTE When necessary to meet national or local provisions, the nitrate removal devices may be required to include additional features; for example:

- automatic initiated regeneration after a certain period without regeneration;
- feature to control microbiological growth.

### 4.2 Quality of materials and chemicals

#### 4.2.1 Anion exchange resin

The anion exchange resin used in the nitrate removal device shall be certified by the resin manufacturer to be suitable for its intended application.

#### 4.2.2 Regenerating salt

Salt shall comply with national and local regulations. All requirements of this European Standard are based on the use of sodium chloride (NaCl) in accordance with EN 973 as regenerating salt.

NOTE Some countries also allow the use of potassium chloride (KCl) as regenerating salt.

### 4.3 Design and manufacturing specifications

#### 4.3.1 Resistance to hydrostatic pressure

The nitrate removal unit shall resist, without visible damage nor leakage, a hydrostatic pressure of 1,5 times the maximum design pressure or 1 000 kPa, whichever is the greater for  $10^{+2}_{-1}$  min as defined in 7.4.1.

#### 4.3.2 Resistance to cyclic pressure

The nitrate removal unit shall resist, without visible damage nor leakage, a cyclic pressure test of not less than 5 000 cycles with the pressure fluctuating at a frequency of  $15^{+2}_{-1}$  cycles per minute between 150 kPa and 1,3 times the maximum design pressure as defined in 7.4.2.

**EN 15219:2006+A1:2007 (E)****4.3.3 Minimum and maximum operating pressure**

When tested in accordance with 7.1.3 d), the nitrate removal device shall operate and regenerate to the requirements of this European Standard with a minimum water supply pressure of 200 kPa and a maximum pressure not less than 60 % of the maximum design pressure.

**4.3.4 Resistance to temperature**

The nitrate removal device shall be designed to operate and regenerate to the requirements of this European Standard with water temperatures between 5 °C and 25 °C and with ambient temperatures between 5 °C and 35 °C.

**4.3.5 Electrical safety**

Nitrate removal units shall conform to the requirements for safety of electrical appliances in accordance with EN 60335-1.

**4.3.6 Salt tank**

The salt tank shall be equipped with a cover to prevent the intrusion of dust and foreign bodies, and an overflow of ample dimensions.

The capacity of the salt tank shall be such that it permits a minimum of five regenerations between refills.

**4.3.7 Continuity of supply during regeneration**

The nitrate removal device design shall permit continuity of the water supply during regeneration (see 7.4.3).

**4.3.8 Protection against backflow and infiltration of brine**

- a) Nitrate removal device shall include an appliance to prevent backflows into the main supply, in accordance with the national implementation of EN 1717. If such an appliance is not evident, the nitrate removal device shall be tested in accordance with 7.4.4.1. There shall be no water or brine collected from the vacuum reservoir.
- b) Infiltration of brine into the treated water supply during normal operation shall also be verified by testing in accordance with 7.4.4.2. In no outlet samples, the chloride concentration shall exceed 1,5 mmol/l over that of the inlet water.

**4.3.9 Noise level**

The nitrate removal unit shall conform to noise levels defined and measured in accordance with EN ISO 3822-1 and EN ISO 3822-3 for both the service and regeneration runs.

**4.3.10 Air vent**

The design shall ensure that any trapped air shall be released in normal operating conditions (see 7.4.5).

**4.3.11 End connections**

The fittings used to assemble the device and to connect it to existing pipework shall conform to the requirements of ISO 7-1 and EN ISO 228-1.

**4.3.12 Drain connections**

The regeneration drain shall be independent from the salt tank overflow.

## **4.4 Operating specifications**

### **4.4.1 Initiation of regeneration**

Regeneration shall be initiated automatically (see 7.5.3.2 a)). Each nitrate removal unit shall also be equipped with a provision for manual initiation of regeneration (see 7.5.3.1).

For a timer controlled device the actual time at which regeneration is initiated shall not vary from that set on the time-clock by more than 30 min (see 7.5.3.2 b)).

For a volume controlled device the volume of water treated between regenerations shall be within 10 % of the programmed water volume (see 7.5.3.2 c)).

For a device which regenerates on the detection of exhaustion of the resin, the exchange capacity of the unit shall not vary by more than 10 % of the rated capacity of the equipment (see 7.5.3.2 d)).

### **4.4.2 Brining efficiency**

When measured under the conditions defined in 7.5.4 and 7.5.5, each kilogram of salt used during a regeneration shall produce a minimum exchange capacity of 140 g (2,26 mol) of nitrate ion.

### **4.4.3 Regeneration water**

When measured in accordance with 7.5.6, the volume of water necessary for a complete regeneration shall not be more than 0,40 l/g of nitrate ion fixed between two regenerations.

### **4.4.4 Quality of treated water after regeneration**

When tested in accordance with 7.5.7, the sodium content after a regeneration shall not exceed 1,5 mmol/l of that of the inlet water.

For mixed beds (see 4.1 and Annex A), in which sodium concentration is modified by the softening resin, to the obtained value in 7.5.7 shall be deducted the sodium increase due to softening resin exchange (see 7.5.7).

### **4.4.5 Continuous flow rate**

For duplex appliances, the nitrate removal efficiency shall be sustained under continuous operation (24 h a day) with test water as defined in 7.1.2.

The contact time shall ensure sufficient dissolution of the salt in the salt tank at the continuous flow rate in order to comply with treated water quality and brine efficiency as defined in 4.4.2 and 4.4.4.

### **4.4.6 Pressure drop**

The pressure drop at the nominal flow rate shall be no greater than 100 kPa, when the bypass valve and blending valve, if fitted, are closed, and shall be verified in accordance with 7.5.2.

### **4.4.7 Exchange capacity**

The exchange capacity, calculated by taking the arithmetic mean of five measurements in accordance with 7.5.4, shall be at least 90 % of the exchange capacity specified by the manufacturer.

**EN 15219:2006+A1:2007 (E)****4.5 Installation specifications****4.5.1 Connection to mains water supply and existing pipe network**

The nitrate removal device shall include the following equipment:

- a) isolating valves upstream and downstream from the nitrate removal unit;
- b) general bypass valve that enables the nitrate removal unit to be isolated from the mains, while maintaining the water supply to the end-user.

**4.5.2 Drain**

The independent regenerant drain and brine tank overflow shall each incorporate a backflow prevention device which has an air gap of at least 20 mm.

**4.5.3 Electrical connection**

The electrical connection of the nitrate removal unit shall conform to EN 60335-1.

**5 Labelling****5.1 Identification of equipment**

The name of the manufacturer or supplier and trade mark, shall be clearly visible on the installation.

A rating plate fixed on the nitrate removal unit shall give information on the type of equipment and serial number or manufacturing date.

**5.2 Safety labelling**

A rating plate, fixed to the nitrate removal unit, combined with or separate from the one indicated in 5.1, shall give the following minimum information:

- a) class of pressure (PN);
- b) working temperature range;
- c) electrical connections: voltage, frequency;
- d) power rating;
- e) protection class;
- f) resin type (only for mixed beds).

The rating plate shall indicate clearly to initiate an operation of full regeneration, in event of the device being out of service for periods longer than 96 h.

**6 Technical documentation**

Each device shall be accompanied by technical documentation in the language of the country where it is installed. In addition to the information defined in Clause 5, this document shall give all the necessary information and instructions for sizing, installation, operation and maintenance, and at the very least:

- a) volume of resin;
- b) nominal flow rate;
- c) exchange capacity and brine efficiency in accordance with this European Standard, i.e. EN 15219 and EN 14743, if the device incorporates hardness reduction by cation exchange;
- d) dimensions, service weight;
- e) type and size of fitting/plumbing connections;
- f) maximum power rating;
- g) continuous flow rate (for duplex appliances);
- h) salt and other reagent consumption;
- i) regeneration water;
- j) details of operation, safety devices, devices for backflow prevention;
- k) additional features (see 4.1, NOTE);
- l) instructions for sizing;
- m) instructions for installation;
- n) instructions for commissioning;
- o) instructions for shutting down and safe operation;
- p) instructions for maintenance.

## 7 Test methods

### 7.1 Test conditions

#### 7.1.1 Ambient air

The temperature of the environment in the immediate vicinity of the test rig shall be  $(20 \pm 5) ^\circ\text{C}$ .

#### 7.1.2 Water and salt

The raw water supply used to verify compliance of a nitrate removal device with this European Standard shall comply with the following quality parameters:

|                           |                                               |
|---------------------------|-----------------------------------------------|
| temperature:              | $(15 \pm 10) ^\circ\text{C}$ ;                |
| conductivity:             | $< 100 \mu\text{S}/\text{cm}$ ;               |
| chloride concentration:   | $< 1,5 \times 10^{-3} \text{ mol}/\text{l}$ ; |
| total iron concentration: | $< 0,2 \text{ mg}/\text{l}$ .                 |

**EN 15219:2006+A1:2007 (E)**

For the tests, add sodium nitrate solution ( $\text{NaNO}_3$ ) and sodium sulphate solution ( $\text{Na}_2\text{SO}_4$ ) (both reagent grade) to raw water using dosing pumps, to obtain the test water with the following concentrations which shall be maintained throughout the tests:

- nitrate ion ( $\text{NO}_3^-$ ):  $(150 \pm 10) \text{ mg/l}$ ;
- sulphate ion ( $\text{SO}_4^{2-}$ ):  $(150 \pm 10) \text{ mg/l}$ .

The test water may alternatively be prepared as a bulk solution that contains these nitrate and sulphate ion concentrations to avoid the use of dosing pumps.

The salt used for tests shall conform to the requirements of EN 973.

**7.1.3 Test rig**

- a) Test rig shall be equipped with a water meter and flow meter. Connect the device to the water supply, power supply (if appropriate) and drain in accordance with the manufacturer's instruction (see Clause 6 m)). Include all of the components supplied that are appropriate for the installation including hoses, bypass valves, connectors etc.
- b) Commission the device in accordance with the manufacturer's instructions (see Clause 6 n)).
- c) Operate the device for at least 15 cycles (two cycles for units with more than 50 l of resin), including service and regeneration at a service flow rate of at least 30 % of the nominal flow rate for the nitrate removal device. The minimum time between two regenerations specified by the manufacturer shall be respected. For volume and resin exhaustion initiated regeneration, allow the automatic system to initiate regeneration. For timer controlled devices, regeneration shall be initiated manually, based on its rated capacity for the test water composition.
- d) After a service break of 24 h operate for a further five operating cycles, using the same operating conditions as those used above, to verify the performance of the device with respect to its operating characteristics (see 7.5). At least one of these runs shall be carried out with the supply pressure reduced to 200 kPa and at least one at a maximum of 60 % of the maximum design pressure as indicated in 4.3.3 with a minimum of 600 kPa.

**7.1.4 Analysis****7.1.4.1 Nitrate**

Determine the concentration of nitrate ion in accordance with EN ISO 10304-1.

**7.1.4.2 Sodium**

Determine the concentration of sodium ion in accordance with EN ISO 11885.

### 7.1.4.3 Total hardness

- a) Determine total hardness in accordance with EN ISO 11885.

NOTE Alternative methods may be used provided that they give equivalent results.

- b) Calculate the total hardness according to Equation (1):

$$TH = [Ca^{2+}] + [Mg^{2+}] \quad (1)$$

where

$TH$  is the total hardness, in mmol/l;

$[Ca^{2+}]$  is the calcium concentration, in mmol/l;

$[Mg^{2+}]$  is the magnesium concentration, in mmol/l.

## 7.2 Anion exchange resin

The manufacturer shall provide documentary evidence of conformity with the requirements for resins in contact with drinking water (see 4.2.1).

## 7.3 Technical documentation

From the manufacturer's documentation provided with the nitrate removal device, confirmed by thorough examination, that the minimum information requirements stipulated in Clause 6 are included.

## 7.4 Manufacturing tests

### 7.4.1 Resistance to hydrostatic pressure

- All components supplied with the nitrate removal device shall be included in the hydrostatic pressure test.
- If an unused device is tested, carry out at least one regeneration to ensure that air is expelled from the pressure vessel, control head and associated components.
- Locate all components behind a safety screen.
- Close the outlet isolation valve.
- Leave the drain connection free and in a visible position.
- Connect a manually operated hydraulic pressure testing pump, with a safety pressure gauge, to the inlet of the device. Develop the hydrostatic test pressure of 1 000 kPa over a minimum period of 30 s with the water at ambient temperature. The pressure shall be maintained for  $10^{+2}_0$  min.
- There shall be no visible evidence of damage or leakage.
- Slowly release the pressure after the test.

### 7.4.2 Resistance to cyclic pressure

- All of the components supplied with the nitrate removal device shall be included in the cyclic pressure test.
- If an unused nitrate removal device is tested, carry out at least one regeneration to ensure that air is expelled from the pressure vessel, control head and associated components.

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- c) Locate all components behind a safety screen.
- d) Connect a pump, capable of delivering a pressure of at least 1,5 times the maximum design pressure at the nominal flow rate of the device, via a pressure gauge to the inlet of the nitrate removal device.
- e) Connect the outlet through an automatic valve and isolation valve to a tank feeding the suction of the pump. The automatic valve shall be equipped with an adjustable limit closing stop.
- f) Start the pump and throttle the outlet isolation valve, with the automatic valve fully open, to give an inlet pressure of 150 kPa.
- g) Adjust the limit stop on the automatic valve to give an inlet pressure of 1,3 times the manufacturer's specified maximum design pressure.
- h) Connect a timer to the automatic valve to cycle it from fully open to its closed limit stop 15 times every minute for 5 000 cycles. The time for pressure increase, the pressure hold at 1,3 times maximum design pressure and the pressure decrease and hold at 150 kPa shall each be  $(1 \pm 0,2)$  s.
- i) Shut down the system and inspect for evidence of damage or leakage.

**7.4.3 Continuity of water supply**

During an automatic regeneration of the nitrate removal device, open the outlet valve and check that water is readily available in compliance with 4.3.7.

**7.4.4 Protection against backflow****7.4.4.1 Protection against backflow of brine into the mains water supply**

- a) Connect the inlet pipe, upstream of the backflow prevention device, to a vacuum reservoir (previously drained) and vacuum pump, via an isolation valve.
- b) With the nitrate removal device in service close the outlet valve, so that the unit is under the supply pressure of at least 400 kPa.
- c) Close the supply valve. Start the vacuum pump and open the vacuum reservoir isolation valve to apply a vacuum of 30 kPa to the nitrate removal device.
- d) After 10 min, shut down the vacuum pump and vent the system. Open the drain valve at the bottom of the vacuum reservoir.
- e) At the end of the test, check for compliance with 4.3.8 a).

**7.4.4.2 Protection against infiltration of brine into the treated water supply**

During the five performance of verification runs, take samples at the inlet and the outlet at 15 %, 50 %, 75 % and 100 % of the cycle and analyse sodium ( $\text{Na}^+$ ) in accordance with 7.1.4.2.

Check for compliance with 4.3.8 b).

NOTE For mixed beds (see 4.1 and Annex A), as the sodium concentration is modified by the softening resin, the obtained value the sodium increase due to softening resin exchange is deducted as follows:

- a) each of the samples for total hardness content is analysed in accordance with 7.1.4.3;
- b) for each sample, the sodium increase due to softening exchange is calculated from Equation (2):

$$A_s = 2 (H_o - H_r) \quad (2)$$

where

$A_s$  is the sodium increase due to softening exchange;

$H_o$  is the total hardness of raw water, in mmol/l  $\text{CaCO}_3$ ;

$H_f$  is the total hardness of treated water, in mmol/l  $\text{CaCO}_3$ .

The sodium increase for brine infiltration is calculated from Equation (3):

$$A_B = A_o - A_s \quad (3)$$

where

$A_B$  is the sodium increase for brine infiltration;

$A_o$  is the sodium increase between outlet and inlet;

$A_s$  is the sodium increase due to softening exchange.

If the test water is completely softened before use, it is not necessary to apply this correction.

#### 7.4.5 Air displacement

Examine the device thoroughly to identify any 'dead legs' where air entrapment can occur. If necessary, dismantle the assembly to inspect the internal waterways and/or obtain detailed drawings of the internals from the manufacturer.

### 7.5 Operating characteristics

#### 7.5.1 General

The operating characteristics shall be checked during the five last cycles, following the preconditioning cycles, as indicated in 7.1.3 d), with the optional bypass and blending valves, if fitted, closed.

#### 7.5.2 Nominal flow rate

- a) Nominal flow rate is measured after an automatic regeneration.
- b) Connect the nitrate removal device to the water supply with a pressure of 400 kPa.
- c) Measure the pressure drop across the unit at various flow rates, measuring the temperature of the water at the same time.
- d) Nominal flow rate is the flow rate at which the measured pressure drop equals the value given in Table 1 for the temperature of the water measured in the test:

Table 1 — Pressure drop

| Temperature of the water<br>°C | Pressure drop corresponding to the nominal flow<br>rate<br>kPa |
|--------------------------------|----------------------------------------------------------------|
| 5                              | 135                                                            |
| 6                              | 132                                                            |
| 7                              | 127                                                            |
| 8                              | 122                                                            |
| 9                              | 119                                                            |
| 10                             | 115                                                            |
| 11                             | 111                                                            |
| 12                             | 109                                                            |
| 13                             | 105                                                            |
| 14                             | 103                                                            |
| 15                             | 100                                                            |
| 16                             | 97                                                             |
| 17                             | 95                                                             |
| 18                             | 93                                                             |
| 19                             | 91                                                             |
| 21                             | 86                                                             |
| 22                             | 85                                                             |
| 23                             | 83                                                             |
| 24                             | 81                                                             |
| 25                             | 79                                                             |

The nominal flow rate measured shall not be lower than 90 % of the value specified by the manufacturer.

### 7.5.3 Regenerations

#### 7.5.3.1 Manual initiation

From the manufacturer's operating instructions (see Clause 6), carry out the procedure to manually initiate a regeneration and confirm by visual observation that a full regeneration cycle is completed.

#### 7.5.3.2 Automatic initiation

- During the five performance verification runs (see 7.1.3 d)), verify that initiation and execution of the regeneration cycle is completed without manual intervention.
- For a timer controlled device, record the actual time and the set time at which regeneration takes place. The actual and set times should not differ by more than 30 min.
- For a volume controlled device, compare the five treated water volume measurements from 7.5.4 a). No single value shall deviate by more than 10 % of the average of the five measurements.
- For devices which regenerate on detection of exhaustion of the resin, compare the exchange capacity measurements from 7.5.4 d). None of them shall deviate from the average of the five by more than 10 %.

- e) Check the compliance with the requirements of 4.4.1.

#### 7.5.4 Exchange capacity

- a) During the five performance verification runs (see 7.1.3 d)), measure by collection or by flow meter (with an accuracy of  $\pm 2\%$ ), the total volume of treated water for each of the five runs.
- b) Sample the treated water at the end of each run and measure the residual nitrate concentration in accordance with 7.1.4.1.
- c) In each of the five verification runs, the residual shall be no more than 25 mg/l.
- d) Exchange capacity is obtained by using Equation (4):

$$K = V \times C \times 62 \quad (4)$$

where

$K$  is the exchange capacity, in grams of nitrate ion;

$V$  is the quantity of water treated between two regenerations, in  $m^3$ ;

$C$  is the nitrate concentration of the supply water, in mmol/l nitrate ion.

#### 7.5.5 Brine efficiency

- a) During the last five performance verification runs (see 7.1.3 d)), place the brine tank on suitable weighing scales.
- b) Measure the mass of the brine tank before each regeneration and at the same step of the run, ensuring that the salt level is above the brine level throughout the five runs.
- c) Difference in mass between two regenerations equals the quantity of salt consumed for each regeneration.
- d) Salt consumption per regeneration is the average of the five measurements. No individual value shall exceed  $\pm 10\%$  of the average.

#### 7.5.6 Regeneration water

During the five performance verification runs (see 7.1.3 d)), record the volume of water used at each regeneration indicated by the water meter on the inlet pipe.

#### 7.5.7 Quality of treated water after a regeneration

- a) During the five performances verification runs (see 7.1.3 d)) and immediately after each completed regeneration, collect a sample of treated water equal to one bed volume with a minimum of 10 l at a flow rate of 30 % of the nominal flow rate.
- b) Analyse each of the five samples for sodium content in accordance with 7.1.4.2.

NOTE For mixed beds (see 4.1 and Annex A), as the concentration is modified by the softening resin, to the obtained value the sodium increase due to softening resin exchange is deducted as indicated in 7.4.4.2.

## Annex A (informative)

### Principles of nitrate reduction using anionic exchange resins

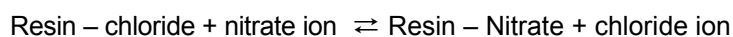
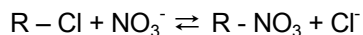
#### A.1 Nitrate effects

Removal of nitrate from potable waters has received increased attention in recent years. Nitrate is reduced to nitrite by bacteria in the stomach. Nitrite passing into the bloodstream can be taken up by a haemoglobin, reducing the ability of the blood to transport oxygen. Infants under six months of age are especially susceptible to this effect. Nitrates can also be converted in the stomach to nitrosamines. In addition, nitrate ions are oxidants and under certain circumstances can increase the corrosivity of the water (EN 12502 series (see [1]) can be used for the assessment of the corrosion likelihood of metallic materials in water distribution and storage systems in terms of water composition).

The maximum permitted value for nitrate concentration in drinking water according to Directive 98/83/EC (see [2]) is 50 mg/l.

#### A.2 Nitrate removal with anionic resins

Nitrate removal with anionic resins is carried out with exchange resins that include chloride ions which are exchanged by nitrate ions:



When exhausted, resins are regenerated with chloride ions, usually with sodium chloride.

In this exchange other ions as chlorides, bicarbonates and, especially, sulphates interfere. For this reason, the design of a nitrate removal device will always be carried out in accordance with the complete analysis of the water to be treated. It should also be considered that chloride concentration will increase in the treated water proportionally to the nitrate exchange.

#### A.3 Selective and non-selective resins

Due to the interference of other ions, two main kinds of resins are commonly used in the market for nitrate removal: "selective" and "non-selective" resins.

Selective resins present the following affinity with anions:  
nitrate > sulphate > chloride > bicarbonate.

While for the non-selective resins the affinity is:  
sulphate > nitrate > chloride > bicarbonate.

Basically, the selective resins exchange nitrates rather than sulphates preferentially and the non-selective exchange preferably sulphates rather than nitrates. On the other hand, usually selective resins present a nitrate leakage somewhat higher than non-selective resins.

When sulphates concentration is high, selective resins give a higher exchange capacity. Whichever type of resin is used, it is important to accommodate the sulphate content of the feed water when specifying the device.

#### A.4 Softening and nitrate removal with mixed beds

Some devices in the market are intended to remove nitrates and to soften water simultaneously. These are commonly known as “mixed beds” and include a mixture of anionic and cationic resin that regenerates simultaneously, normally with sodium chloride (the sodium ion regenerates the cationic resin and the chloride ion regenerates the anionic resin).

When a mixed bed is used it should be considered that:

- a) In the anionic resin, together with nitrates, sulphates are also partially exchanged. If the sulphate concentration in water is high, an important amount of them can be retained in the resin. On the other hand calcium and magnesium are exchanged in the cationic resin.

When the regeneration process take place, sulphate ions blend with calcium ions and flow together into drain; if there is a high concentration of sulphates, this may produce a precipitation of calcium sulphate. It is recommended to avoid mixed beds when water has a high concentration of sulphates ( $> 150$  mg/l).

- b) If a blending valve is used to adjust the residual hardness, it will also allow nitrates to pass into the treated water.

## Annex B (normative)

### **A<sub>1</sub>** Installation, operation and maintenance

#### B.1 Introduction

This annex defines essential information and instructions on the installation, operation, maintenance and repair of nitrate removal devices. It transposes the general requirements in EN 15161 into specific requirements for nitrate removal devices.

Correct operation and maintenance of the device is essential for successful and hygienic performance. Devices in compliance with this European Standard shall be provided with all necessary information and instructions on operation and maintenance appropriate to the device being supplied. The following information is stipulated as a minimum, it is not exhaustive and it is not intended to substitute for the supplier's instructions.

**NOTE** For the purposes of this European Standard, the supplier is the organisation in whose name is identified on the product being sold. The supplier may or may not be the manufacturer.

#### B.2 Installation requirements

##### B.2.1 Equipment selection

Selection of a device that is appropriate to the performance and operational expectations, and to the intended installation site, is essential. Information outlining the key installation and operation requirements shall be made available at the point of purchase, in the form of either brochures or specification sheets or clearly marked on the external product packaging. This information shall identify limitations on the location for installation in terms of dimensional requirements and environmental conditions (e.g. ambient temperature). The information shall offer guidance on frequency of periodic operation and maintenance along with any associated accessibility required. It shall also identify the water supply requirements (pressure limitations, pipe sizes) along with proximity requirements for other services which may be necessary such as availability of electric power, drainage facilities etc.

##### B.2.2 Installation

Installation instructions, provided with the device shall include a list of the components provided with the device along with a list clearly identifying any other components deemed necessary to complete a successful installation (e.g. pressure reducing valve). The characteristics of such additional equipment shall be clearly identified.

The instructions shall include a sequenced procedure outlining assembly of the components including connection to the water supply and to any other service(s) required. The instructions shall include definitive guidelines identifying the dimensional and orientational requirements essential to position the device and its ancillaries in order to provide adequate access for operation and maintenance at the chosen installation site.

In addition, the installation instructions shall include a checklist to ensure that the device is located:

- in a suitable location (e.g. clean, well ventilated, adequately illuminated and protected against pests, frost, physical damage) within the domestic water distribution system;
- remote or insulated from sources of heat (e. g. washing machines, dishwashers, boilers, cookers and hot water pipework);

- as close as possible to the existing distribution system and to other necessary services;
- avoiding or minimising dead-legs that can encourage stagnation.

NOTE Drinking water for cleaning purposes and appropriate waste disposal facilities should be available.

### B.2.3 Labelling

The device as supplied shall be labelled, with a durable waterproof label mounted on, or close to the device, with the information required in accordance with Clause 5.

### B.2.4 Commissioning

The instructions shall contain a procedure for putting the device into service including as a minimum:

- initial filling and pressurisation of the system;
- checking for leaks;
- flushing and sanitization requirements (time and/or volume);
- setting-up, e.g. operating cycle, salt consumption;
- performance check, e.g. each functional hydraulic step, the nitrate concentration in raw and treated waters;
- recording in the logbook about all the commissioning values and adjustments.

The instructions shall provide advice on checking performance and, where a control kit is provided, detailed instructions on the use of it and interpretation of the results.

### B.2.5 Hand over

The instructions shall identify that, where commissioning is carried out by a third party, this third party shall, after checking the performance of the device, hand over to the owner all of the printed instructions on its use (e.g. testing procedure and frequency, actions to be taken dependant upon the testing results), along with the updated logbook and the control kit, where provided, for monitoring the device performance.

NOTE 1 Depending on the intended application of the nitrate removal device, the control kit could include one or more of the following:

- nitrate concentration;
- hardness (for mixed beds).

NOTE 2 In its simplest form, the logbook may be a single sheet (which may be adhesive backed to secure to the device) which permits, at the very least, a record of the operations performed during the last maintenance and of the performance checks.

## B.3 Operation requirements

The instructions shall include procedures on checks to be made by the user during normal day to day operation for optimum performance of the device. The checklist shall include, as a minimum, instructions:

- to control the device operation (e. g. salt consumption, regeneration cycle);

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- to carry out performance checks using the control kit, if provided, to verify the treated water quality with respect to the treatment expectations (e.g. nitrate concentration in the treated water);
- to use only appropriate consumables (e.g. salt for regeneration in accordance with EN 973);
- to call for maintenance, if the device has not been used for a long time.

**B.4 Maintenance requirements**

In order to maintain optimum performance of the device, the instructions shall include procedures and checks to be made at specified time intervals, including instructions:

- to carry out regular water analysis to verify the device adjustments (e.g. nitrates, chlorides and sulphates in the raw to adjust the operating cycle);
- to inspect the device for signs of leakage or damage;
- to clean or sanitize the device or some particular part (e.g. brine storage tank cleaning, resin sanitization);
- to carry out the replacement procedure for worn or consumable parts (e.g. pre-filter);
- to record on the logbook the date of interventions;
- to call for repair in the event that any defect or failure is noticed (e.g. increase of nitrate concentration in the treated water).

The instructions shall provide guidance on the hygiene precautions necessary for any maintenance operations that require dismantling of the system.

NOTE An example of good practice is as follows:

**Hygiene.** Maintenance operations that require dismantling the system, such that water contact parts are exposed, should be subject to careful, hygienic control in order to avoid contamination of the system. Preferably, disposable gloves should be used to avoid personal contamination of the system parts; any tools used that may come into contact with the wetted parts should be cleaned and disinfected in accordance with the instructions before use. Disposable parts should carefully be disposed of and the replacement parts should remain sealed in its protective wrapping until the last practical moment.

Routine maintenance and timely replacement of consumable parts are essential to the satisfactory performance of the device. A maintenance failure, e.g. brine tank dirtiness, can result in a device malfunction.

Regular use is also important; long periods of stagnation can give rise to off-taste in the treated water so, as with any drinking water supply, the system should be flushed before reuse (including a resin regeneration), if it has been out of use for a period of 96 h or more. This operation should be included in the maintenance protocol.

**B.5 Repair requirements****B.5.1 General**

The instructions shall include advice stating that any corrective action carried out on the system that is not regarded as routine and, therefore, not described in the instructions, is to be performed only by a competent repair person. The instructions shall identify, either contact details for approved repair engineers or alternatively provide a route (telephone, website) for contacting the supplier to obtain information on such service.

### **B.5.2 Repair documentation**

The instructions shall contain a statement advising that a record of any repair intervention is kept within the logbook.

## **B.6 Troubleshooting**

The instructions shall provide guidance on troubleshooting in the event that problems occur with the device.

An example of a troubleshooting guide is given in Table B.1.

Table B.1 — Troubleshooting guide (example)

| Observation                                                              | Possible cause                                                                                             | Remedy                                                                                                                                                                                      |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nitrate concentration in treated water increases at the end of the cycle | Raw water composition has changed and this modifies the required regeneration cycle                        | Check raw water quality analysis (nitrates, chlorides, sulphates) and modify the device adjustments                                                                                         |
|                                                                          | Resin regeneration is not complete<br>The resin may be damaged or not enough salt is used to regenerate it | Verify raw water pressure<br>Verify the salt consumption<br>Control brine introduction during the regeneration step<br>Verify the brine valve<br>Examine resin and replace it, if necessary |
| Device does not remove nitrates or nitrate reduction efficiency is low   | Resin is damaged or not regenerated                                                                        | Control the salt level<br>Control brine introduction during the regeneration step. Verify the brine valve operation<br>Examine resin and substitute it, if necessary                        |
|                                                                          | The device is internally damaged<br>There is a connection between raw water and treated water              | Open the resin container, verify that water flows through the resin                                                                                                                         |
| Abnormal taste or odor in the treated water                              | Regeneration is not completed, some brine has entered the treated water                                    | Check all regeneration steps, verify that rinsing is correctly done                                                                                                                         |
|                                                                          | Resin contamination                                                                                        | Empty and clean the salt storage tank<br>Follow the instruction manual for a sanitizing process                                                                                             |
| Low flow from the device                                                 | Low supply pressure                                                                                        | Check raw water pressure                                                                                                                                                                    |
|                                                                          | High pressure drop in the resin bed                                                                        | Examine resin bed<br>Initiate a manual regeneration to clean it                                                                                                                             |
|                                                                          | High pressure drop in internal components                                                                  | Verify all device components, replace those damaged                                                                                                                                         |

## Bibliography

- [1] EN 12502 (all parts), *Protection of metallic materials against corrosion*
- [2] 98/83/EC, *Council Directive 98/83/EC of 3 November 1998 on the quality of water for human consumption*