

**RWANDA
STANDARD**

CD
353-4

First edition

2018-mm-dd

**Water quality — Chemicals used for
treatment of water intended for human
consumption —**

Part 4:

Sodium Chloride



Reference number

PDS 353-4: 2018

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

PDS 353-4 was prepared by Technical Committee RSB/TC 013, *Water and Sanitation*,

In the preparation of this standard, reference was made to the following standard (s):

BS EN 16370:2013: Chemicals used for treatment of water intended for human consumption —Sodium chloride for onsite electrochlorination using membrane cells

The assistance derived from the above source is hereby acknowledged with thanks.

PDS 353 consists of the following parts, under the general title *Water quality — Chemicals used for treatment of water intended for human consumption*:

- *Part 1: Aluminium sulfate*
- *Part 2: Calcium hypochlorite*
- *Part 3: Sodium chlorate*
- *Part 4: Sodium chloride*

Committee membership

The following organizations were represented on the Technical Committee on **Water and Sanitation** (RSB/TC 013) in the preparation of this standard.

Integrated Polytechnic Regional Centre/Kigali (IPRC-Kigali)

Rwanda Utility Regulatory Authority (RURA)

SULFO Rwanda Ltd

Rwanda Association of Professional Environmentalist Practitioners (RAPEP)

Shine Engineers Multisectorial Company *Ltd* (SEMC)

Rwanda Fisheries Sector (RSF)

Water and Sanitation Corporation Ltd (WASAC)

Rwanda Standards Board (RSB) – Secretariat

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Introduction

Treatment of water intended for human consumption can be achieved by using various chemicals which might raise the risk of cancer or cause other health hazards by creating toxic by-products that need tighter control in order to avoid those risks and meets requirements of drinking water as stated in RS EAS 153

Chemicals used during treatment of water have to be of good quality and meet standards requirement, in order to avoid any contamination of water by impurities of these chemicals and therefore ensure a successful water treatment

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Water quality — Chemicals used for treatment of water intended for human consumption — Part 4: Sodium chloride

1 Scope

This Committee Draft Rwanda Standard is applicable to sodium chloride intended for onsite electrochlorination of water intended for human consumption. It describes the characteristics and specifies the requirements and the corresponding test methods for sodium chloride. It also gives information on its use in water treatment.

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.

ISO 3696, *Water for analytical laboratory use — Specification and test methods* (ISO 3696)

ISO 2479, *Sodium chloride for industrial use — Determination of matter insoluble in water or in acid and preparation of principal solutions for other determinations*

ISO 2480, *Sodium chloride for industrial use — Determination of sulphate content — Barium sulphate gravimetric method*

ISO 2482, *Sodium chloride for industrial use — Determination of calcium and magnesium contents — EDTA complexometric methods*

ISO 2483, *Sodium chloride for industrial use — Determination of the loss of mass at 110 °C*

ISO 3165, *Sampling of chemical products for industrial use — Safety in sampling*

ISO 6206, *Chemical products for industrial use — Sampling — Vocabulary*

ISO 6227, *Chemical products for industrial use — General method for determination of chloride ions — Potentiometric method*

ISO 8213, *Chemical products for industrial use — Sampling techniques — Solid chemical products in the form of particles varying from powders to coarse lumps.*

ISO 11885, *Water quality -- Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES)*

ISO 17378-2, *Water quality -- Determination of arsenic and antimony -- Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)*

3 Description

3.1 Identification

3.1.1 Chemical name

Sodium chloride.

3.1.2 Synonym or common name

Salt.

3.1.3 Relative molecular mass

58.45 for sodium chloride.

3.1.4 Empirical formula

NaCl.

3.1.5 Chemical formula

NaCl.

3.2 Commercial forms

These products are available as rock salt, sea salt or evaporated salt, and it is supplied as free-flowing crystals or their compacted forms.

3.3 Physical properties

3.3.1 Appearance

The product is white and crystalline.

3.3.2 Density

The density of the solid crystal is 2.16 g/cm³ at 20 °C.

The bulk density depends on the particle size distribution.

3.3.3 Solubility (in water)

The solubility of the product depends on the temperature as given in Figure 1.

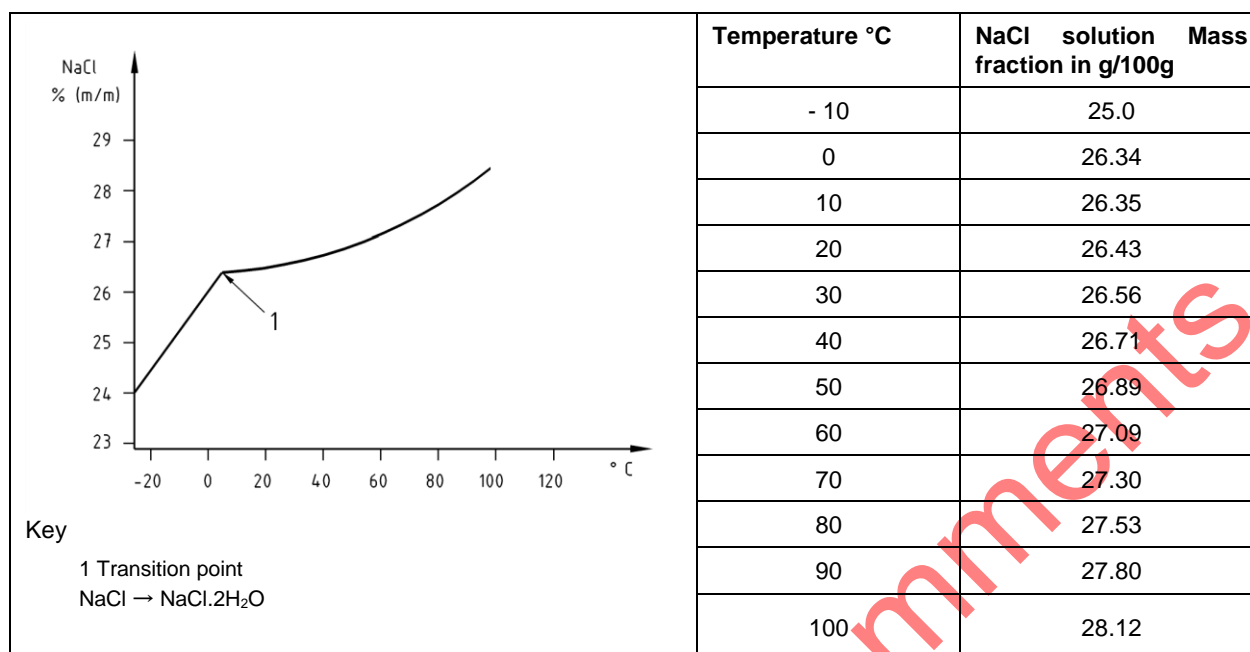


Figure 1 - Solubility curve for sodium chloride in water

3.3.4 Melting point at 100kPa

801 °C for sodium chloride.

3.3.5 Specific heat

Approximately 850 J/(kg.K) at 25 °C for the solid.

3.3.6 Viscosity (dynamic)

The viscosity of the saturated solution at 20 °C is approximately 1.9 mPa.s.¹

3.3.7 Physical hardness

The hardness of solid salt is given as 2 to 2.5 on the Mohs' scale of hardness.

3.4 Chemical properties

Sodium chloride is stable, non-volatile and aqueous solutions have good electrical conductivity.

¹ 1 Centipoise = 1 mPa.s (Millipascal Second)

Sodium chloride reacts with a number of acids (e.g. sulfuric acid, phosphoric acid) and strong oxidising agents. The reactions are often complex and require heat for completion.

NOTE Under certain conditions, a sodium chloride solution can cause corrosion of metallic surfaces

4 Purity criteria

4.1 General

4.1.1 This Standard specifies the minimum purity requirements for sodium chloride for onsite electrochlorination of water intended for human consumption. The basic quality of the applied salt shall meet the requirements of Codex Alimentarius for Food Grade Salt.

4.1.2 chemicals produced by this process is chlorine or sodium hypochlorite, attention shall be paid to the minimization of likely impurity commonly present in the product.

4.1.3 Users of the product shall check the national regulations in order to clarify whether it is allowed/not banned and is of appropriate purity for treatment of water intended for human consumption, taking into account raw water quality, required dosage, contents of other impurities and additives used in the product not stated in the product standard, and other relevant factors.

4.2 Composition of commercial product

The content of sodium chloride in the dry product shall not be less than:

- grade 1: mass fraction 99,4 % of dry NaCl;
- grade 2: mass fraction 98,5 % of dry NaCl.

NOTE An anticaking agent, sodium or potassium hexacyanoferrate $[\text{Fe}(\text{CN})_6]^{-4}$, is not allowed. Impurities and by-products

The product shall conform to the requirements specified in Table 1.

Table 1 — Impurities and by-products

Impurity/by-product	Limit in mass fraction of NaCl content (mg/kg)		Test methods
	Grade 1	Grade 2	
Moisture, dry product	≤ 1 000	≤ 1 000	See 5.2.2.2
Moisture, wet product	≤ 50 000 (a)	≤ 50 000	
Water-insoluble matter	≤ 500	≤ 1000	See 5.2.2.1
Bromide	≤ 50	≤ 250	See 5.2.2.3
Iron	≤ 2	≤ 2	ISO 11885

Manganese	≤ 0,5	≤ 1	
Calcium + magnesium	≤ 25	≤ 300	ISO 2482
Sulfate	≤ 400	≤ 600	ISO 2480
NOTE The flowability of the products is reduced by a high moisture content; further information should be availed by the supplier of the product.			

NOTE The grade should be selected based on the requirements of the electrochlorination equipment depending on the susceptibility of the membrane to fouling. The electrochlorination equipment manufacturers will specify which grade can be used to meet the requirements of the Drinking Water standards.

4.3 Chemical parameters

The products shall conform to the requirements specified in Table 3.

Table 3 — Chemical parameters

Parameter	Limits in mg/kg of commercial product	Test method
Arsenic (As)	≤ 0,3	ISO 17378-2
Cadmium (Cd)	≤ 0,5	ISO 11885
Chromium (Cr)	≤ 0,5	
Nickel (Ni)	≤ 0,5	
Lead (Pb)	≤ 2	
Antimony (Sb)	≤ 2	
Selenium (Se)	≤ 2	
Mercury (Hg)	≤ 0,1	ISO 12846

5 Test methods

5.1 Sampling

A test sample of about 500 g shall be taken for analysis, ensuring that it is representative of the whole batch, and taking account of ISO 3165 and ISO 6206. Prepare the laboratory sample(s) required in accordance with ISO 8213.

5.2 Analyses

5.2.1 Main product

The mass fraction in % of sodium chloride (NaCl) shall be determined by calculation, on the basis of the results of the determinations of sulfate (according to ISO 2480), halogens (according to ISO 6227), calcium and magnesium (according to ISO 2482), and loss of mass on drying (according to ISO 2483). Convert sulfate to calcium sulfate and unused calcium to calcium chloride, unless sulfate in sample exceeds the amount necessary to combine with calcium, in which case convert calcium to calcium sulfate and unused sulfate to first to magnesium sulfate and the remaining sulfate to sodium sulfate. Convert unused magnesium to magnesium chloride. Convert unused halogens to sodium chloride. Report the sodium chloride contents on a dry matter basis, multiplying the mass fraction in % of sodium chloride by $100/(100 - P)$, where P is the percentage of the loss of mass on drying (see 5.2.2.2).

5.2.2 Impurities

5.2.2.1 Water-insoluble matter

The content of water-insoluble matter shall be determined in accordance with ISO 2479.

5.2.2.2 Moisture content

The loss of mass at 110 °C shall be determined in accordance with ISO 2483.

5.2.2.3 Bromide

5.2.2.3.1 General

The present method describes a titrimetric method with sodium thiosulfate for the determination of total bromine and iodine in sodium chloride. The method is applicable to products of bromine and iodine content (expressed conventionally as bromide, Br⁻) equal to or greater than 3 mg bromine per kilogram of salt. Bromine or bromide are equivalent for the expression of the results.

5.2.2.3.2 Principle

The sample is dissolved in water. Oxidation of iodide to iodate and bromide to bromate is achieved with hypochlorite in a buffered medium and the excess of oxidant is eliminated with formic acid. Free iodine, equivalent to the amount of the present iodate and bromate, is formed by addition of hydrochloric acid and potassium iodide. The free iodine is titrated with sodium thiosulfate using starch as indicator.

5.2.2.3.3 Reactions



Titration of the iodate and bromate follows the reactions:



NOTE Reactions (1) and (2) require for completion the presence of chloride ions that are added into the buffer solution.

5.2.2.3.4 Reagents

Unless otherwise stated, use only reagents of recognised analytical grade and only water conforming to grade 3 in accordance with ISO 3696.

5.2.2.3.4.1 Calcium carbonate, precipitated.

5.2.2.3.4.2 Hydrochloric acid, $c(\text{HCl}) \approx 4 \text{ mol/l}$.

5.2.2.3.4.3 Formic acid, $c(\text{HCOOH}) \approx 3 \text{ mol/l}$.

5.2.2.3.4.4 Potassium iodide, $\beta(\text{KI}) \approx 100 \text{ g/l}$.

Prepare this solution on the day of use and store it in a dark bottle.

5.2.2.3.4.5 Sodium hypochlorite, $\beta(\text{NaClO}) \approx 19 \text{ g/l}$.

Prepare this solution by dilution of a concentrated technical sodium hypochlorite solution. Renew the solution each week.

Commercial household solutions which can contain interfering additives should not be used.

5.2.2.3.4.6 Buffer solution

Dissolve 50 g of sodium dihydrogen orthophosphate dihydrate, ($\text{NaH}_2\text{PO}_4 \cdot 2 \text{H}_2\text{O}$), 50g of disodium hydrogen orthophosphate dodecahydrate ($\text{Na}_2\text{HPO}_4 \cdot 12 \text{H}_2\text{O}$), 50g of tetrasodium pyrophosphate decahydrate ($\text{Na}_4\text{P}_2\text{O}_7 \cdot 10 \text{H}_2\text{O}$) and 150 g of sodium chloride (see note) in 650 ml of water.

NOTE As the same quantity of buffer solution is used for the sample and for the blank test solution, it is not necessary to use products completely free of iodine and bromine.

5.2.2.3.4.7 Sodium thiosulfate, standard volumetric solution, $c(\text{Na}_2\text{S}_2\text{O}_3) = 0,01 \text{ mol/l}$.

Prepare this solution by dilution of a standard volumetric solution $c(\text{Na}_2\text{S}_2\text{O}_3) = 0,1 \text{ mol/l}$ and standardise with a potassium iodate solution [$c(1/6 \text{KIO}_3) = 0,01 \text{ mol/l}$].

5.2.2.3.4.8 Methyl red, 0,5 g/l solution in volume fraction 95 % ethanol.

5.2.2.3.4.9 Starch solution, 2 g/l solution.

Prepare this solution at the time of use from soluble starch.

5.2.2.3.5 Apparatus

Ordinary laboratory apparatus and:

5.2.2.3.5.1 **Burette** allowing the distribution and measurement of 0,01 ml.

5.2.2.3.6 Procedure

5.2.2.3.6.1 Test portion

Weigh, to the nearest 0,1 g, about 40 g of the test sample.

For bromine plus iodine content greater than 200 mg per kilogram of salt, the test portion should be reduced accordingly.

5.2.2.3.6.2 Test solution

Transfer the test portion (5.2.2.3.6.1) and 150 ml of water into a 500 ml conical flask, stir to dissolve.

5.2.2.3.6.3 Blank test solution

Transfer 150 ml of water into a 500 ml conical flask.

5.2.2.3.6.4 Determination

Proceed with the conical flasks prepared in (5.2.2.3.6.2) and (5.2.2.3.6.3) in the following way.

Add 4 drops of methyl red (5.2.2.3.4.8) and hydrochloric acid (5.2.2.3.4.2) until the solution turns red. Neutralise by addition of calcium carbonate (5.2.2.3.4.1) to a permanent slight cloudiness.

Add 6,0 ml of buffer solution (5.2.2.3.4.6) and 5,0 ml of sodium hypochlorite solution (5.2.2.3.4.5). Heat to (90 ± 2) °C with agitation to avoid local overheating and keep at this temperature for 20 min.

Add 10 ml of formic acid (5.2.2.3.4.3) and swirl. When CO₂ ceases to evolve, cool to about 20 °C, add 2,0 ml of potassium iodide solution (5.2.2.3.4.4) and 25 ml of hydrochloric acid (5.2.2.3.4.2). Swirl and allow to stand for 1 min.

Titrate with the sodium thiosulfate standard volumetric solution 0,01 mol/l (5.2.2.3.4.7) using a burette (5.2.2.3.5.1). When the solution is nearly discoloured, add 1 ml of starch solution (5.2.2.3.4.9) and continue the titration until the blue colour disappears during at least 30 s.

The presence of oxidising agents can lead to inaccurate results. The Fe³⁺ interference can be avoided by complexation with EDTA. An automatic titrator provided with a platinum electrode and an Ag/AgCl reference

electrode can be used. In this case, the addition of starch solution (5.2.2.3.4.9) during the determination should be avoided.

5.2.2.3.7 Expression of results

5.2.2.3.7.1 Method of calculation

The bromine plus iodine content of the sample, $w_{(Br)}$, expressed as milligrams of bromine per kilogram of salt, is given by the following formula:

$$w_{Br} = 13,318 \times c(Na_2S_2O_3) \times + \frac{1000}{m} \times (V_1 - V_0)$$

where

m is the mass, in grams, of the test portion (5.2.2.3.6.1);

V_1 is the volume, in millilitres, of sodium thiosulfate (5.2.2.3.4.7) used for the titration of the test solution (5.2.2.3.6.2);

V_0 is the volume, in millilitres, of sodium thiosulfate (5.2.2.3.4.7) used for the titration of the blank test solution (5.2.2.3.6.3);

$c(Na_2S_2O_3)$ is the concentration in moles per litre of the sodium thiosulfate standard volumetric solution (5.2.2.3.4.7). $c(Na_2S_2O_3)$

6 Marking – Transportation – Storage

6.1 transportation

Sodium chloride is not classified as a dangerous product for road, rail, sea and air transportation.

Sodium chloride shall be delivered in bulk or in bags.

In order that the purity of the product is not affected, the means of delivery shall not have been used previously for any different product or it shall have been specially cleaned and prepared before use.

6.2 Marking

The marking shall include the following information:

- the name "Sodium chloride, salt for electrochlorination , "dry salt" or "undried salt" and trade name;
- net mass;
- density/concentration;

- d) name and the address of the supplier and/or manufacturer;
- e) statement of conformity to the standard;
- f) Shelf life;
- g) Storage conditions; and
- h) Batch number

The supplier shall provide a certificate of analysis against the standards and the material Safety Data sheet

Note the user should verify the relevance of that certificate

6.3 Storage

6.3.1 Long term stability

Sodium chloride is stable during long-term storage, providing it is kept in a dry place.

6.3.2 Storage incompatibilities

Sodium chloride shall be stored in covered and dry conditions to avoid any risk of contamination.

The product shall not be allowed to come into contact with strong acids, e.g. sulfuric acid or phosphoric acid.

Annex A (informative)

General information on sodium chloride for electrochlorination by membrane cell

A.1 Origin

- a) Rock salt: Salt produced by mining salt deposits of different geological formations derived from ancient seas.
- b) Sea salt: Salt produced by sea water evaporation via the action of sun and wind.
- c) Evaporated salt: Salt produced by evaporating water from a salt solution in a special evaporator leading to the recrystallisation of the salt.

A.2 Chemical composition

A.2.1 Organic components of sodium chloride can also affect equipment efficiency. As these requirements can vary considerably, both equipment and salt suppliers should be consulted when selecting salt for this application.

The organic content should be limited, as it can form halogen-organic compounds. If necessary, it should be explained which type of salt is concerned, especially rock salt and sea salt.

A.2.2 It should also be noted that the quality of water used in preparing salt solutions for this application might also need to be taken into account when selecting the salt to be used.

A.2.3 The sodium chlorate (NaClO_3) content of the sodium hypochlorite produced should not exceed a mass fraction of 5,4 % of available chlorine.

NOTE Sodium chlorate is a by-product of the manufacturing process and can be formed during storage.

The treated water should not contain more than 700 $\mu\text{g/l}$ chlorate.

A.3 Use

A.3.1 Function

Salt to be used to produce active chlorine (Cl_2 or NaClO) by electrolysis of the brine for disinfection of the water.

A.3.2 Form in which the product is used

It is used in the form of a saturated solution.

A.3.3 Consumption of salt for electrochlorination

The consumption is variable and depends on the applied technique, and is typically in the range of 1,7 kg to 3 kg of NaCl per kilogram of chlorine.

A.3.4 Means of application

To be documented by the equipment supplier.

A.3.5 Secondary effects

- Increase of the chloride content;
- in some cases, formation of halomethanes.

A.3.6 Spillage

The product should be collected, then the area should be rinsed with plenty of water.

A.3.7 Fire

Sodium chloride is not combustible.

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Bibliography

[1] RS 127-1, *Bleaching agents — Specification — Part 1: Sodium hypochlorite solutions for water treatment*

[2]

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ICS 71.100.80