RWANDA STANDARD

DRS 353-1

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

Part 1:

Aluminium sulfate

Rwanda Standards Board

Reference number

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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.

DRS 353-1 was prepared by Technical Committee RSB/TC 013, *Environment, Health and Safety*.

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

BS EN 878, *Chemicals used for treatment of water intended for human consumption — Aluminium sulfate*

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

DRS 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*

Committee membership

The following organizations were represented on the Technical Committee on Environment, Health and Safety (RSB/TC 013) in the preparation of this standard.

Integrated Polytechnic Regional Centre – Kigali (IPRC-Kigali)

Inyange Industries Ltd

National Industrial Research and Development Agency (NIRDA)

Rwanda Natural Resource Authority (RNRA)

Star Construction & Consultancy (SCC)

University of Kibungo (UNIK)

Water and Sanitation Corporation (WASAC)

Rwanda Standards Board(RSB) – Secretariat

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.

Water quality — Chemicals used for treatment of water intended for human consumption — Part 1: Aluminium sulfate

1 Scope

This Preliminary Rwanda Standard describes the characteristics, specifies the requirements and gives reference to the analytical methods of aluminum sulfate. It gives information on its use in water treatment and also determines the rules relating to safe handling and use of aluminium sulfate.

This standard is applicable only to aluminium sulfate used for treatment of water intended for human consumption.

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.

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

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

3 Description

3.1 Identification

3.1.1 Chemical name

Aluminium sulfate.

3.1.2 Synonyms or common names

Aluminium sulfate, cake alum, alum.

NOTE In English the generic term “alum” is imprecise and is deprecated and in German the term “Alaun” is misleading.

3.1.3 Relative molecular mass

342,14 for $Al_2(SO_4)_3$

3.1.4 Empirical formula

$Al_2(SO_4)_3$

3.1.5 Chemical formula

$Al_2(SO_4)_3 \cdot n\ H_2O$

3.1.6 Commercial forms

Aluminium sulfate is available in solid hydrated forms, with different particle sizes (slabs, kibbled, ground, granulated) and as aqueous solutions.

3.2 Physical properties

3.2.1 Appearance

The product is a white solid or colourless to yellow, clear liquid

3.2.2 Density

The density of a typical aluminium sulfate solution is given in Table 1 and varies depending on the concentration of the active matter (aluminium content), expressed in grams per kilogram of solution (Al g/kg).

Table 1 — Density of solution

Al g/kg of solution	Density (g/ml) at 15 °C
40,8	1,310
41,6	1,315
42,5	1,320
43,3	1,325
44,2	1,330
45,0	1,335

3.2.3 Solubility

3.2.3.1 The theoretical limit of active matter content for a typical solution is given in Table 2

Table 2 — Solubility

Temperature °C	Active matter in Al g/kg of solution
24	44,8

3.2.3.2 The practical limit of solubility depends on the temperature and the device used for solubilisation of the solid form (slabs, kibbled, ground or granulated).

3.2.3.3 An indication of practical limits is given in Table 3.

Table 3 — Indication of practical limits of solubility

Temperature °C	Active matter Al g/kg of solution	Solubility in grams solid form (containing Al 90 g/kg of solid) per kilogram of solution
15	37	410

3.2.4 Crystallization point

The crystallization point of aluminium sulfate varies, depending on the concentration of the active matter. For example:

– - 7 °C for a typical solution of aluminium content of 42,4 g/kg of solution.

– Solution stored at low temperatures (below 0°C) can spontaneously form a solid mass of crystal hydrate.

3.2.5 Viscosity (dynamic)

The viscosity of aluminium sulfate solution varies greatly, depending on the concentration of the active matter. For a typical solution of aluminium content of 42,4 g/kg of solution, the viscosity is given in Table 4.

Table 4 — Viscosity

Temperature °C	Viscosity mPa.s (millipascal second)
0	40,0
10	26,5
20	18,6
30	13,2
40	8,8

3.2.6 Chemical properties

Aluminium sulfate is an acidic hydrated salt or solution. Very dilute solutions hydrolyse and form a precipitate of aluminium hydroxide.

NOTE Since aluminium compounds are amphoteric in nature, the solubility of aluminium depends on the pH value and it is advised to use the product within an appropriate pH range

4 Purity criteria

4.1 General

4.1.1 This Standard specifies the minimum purity requirements for aluminium sulfate used for the treatment of water intended for human consumption. Limits are given for impurities commonly present in the product. Depending on the raw material and the manufacturing process other impurities can be present and, if so, this shall be notified to the user and when necessary to relevant authorities.

4.1.2 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 concentration of active matter (aluminium content) in the product expressed as grams per kilogram of product shall be within ± 3 % of the manufacturer's declared values.

NOTE The concentration of water-soluble aluminium in commercial products varies. Typical values are given here below:

Commercial form	Al g/kg of product
Solid	72 to 91
Solution	32 to 44

4.3 Impurities and main by-products

The product shall conform to the requirements specified in Table 5.

Table 5 — Limits of impurities

Grade	Impurity		Limit (g/kg)
Iron free	Iron (Fe)	max.	1,60
Low iron	Iron (Fe)		1,60 < Fe ≤ 115
All grades	Insoluble matter	max.	23
NOTE The value quoted for iron is for both iron (II) and iron (III). Iron can be present as a component of the product and will usually be removed in the treatment process.			

4.4 Chemical parameters

The product shall conform to the requirements specified in Table 6.

Table 6 — Chemical parameters

Parameter		Limit (mg/kg)		
		Type 1	Type 2	Type 3
Arsenic (As)	max.	14	40	100
Cadmium (Cd)	max.	3	50	100
Chromium (Cr)	max.	30	700	1 000
Mercury (Hg)	max.	4	10	20
Nickel (Ni)	max.	20	700	1 000
Lead (Pb)	max.	40	200	800
Antimony (Sb)	max.	20	40	120
Selenium (Se)	max.	20	40	120
NOTE Cyanide (CN^-) is usually not relevant because of the acidity of the product. Pesticides and polycyclic aromatic hydrocarbons are not relevant since the raw materials used in the manufacturing process are free of them. For maximum impact of these products on trace metal content in drinking water see A.2.				

5 Labelling - Transportation - Storage

5.1 Means of delivery

6.1.1 Solids: the product shall be delivered in suitable packages, paper or plastics bags, or by aluminium or mild steel tippers, or by rubber-lined or plastics-lined bulk truck (20 t to 35 t depending on transport regulations if applicable)

6.1.2 Bulk liquids: the product shall be delivered in tankers of corrosion-resistant materials.

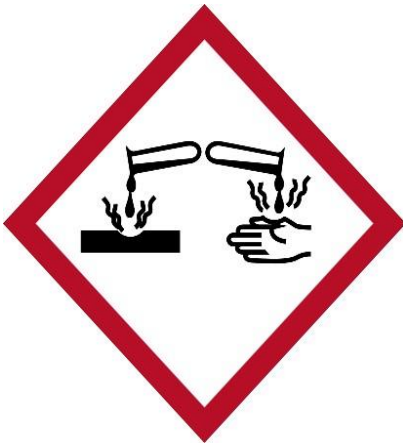
Note The manufacturer can provide advice on suitable materials.

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

5.2 Labelling

Labelling showing hazard statement shall apply to aluminium sulphate products

The following label but not limited to should be used



Signal word:

Danger

Hazard statements:

- Causes serious eye damage
- May be corrosive to metals
- Skin attack
- Etc

Disposal statement

5.3 Marking

The marking shall include the following information:

– name: “aluminium sulfate” trade name and grade;

– net mass;

– name and the address of the supplier and/or manufacturer; and

– statement of conformity to the standard”.

– Shelf life

– Storage conditions

– Batch number

The supplier shall provide a certificate of analysis against the standards

Note the user should verify the relevance of that certificate

5.4 Storage

5.4.1 General

Storage in a cool and dry place

NOTE The manufacturer can provide advice on suitable materials and storage temperatures.

Annex A
(normative)

General rules relating to safety

A.1 Rules for safe handling and use

The supplier shall provide current safety instructions.

A.2 Emergency procedures

A.2.1 First aid

A.2.1.1 In case of contact with skin wash thoroughly with cold water and seek medical advice if irritation persists.

A.2.1.2 In case of contact with eyes rinse thoroughly with cold water and seek medical advice.

A.2.1.3 In case of inhalation remove to fresh air, loosen clothing and seek medical advice.

A.2.1.4 In case of ingestion seek medical advice immediately.

NOTE In general, it is advised to treat the product as a weak acid.

A.2.2 Spillage

A.2.2.1 Refer to 6.5.3 for incompatibilities.

A.2.2.2 Put on protective clothing. Collect and dispose of spillages carefully.

A.2.2.3 Dilute small spillages of liquid with water and flush to sewer.

A.2.2.4 Neutralize and dispose of large spillages of liquid.

NOTE 1 Local regulations might apply to the disposal of this product.

NOTE 2 Suitable neutralizing chemicals are diluted sodium hydroxide or sodium carbonate.

A.2.3 Fire

The product is non-flammable. Any extinguishing media can be used. The product can liberate toxic and corrosive fumes of sulfur dioxide and trioxide under extreme conditions when boiled to dryness or heated above 600 °C.

Annex B
(informative)

General information on aluminium sulfate

B.1 Origin

B.1.1 Raw materials

The typical raw materials are:

a) sulfuric acid; and

b) aluminium or aluminium oxide compounds such as:

1) trihydrate;

2) bauxite or clays of suitable composition;

3) pickle liquors, purified if necessary; and

4) aluminium foundry residues, purified if necessary.

B.1.2 Manufacturing process

A.1.2.1 Aluminium sulfate is a synthetically manufactured product.

A.1.2.2 The typical manufacturing process is the reaction of a raw material containing aluminium or aluminium compounds with sulfuric acid.

B.2 Quality of commercial product

The three types of aluminium sulfate specified in Table 6 reflect the quality of commercially available products. Figures B.1 to B.2 show the maximum concentrations of trace metals that would be added to the raw water by the addition of products corresponding to the purity levels specified in Table 6. Furthermore, the figures overstate the concentrations of metals that would be present in the treated water since a substantial proportion of the trace metals will be incorporated in the sludge. Users of this product should select an appropriate grade and type to enable them to achieve treated water quality targets taking into account raw water characteristics, required dosage, process plant conditions and other relevant factors.

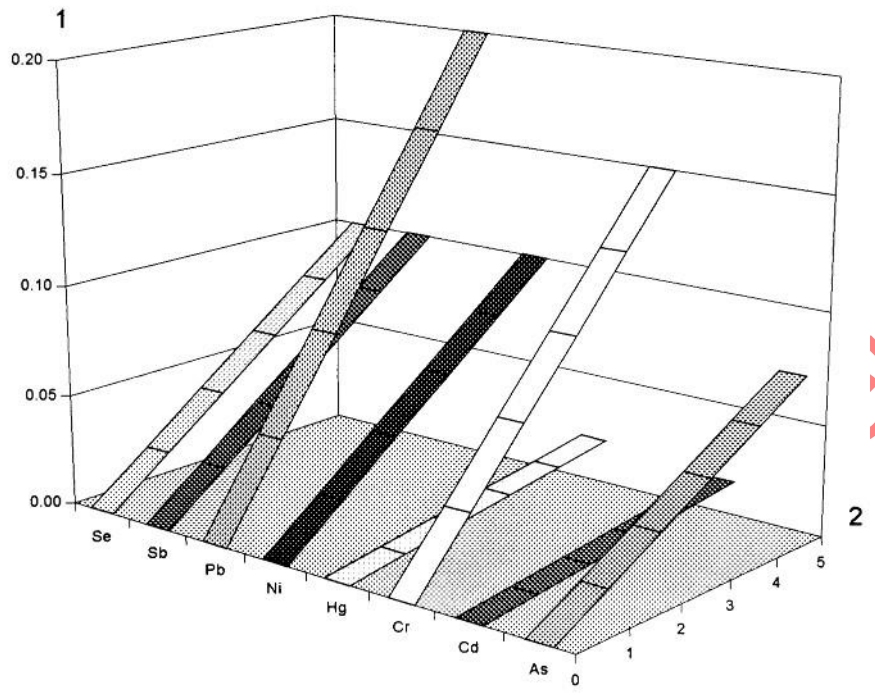


Figure B.2 — Maximum impact of aluminium sulfate, Type 2, on trace metal content of water

Key

1 maximum addition to water µg/l metal

2 product dosage mg/l Al - Typical dose

B.3 Use

B.3.1 Function

Aluminium sulfate is used as a coagulant.

B.3.2 Form in which it is used

For a liquid product, the concentration of the solution used, expressed as Al, is generally about 10 g/l to 55 g/l (typically 10 g/kg to 44 g/kg).

NOTE Very dilute solutions hydrolyse and form a precipitate.

B.3.3 Treatment dose

The treatment dose is generally 1 mg/l or more, expressed as Al, depending on raw water quality.

B.3.4 Means of application

Solutions are usually applied using a positive displacement metering pump. Sufficient turbulence should be provided at the point of addition to promote rapid dispersion.

B.3.5 Secondary effects

a) reduction of pH value;

b) reduction of alkalinity; and

c) increase in sulfate concentration.

B.3.6 Removal of excess product

The coagulation process should be operated under conditions (e.g. pH) in which the aluminium ions in the system are precipitated and reduced below the maximum allowable concentration.

Annex C
(informative)

Recommended test methods

C.1 Test methods

C.1.1 Sampling

C.1.1.1 Solid

Observe the general recommendations of ISO 3165 and take into account **ISO 6206.**

Prepare the laboratory sample(s) required by the relevant procedure described **in ISO 8213.**

C.1.1.2 Liquid

C.1.1.2.1 Sampling from drums and bottles

C.1.1.2.1.1 General

C.1.1.2.1.1.1 Mix the contents of each container to be sampled by shaking the container, by rolling it or by rocking it from side to side, taking care not to damage the container or spill any of the liquid.

C.1.1.2.1.1.2 If the design of the container is such (for example, a narrow-necked bottle) that it is impracticable to use a sampling implement, take a sample by pouring after the contents have been thoroughly mixed. Otherwise, proceed as described in **C.1.1.2.1.1.3**.

C.1.1.2.1.1.3 Examine the surface of the liquid. If there are signs of surface contamination, take samples from the surface as described in C.1.1.2.1.2; otherwise, take samples as described in C.1.1.2.1.3.

C.1.1.2.1.2 Surface sampling

Take a sample using a suitable ladle. Lower the ladle into the liquid until the rim is just below the surface, so that the surface layer runs into it. Withdraw the ladle just before it fills completely and allow any liquid adhering to the ladle to drain off. If necessary, repeat this operation so that, when the other selected containers have been sampled in a similar manner, the total volume of sample required for subsequent analysis is obtained.

C.1.1.2.1.3 Bottom sampling

C.1.1.2.1.3.1 Take a sample using an open sampling tube, or a bottom-valve sampling tube, suited to the size of container and the viscosity of the liquid.

C.1.1.2.1.3.2 When using an open sampling tube, close it at the top and then lower the bottom end to the bottom of the container. Open the tube and move it rapidly so that the bottom of the tube traverses the bottom of the container before the tube is filled. Close the tube, withdraw it from the container and allow any liquid adhering to the outside of the tube to drain off.

C.1.1.2.1.3.3 When using a bottom-valve sampling tube, close the valve before lowering the tube into the container and then proceed in a similar manner to that when using an open sampling tube.

C.1.1.2.1.4 Sampling from tanks and tankers

From each access point, take samples as follows:

d) from the surface of the liquid, using a ladle as described in C.1.1.2.1.2; and

e) from the bottom of the tank or tanker, using a sampling tube as described in C.1.1.2.1.3 or using a specially designed bottom-sampling apparatus;

From one or more positions, depending on the overall depth, between the bottom and the surface using a weighted sampling can.

C.1.2 Analyses

The methods to be used for analysis of aluminium-based coagulants and the principles of each method are listed in Table C.1.2

Table C.1.2 — Methods of analysis

Determination	Method
Aluminium	EDTA complexometric method, titration with EDTA
Aluminium	Separation of iron, CDTA complexometric titration
Iron	Atomic absorption spectrometry (flame)
Iron	Potentiometric titration
Sodium	Atomic absorption spectrometry (flame)
Calcium	Atomic absorption spectrometry (flame)
Chloride	Potentiometric titration
Sulfate	Barium sulfategravimetry
Silicate	Reduced molybdosilicate spectrophotometry
Free acidity	Acidimetric titration
Basicity	Acidimetric titration, oxalate method
Basicity	Acidimetric titration, KF method
Insoluble matter	Gravimetry
Arsenic	Inductively coupled plasma optical emission spectrometry (ICP/OES) (hydride)
Cadmium	Inductively coupled plasma optical emission spectrometry (ICP/OES)
Chromium	Inductively coupled plasma optical emission spectrometry (ICP/OES)
Mercury	Atomic absorption spectrometry (flameless)
Nickel	Inductively coupled plasma optical emission spectrometry (ICP/OES)
Lead	Inductively coupled plasma optical emission spectrometry (ICP/OES)
Antimony	Inductively coupled plasma optical emission spectrometry (ICP/OES) (hydride)
Selenium	Inductively coupled plasma optical emission spectrometry (ICP/OES) (hydride)

C.1.3 Expression of results

C.1.3.1 Aluminium content

The aluminium content shall be expressed in grams of aluminium per kilogram of product (Al g/kg). The following equation gives the aluminium content expressed as alumina (Al_2O_3):

$$Al_2O_3 = (Al) \times \frac{102}{54}$$

C.1.3.2 Repeatability

Laboratory shall calculate the repeatability of the method under their laboratory conditions according to the procedure defined in *ISO 5725-2*.

Bibliography

[1] *EN 1302, Chemicals used for treatment of water intended for human consumption - Aluminium-based coagulants - Analytical methods*

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

ICS 71.100.80