SPECIFICATION FOR ALUMINIUM SULPHATE FOR THE PURIFICATION OF DRINKING WATER

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GENERAL

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GENERAL

1 Ambient Conditions

All materials shall be in every respect suitable for storage, use and operation in the conditions of temperature and humidity appertaining in Sri Lanka.

The annual average temperature is 35 °C while the relative humidity varies generally from 70% during the day to 90% at night.

2 Suitability for Potable Water

Aluminium Sulphate will come into contact with potable water shall not constitute a toxic hazard and shall not support microbial growth.

3 Definitions

The definitions given in the relevant standards which are referred to in the specification shall apply for the terms used in this specification.

4 Inspection and Testing

The Manufacturer shall supply, furnish and prepare the necessary test samples of materials and supply the labour facilities and appliances for such testing as may be required to be carried out on his premises according to this specification. If there are no facilities at his own works for making the prescribed tests the Contractor shall bear the cost of carrying out the tests elsewhere.

The Engineer and nominated Inspection Authority shall have full access to all parts of the plant that are concerned with the testing, furnishing or preparation of materials for the performance and testing of work under this Specification.

The Contractor shall furnish the Engineer with reasonable facilities and space (without charge) for the inspection, testing and obtaining of such information, as he desires regarding the character of material in use and the progress and manner of the work.

Further all materials shall be tested to the appropriate tests at the manufacturer’s premises and shall be supported by a test certificate from the manufacturer.

Contractor is held responsible for the assuring quality of the goods until the final delivery point. Aluminium Sulphate is tested at the Employer’s final delivery point by the Employer and goods shall conform to the standards for the acceptance.

5 Marking

All markings shall be legible and durable unless otherwise specified and shall be as specified in this specification.

6. Protection During Delivery

The contractor shall provide protection to the material as approved by the Engineer, prior to the materials leaving the place of manufacture and shall maintain such protection until the items reach their destination in order to guard effectively against damage during transit and storage and the ingress of foreign matter into the packages.

All details of the proposed method of providing such protection shall be submitted at the time of tendering.

The cost of providing protection shall be included in the unit prices tendered in the Bills of Quantities.

7. Storing, Handling and Hauling of Materials.

All materials shall be stored in an approved location and in such a manner as to preserve their quality and condition.

Storage shall be in accordance with the manufacturers recommendation and shall be stored in a dry place with a proper packing.

Materials and components shall be handled in such a manner as to avoid any damage or contamination and in accordance with all applicable recommendations of the manufacturers.

The contractor shall give instructions to the shipper on precautions to be taken in the handling of materials during loading, towage delivery and unloading and shall give particulars of these instructions to the purchaser.

8. Manufacturer’s Certificate

The Manufacturer shall supply to the Engineer a certificate stating that each item supplied has been subjected to the tests laid down herein and conforms in all respects to this Specification or such other Specification which has been submitted to and approved by the Engineer. In addition to this, contractor shall provide certificate for the conformity to the Standards (SLS 1535: 2016) suitable for human consumption from the independent testing agencies mentioned in General condition of contract.

9. Quality and Workmanship

The Bidder shall provide ISO 9001 : 2015 Quality Management System requirement certificate for Quality Assurance for the goods manufacturing factory from an accredited agency for Aluminium Sulphate. Accredited Agency shall be a member of International Accredited Forum (IAF) and shall have the authority for the accreditation of mentioned goods in their scope of accreditation. Scope of the production shall be clearly specified in the certificate. Manufacturer shall maintain the validity of this certificate during the contract Period. If the supply is made from several factories, ISO 9001 : 2015 certificates for quality management system requirement shall be submitted for each factory.

TECHNICAL SPECIFICATIONS FOR ALUMINIUM SULPHATE

1.0 GENERAL REQUIREMENT

All materials to be supplied under this contract shall conform to Sri Lanka Standard SLS 1535: 2016 – Specification for Aluminium Sulphate for purification of drinking water supplies.

1. Solid Aluminium Sulphate (Type1) shall be either in Lump, Powder or flaked(chips) forms and shall conforms to the requirements given in Table 1, and tested according to the test method given in Table 1.
2. Colour –White and free from visible impurities
3. Other Requirements
    - Particle size of the lump shall be less than 40mm
    - Particle size of the flaked shall be less than 25mm
    - Particle size of the powder shall be less than 5mm

   When tested as prescribed in Appendix B hereof.
4. Supplier shall provide documentary evidence of compliance with the International Standards to the effect that Aluminium Sulphate is of food grade quality.

Table 1

Characteristics	**Requirements** Solid (Type1)	**Method of Test**
Water soluble Aluminium Sulphate as Al_2O_3 percent by mass, min	16.0	Appendix C
Water insoluble matter, percent by mass, max	0.5	Appendix D
PH at 27 ± 2° C, min	2.8	Appendix E
Arsenic (as As) mg/kg, max	4.0	Appendix F
Lead (as Pb) mg/kg, max	10.0	Appendix F
Manganese (as Mn) mg/kg, max	25.0	Appendix F
Cadmium (as Cd) mg/kg, max	2.0	Appendix F
Mercury (as Hg) mg/kg, max	0.2	Appendix F
Chromium (as Cr) mg/kg, max	10.0	Appendix F
Iron (as Fe) percent by mass, max	0.48	Appendix G
Ammoniacal Nitrogen (N) mg/kg , max	300.0	Appendix H
Age of Aluminium Sulphate from the date of manufacture when shipping.	Not more than 02 Months from the date of Manufacture	

1.2. PACKING REQUIREMENTS

This material shall be supplied in 25kg or 50 Kg quantities in HDPE bags with inner liner.

1.3 MARKING

Each package shall be marked legibly & indelibly with the following information : (letter height shall be 50mm)

a) Name of the product

b) Name and address of the manufacturer and local agent including country of origin

c) Registered trade mark,

d) Net mass, in kg.

e) Type and Grade

(f) Employer's Name as 'NWSDB'

(g) Conformity to standard as "SLS 1535:2016"

(h) Date of manufacture & Date of expiry

(i) Contract No

(j) Batch or code number

2.0 SAMPLING

Representative samples of the product for ascertaining conformity to the requirements of this Specification shall be drawn as prescribed in Clause 3 here of.

3.0 COMPLIANCE OF A LOT

The sampling scheme given in this Specification should be applied where compliance of a lot to the requirements of the standard is to be assessed based on statistical sampling and inspection.

Where compliance with the Standard is to be assured based on manufacture's control systems coupled with type testing and check tests or any other procedure, appropriate schemes of sampling and inspection should be adopted.

3.1 LOT

In any consignment all the packages and containers of the same size, same type and belonging to one batch of manufacturer or supply shall constitute a lot.

3.2 GENERAL REQUIREMENTS OF SAMPLING

In drawing, handling and preparing samples, the following precautions shall be observed.

3.2.1 The samples shall not be taken from broken packages.

3.2.2 The sampling instrument shall be clean and dry when used.

3.2.3 The samples shall be placed in clean, dry and air-tight glass or suitable containers.

3.2.4 The material being sampled, the sampling instruments and the containers for samples shall be protected from adventitious contamination.

3.2.5 The sample containers shall be air-tight after filling and marked with necessary details of sampling. Samples shall be stored in the shade.

3.3 SAMPLING INSTRUMENTS

3.3.1 Shovel or other effective device shall be used for drawing samples from solid bulk.
3.3.2 Hand scoop or other effective device shall be used for drawing samples of powder materials from containers or conveyors.

3.4 SCALE OF SAMPLING

3.4.1 Samples shall be tested from each lot for ascertaining its conformity of the material to the requirements of this Specification.

3.4.2 **Sampling from solid materials supplied in packages.**

3.4.2.1 The number of packages to be selected from a lot shall be in accordance with table 2 – Scale of sampling.

3.4.2.2 The packages shall be selected at random. In order to ensure randomness of selection, random number tables as given in SLS 428 shall be used.

3.4.2.3 In case of lump material or flaked (chips) materials, each package selected as in 3.4.2.1 shall be emptied and a shovel shall be used to take sufficient quantity of material drawn from various parts of the mass being sampled.

3.4.2.4 In case of powder material, a hand scoop shall be inserted into each package being sampled as in 3.4.2.1, so that it will take a core of material from substantially the entire length of the package.

3.4.2.5 The material obtained from each package shall be thoroughly mixed to make the composite sample and reduced to obtain a test sample.

Table 2 – Scale of Sampling

Number of Packages in the lot (1)	Number of Packages to be selected (2)
Up to 50	5
51 to 150	20
151 to 280	32
281 to 500	50
501 to 1200	80
1201 to 3200	125
3201 to 10000	200
10001 to 35000	315
35001 and above	500

3.5 NUMBER OF TESTS

3.5.1 Each package selected as in 3.4.2 shall be inspected for marking requirements. This shall be done at the place of sampling.

3.5.2 Each sample selected as in 3.4.2.5 shall be examined for each relevant requirement given in Clause 1 hereof.

3.6 CRITERIA FOR CONFORMITY

A lot shall be declared as conforming to the requirements of this specification, if the following conditions are satisfied.

3.6.1 Each package inspected for marking as in 3.5.1 satisfies the relevant requirements.

3.6.2 The test results on each sample tested as in 3.5.2 satisfy the relevant requirements.

APPENDIX B

DETERMINATION OF PARTICLE SIZE

B.1 APPARATUS

Test sieves, of aperture size, 40mm, 25mm, 5mm conforming to **SLS 124**.

B.2 PROCEDURE

B.2.1 Lump form

Weigh, to the nearest 0.1g, about 100g of the sample and place it on the sieve of aperture size 40mm. Shake the sieve with material pass through the sieve and until no visible particles retain on the sieve.

B.2.2 Flaked form

Weigh, to the nearest 0.1g, about 100g of the sample and place it on the sieve of aperture size 5mm. Shake the sieve with material pass through the sieve and until no visible particles retain on the sieve.

B.2.3 Powder form

Weigh, to the nearest 0.1g, about 100g of the sample and place it on the sieve of aperture size 1mm. Shake the sieve with material pass through the sieve and until no visible particles retain on the sieve.

APPENDIX C

DETERMINATION OF WATER SOLUBLE ALUMINIUM SULPHATE

Two methods have been prescribed for the determination of water soluble aluminium sulphate. The method prescribed in C.1 shall be the reference method and shall be carried out in case of any dispute.

C.1 METHOD 1

C.1.1 Reagents

C1.1.1 0.05mol/L EDTA *solution*

Weigh 18.61g of Dihydrogen disodium ethylene diamine tetra acetate dehydrate, add 1000 ml of water to dissolve it, and store it in an air-tight polyethylene bottle.

C.1.1.2 *Sodium acetate buffer solution*

Dissolve 272 g of sodium acetate trihydrate in water to make 1000ml.

C.1.1.3 *Xylenol orange solution (1 g/L)*

Dissolve 0.1g of Xylenol orange in water to make 100 ml **.**

C.1.1.4 *Aluminium standard solution (1mg Al/ml)*

Weigh 1.000g of Aluminium (purity 99.99%), put it in a 100-ml beaker, cover its upper with a watch glass, add carefully a small quantity of Nitric acid (1:1) and dissolve it by heating. After allowing it to cool transfer whole liquid into a 1000-ml measuring flask and add Nitric acid (1:30) upto the marked line.

C.1.1.5 0.02 mol/L *Zinc solution*

Weigh 1.308g of Zinc, put it in a 100-ml beaker, add 6 ml to 7 ml of Hydrochloric acid and small quantity of water and dissolve it by heating. Evaporate water on a water bath nearly to dry up, add water to dissolve it, transfer it into a 1000-ml measuring flask and add water up to the marked line.

Take 20 ml of 0.05 mol/L EDTA solution into a 200 ml beaker, add 2 ml of Nitric acid (1:12), carry out the procedures shown in **C.1.2.3** and **C.1.2.4** in below **C.1.2** and the used quantity (ml) of 0.02 mol/l Zinc solution shall be made (V_1). Take 20 ml of Aluminium standard solution and 20 ml of 0.05 mol/L EDTA solution into another 200 ml beaker, add 2 ml of Nitric acid (1:12), cover it with a watch glass, boil it for 1 min, allow it to cool, carry out the procedures shown in **C.1.2.3** and **C.1.2.4** in below **C 1.2** and the used quantity in mililiter of 0.02 mol/L Zinc solution shall be made (V_2).

Amount of Aluminium, equivalent to 1 ml of 0.02 mol/L Zinc solution, is given by the following formula:

$$W_1 = \frac{0.001 \times 20}{V_1 - V_2}$$

Where,

W_1 is amount, in g, of Alumimium equivalent to 1 ml of 0.02 mol/L Zinc solution.

V_1 is volume, in ml, of 0.02 mol/L Zinc solution consumed at C.1.2.4 for sample solution;

V_2 is volume, in ml, of 0.02 mol/L Zinc solution consumed for Aluminium Standard solution.

C.1.2 Procedure

C1.2.1 Weigh sample by about 5 g of solid to the nearest 1 mg, put it in a 200 ml beaker, and add about 100 ml of water dissolve it. Filter it if necessary, transfer it into a 500 ml measuring flask, and add water up to the marked line.

C.1.2.2 Take 20 ml of this solution into a 200 ml Erlenmeyer flask, add 20 ml of 0.05 mol/L EDTA solution **(C.1.1.1)** and after boiling for 1 minute, allow it to cool.

C.1.2.3 Add about 10 ml of Sodium acetate buffer solution **(C.1.1.2)** and 2 drops to 5 drops of xylenol orange solution (1g/L) **(C1.1.3)**

C.1.2.4 Titrate it with 0.02 mol/L Zinc solution **(C.1.1.5)** and make it an end point when color of the solution turns faint red.

C.1.2.5 Take 20 ml of 0.05 mol/L EDTA solution **(C.1.2.1)** transfer it into another 200 ml Erlenmeyer flask, add about 20 ml of water and 2 ml of Nitric acid (1:12), and thereafter carry out procedures as shown in **C.1.2.3** and **C.1.2.4**

C.1.3 Calculations

Concentration of Aluminium oxide as Al_2O_3 (Per cent by mass) in the sample is given by the following formula:

$$M = \frac{1.8895 \times (V_3 - V_4) \times W_1 \times 100}{W_2 \times \frac{20}{500}} - (A \times 0.9129)$$

Where,

M	is per cent, by mass of Aluminium oxide;
V3	is volume, in ml, of 0.02 mol/L Zinc solution consumed at **C.1.2.5** for sample solution;
V4	is volume, in ml, of 0.02 mol/L Zinc solution consumed for sample solution;
W1	is amount, in g, of Aluminium equivalent to 1 ml of 0.02 mol/L Zinc solution;
A	is per cent, by mass of iron determined in Appendix **G;**
W2	is mass, in g, of sample: 1.8895 is conversion factor from 1g of Aluminium to Aluminium oxide; and 0.9129 is conversion factor from iron to Aluminium oxide.

C.2 Method 2

C.2.1 Reagents

C.2.1.1 *Concentrated Hydrochloric acid, relative density* = 1.18

C.2.1.2 *Concentrated Nitric acid, relative density* = 1.42

C.2.1.3 *Methyl red indicator, 1 g of methyl red in 500 ml of per cent ethanol.*

C.2.1.4 *Concentrated Ammonium hydroxide (1:1 Ammonium hydroxide), relative density =0.88*

C.2.1.5 *Ammonium nitrate, Dissolve 2 g in 100 ml of water*.

C2.2 Procedure

C.2.2.1 Weigh, to the nearest 0.01g, about 5 g of sample and dissolve in 100 ml of water. Digest on a steam bath for 5 minutes. Stir and filter while hot through a tarred sintered glass crucible of pore size between 5 µm dia. to 15 µm dia. (porosity no. 4). Wash with hot water until a washing is free of sulphate (approximately 10 separate washings). Retain the residue for the water insoluble matter determination in Appendix **D**. Transfer the filtrate and washings into a 500 ml volumetric flask, cool to room Temperature, and make up to the volume with water. Transfer a 50 ml aliquot to a 400 ml beaker and dilute with 150 ml of water. Add 10 ml of concentrated Hydrochloric acid **(C.2.1.1)** and a few drops of concentrated Nitric acid **(C2.1.2)** and heat to boiling.

C.2.2.2 Add 3 drops of methyl red indicator **(C.2.1.3)** and a small amount of ashless filter paper pulp. Neutralize with concentrated 1:1 Ammonium hydroxide solution **(C.2.1.4)** and add 3 drops in excess. Boil for 2 minutes. Allow the precipitate to settle and filter quantitatively through Whatman No. 41 filter paper (or equivalent). Return the filter paper and contents to the 400 ml beaker, add 10 ml of concentrated Hydrochloric acid, and macerate the paper to a pulp with the aid of a stirring rod. Add 150 ml of hot water and 3 drops of the methyl red indicator and heat to boiling. Neutralize with 1:1 Ammonium hydroxide solution and add 3 drops in excess. Boil for 2 minutes. Allow the precipitate to settle and quantitatively filter through Whatman No. 41 filter paper (or equivalent). Wash the filtrate six times with hot Ammonium nitrate solution **(C.2.1.5)**. Ignite the filter paper and precipitate in a tarred platinum crucible at 1200^0C. Cool and weigh. Repeat the process until the difference in mass between two successive weighing does not exceed 1 mg.

C.2.3 Calculation

Water soluble Aluminium sulphate, as Al_2O_3, percent by mass= $\frac{m_1 x 1000}{m_2}$ –A

where

m_1 is mass, in g, of residue;
m_2 is mass, in g, of sample; and
A is per cent, by mass of iron oxide (Fe_2O_3) calculated based on iron determined in Appendix **G**.

APPENDIX D

DETERMINATION OF WATER INSOLUBLE MATTER

D.1 PROCEDURE

Dry the sintered glass crucible and residue retained from Appendix **C**. Cool and weigh. Repeat the process until the difference in mass between two successive weightings does not exceed 1 mg.

D.2 CALCULATION

Water insoluble matter, percent by mass = $\frac{m_1}{m_2}$ x 100

Where,
m_1 is mass, in g, of insoluble matter; and
m_2 is mass, in g, of sample in Appendix C.

APPENDIX E

DETERMINATION OF pH

E.1 PROCEDURE

Weigh 1.0g of solid material and dissolve in 100 ml of freshly boiled and cooled distilled water. Measure the pH of the solution at 27± 2^0C by a suitable pH meter, using a glass electrode.

APPENDIX F

DETERMINATION OF HEAVY METALS

Atomic Absorption Spectroscopy (AAS) methodology shall be used for determination of heavy metals.

APPENDIX G

DETERMINATION OF IRON

Two methods have been prescribed for the determination of Iron. The method prescribed in **G.1** shall be the reference method and shall be carried out in case of any dispute.

G.1 METHOD 1 (BIPYRIDAL METHOD)

G.1.1 Reagents

G.1.1.1 *Concentrated Sulfuric Acid, relative density* = 1.84

G.1.1.2 *Phosphoric acid,* 25 *percent (V/V) solution, prepared by using concentrated phosphoric acid, relative density* = 1.69

G.1.1.3 *Sodium diphenylamine sulfonate indicator,* 2 g/L

G.1.1.4 *Potassium dichromate, standard volumetric solution*, C ($K_2Cr_2O_7$) = 0.017 mol/L

G.1.2 Procedure

G.1.2.1 Weigh, to the nearest milligram, about 10 g of the sample and dissolve in 100 ml of hot water. After stirring for a few minutes, digest on a hotplate for 30 minutes just below the boiling point. Filter through a Whatman No. 42 filter paper (or equivalent). Wash with hot water until the washing is free of sulphate (approximately 10 separate washings). Collect the filtrate and washings into a 250ml Erlenmeyer flask and close with a stopper fitted with a bunsen valve. Add appromixately 3 g of granulated Zinc and 8ml to 10ml of concentrated Sulphuric acid, **(G.1.1.1)**. After the Zinc has dissolved, boil the solution for 2 to 3 minutes. Cool under running tap water.

G.1.2.2 Add 40 ml of Phosphoric acid **(G.1.1.2)** and 4 drops of Sodium diphenylamine sulfonate indicator **(G.1.1.3)**. Titrate slowly with Potassium dichromate solution **(G.1.1.4)**, while stirring constantly, until the colour of the solution changes from green to grey-green. Continue the titration until the first tinge of purple or violet-blue appears. Run a blank determination.

G.1.3 Calculation

$$\text{Iron, as Fe, per cent by mass (A)} = \frac{33.51 \times C (V_1 - V_2)}{m}$$

Where,

C is concentration, in mol/L, of the Potassium dichromate solution used;

V_1 is volume, in ml, of Potassium dichromate solution required for the sample;

V_2 is volume, in ml, of Potassium dichromate solution required for the blank; and

m is mass, in g,of the sample.

G.2 METHOD 2 (AAS METHOD)

Atomic Absorption Spectroscopy (AAS) methodology shall be used for determination of iron.

APPENDIX H

DETERMINATION OF AMMONIACAL NITROGEN

H.1 REAGENTS

H.1.1 Sodium carbonate, solution (30 g/L).

Dissolve 3 g of Sodium carbonate (anhydride) in water to make 100 ml solution.

H.1.2 Sodium hydroxide solution (10 g/L)

Dissolve 1 g of Sodium hydroxide in water to make 100 ml solution.

H.1.3 Sodium hypochlorite solution (1 g/L)

Dissolve (100/Concentration of available chlorine (ml) of sodium hypochlorite) and 15 g of Sodium hydroxide in water to make 1000 ml solution.

H.1.4 EDTA – Sodium hydroxide mixed solution

Dissolve 0.93 g of Disodium ethylene diamine tetra acetate dihydrate in Sodium hydroxide solution (40 g/L) to make 250 ml solution.

H.1.5 1 – Naphthol solution

Dissolve 1.6 g of 1 – naphthol in acetone – ethyl alcohol solution (15:85) to make 100 ml solution.

H.1.6 Ammoniacal nitrogen standard stock solution (0.1 mg N/ml)

Keep Ammonium chloride in a desiccator (keeping manganese perchlorate) for at least 16 h, weigh 0.382 g and put it in a 100 ml beaker and dissolve it in a small quantity of water transfer it into a 1000 ml measuring flask, and add water up to the marked line.

H.1.7 Ammoniacal nitrogen standard solution (5 µgN/ml)

Take 50 ml of Ammoniacal – nitrogen standard stock solution (0.1 mgN/ml), transfer it into a 1000 ml measuring flask, and add water upto the marked line. Prepare this solution when it is used.

H.2 PROCEDURE

H.2.1. Weigh to the nearest 1 mg, about 5 g of the solid sample, put it in a 200 ml beaker and add about 100 ml of water to dissolve it. Transfer it in to the 500 ml measuring flask and add water up to the marked line. Pipette 25 ml of this solution into a 100 ml measuring cylinder with a stopper, add 5 ml of sodium carbonate solution **(H.1.1)** and add water up to the marked line.

H.2.2. Gently shake the measuring cylinder and stand to precipitate Hydroxide. Take 50 ml of the supernatant, and transfer it into a 100 ml color comparison tube with a ground stopper. Add sodium hydroxide solution **(H.1.2)** to control its pH and make its pH about 11 (See **Note 1**).

H.2.3 Add 1 ml of Sodium hypochlorite solution (available chlorine 1 g/l) **(H.1.3)** mix thoroughly after 2 minutes and within 5 minutes add 1 ml of EDTA sodium hydroxide mixed solution and mix it again. After 1 minute and within 5 minutes (see Note 2) add 5 ml of 1 – naphthol solution, mix well and add water upto the marked line and allow it to stand for 15 minutes at 25^0C to 30^0C.

H.2.4 Take its portion into a 10 mm absorption cell, and measure its absorbance at wavelength of 720nm.

H.2.5 Preparation of working curve

Transfer 0, 1, 2…. up to 7 ml of Ammoniacal nitrogen Standard solution (H.1.7) into 100 ml measuring flasks and add water to make 50 ml solution. Then carry out the procedure described in (H.2.3) and (H.2.4) and plot the working curve making use of the relation between the quantity of Ammoniacal nitrogen and the absorbance.

NOTES

1) *The blank for working curve and standard solution have a low buffer action, so pH adjustment is not needed.*
2) *The time control needed when reagents are added shall be carried out accurately, including working curve preparation.*

H.3 CALCULATION

On the working curve prepared in (H.2.5), find the amount of Ammoniacal nitrogen (µg) which is equivalent to absorbance measured at (H.2.4) and calculate the concentration of Ammoniacal nitrogen (mg/kg) in the sample according to the following formula:

$$C = \frac{W}{m \times \frac{25}{500} \times \frac{50}{100}}$$

Where,
C is concentration, in mg/kg, of Ammoniacal nitrogen in sample;
W is amount, in µg, of Ammoniacal nitrogen; and
m is mass, in g, of the sample.