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# Standard for the Supply of Polyaluminium Chloride for Use in Water Treatment

Second Edition

2013

**water**  
NEW ZEALAND  
*The New Zealand Water & Wastes Association Waiora Aotearoa*



# **STANDARD FOR THE SUPPLY OF POLYALUMINIUM CHLORIDE FOR USE IN WATER TREATMENT**

**Second Edition**

**2013**

The first edition of this standard was prepared for the Water Supply Managers' Group of the New Zealand Water & Wastes Association (now trading as Water New Zealand) and the Ministry of Health by Works Consultancy Services Ltd in 1994.

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# 1 General

## 1.1 Scope

This Standard covers polyaluminium chloride as used in the treatment of water supplies. This is abbreviated to PolyAC in this standard. It may be supplied in liquid or powdered form.

## 1.2 Purpose

The main purpose of this Standard is to provide purchasers, manufacturers and suppliers with the minimum requirements for polyaluminium chloride, including physical, chemical and testing requirements.

## 1.3 Application

This Standard can be referenced in specifications for purchasing and receiving polyaluminium chloride and can be used as a guide for testing the physical and chemical properties in samples of this product. The stipulations of this Standard apply when this document has been referenced and only for polyaluminium chloride intended for use in water treatment.

## 1.4 Uses in Water Treatment

Polyaluminium chloride is used in the water treatment industry for the coagulation of organic and mineral colloids prior to sedimentation and/or filtration. The aluminium destabilises fine colloidal suspensions and promotes the forming together of large conglomerations of this material bound in a chemical precipitate (called floc) which is able to be removed from the water by sedimentation, flotation and/or filtration. In general, polyaluminium chloride is preferred over aluminium sulphate if a larger, faster forming floc is desired, as this may remove the need for a flocculant to facilitate sedimentation.

## 1.5 Manufacture

Liquid polyaluminium chloride is prepared by combining aluminium hydroxide with hydrochloric acid and sulphuric acid at elevated temperatures, then treating the resultant product with calcium carbonate to raise its basicity. The resulting mixture is then put through a centrifuge to separate the liquid polyaluminium chloride from the solid product (gypsum). Powdered polyaluminium chloride is produced from the reaction of hot HCl gas with an aluminium substrate producing a dry material.

## 1.6 Description of Chemicals

Polyaluminium chloride is available in the following forms in New Zealand:

- powdered
- liquid

**Powdered** PolyAC is available as a white powder which comes in 20 or 25 kg bags.

**Liquid** PolyAC is usually sold as a 34% w/w solution, either via bulk tanker, or in smaller containers such as 20 L jerry cans, 200 L drums, or 1000 kg intermediate bulk containers (IBCs).

## 1.7 Methods of Dosing

Polyaluminium chloride is dosed as a liquid solution. It is usually dosed via diaphragm pumps into a zone of high water turbulence to facilitate rapid mixing of the solution with the water. It is normal to pump the solution with additional dilution water into the water being treated in order to facilitate good mixing and rapid coagulation.

## 1.8 Definitions

The following definitions shall apply in this Standard:

<i>PolyAC</i>	PolyAC refers to polyaluminium chloride.
<i>Polyaluminium chloride</i>	A compound with the formula $[Al(OH)_aCl_b(SO_4)_c]_n$ , where $(a + b + 2c) = 3$ , with $a > 1.05$ . Some polyaluminium chlorides may not contain $SO_4$ and conform to the formula $[Al(OH)_aCl_b]_n$ , where $(a + b) = 3$ , with $a > 1.05$ . Generally the basicity of these compounds used in the water treatment industry does not exceed 60% (see reference 1)
<i>Manufacturer</i>	The party that manufactures fabricates or produces materials or products.
<i>MAV</i>	Maximum acceptable values
<i>Purchaser</i>	The person, company or organisation that purchases any materials or work to be performed.
<i>Reception Point</i>	The point of physical transfer of materials from the supplier to the purchaser.
<i>SIL</i>	Specific impurity limit for a specified determinand identified by the purchaser
<i>Supplier</i>	The party who supplies material or services. A supplier may or may not be the manufacturer.
<i>w/w</i>	Weight for weight.

## 2 MATERIALS

### 2.1 Physical Properties

**Solid PolyAC** shall be clean and dry, and shall be in the powdered form.

**Liquid PolyAC** shall be a nearly saturated solution of polyaluminium chloride and it shall have not greater than 0.2% precipitated material present in the solution.

Some physical properties of the forms of PolyAC are listed in Table 1.

Property	Form of Polyaluminium chloride	
	Solid	Liquid*
pH of solution	N/A	2.6 ± 0.3
Specific gravity	N/A	1.2 (at 10.1% Al <sub>2</sub> O <sub>3</sub> , or 5.3% as Al)
Bulk density	0.77 tonne/m <sup>3</sup>	N/A

\*Figures are given for a 34% w/w solution of polyaluminium chloride.

**Table 1: Some physical properties of the two forms of polyaluminium chloride**

### 2.2 Chemical Requirements

The chemical requirements of both forms of polyaluminium chloride are given below.

Powdered PolyAC shall contain water-soluble aluminium of not less than 14 ± 0.3% w/w as Al, or 30% w/w as Al<sub>2</sub>O<sub>3</sub>.

Liquid PolyAC shall contain water-soluble aluminium of not less than 2.16% w/w as Al or 10% w/w as Al<sub>2</sub>O<sub>3</sub>. In liquid PolyAC, the water-insoluble matter shall not exceed 0.2% w/w.

### 2.3 Impurities

#### 2.3.1 Specific Impurity Limits

**2.3.1.1** The limits of specific impurities in the PolyAC shall be set by the purchaser. In setting impurity limits, the purchaser shall take into consideration the expected maximum dosage (MD) of inorganic coagulant, the maximum acceptable value (MAV) of a determinand taken from the Drinking-water Standards for New Zealand 2005 (revised 2008) and a safety factor which reflects the maximum percentage of a MAV that may be contributed by a specific impurity. The specific impurity limits shall be calculated using the following equation.

$$SIL (mg/kg) = \frac{MAV (mg / litre) \times 10^6}{MD (mg / litre) \times SF}$$

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Where	SIL	=	Specific Impurity Limit
	MAV	=	Maximum Acceptable Value (see DWSNZ 2005 (Revised 2008))
	MD	=	Maximum Dosage
	SF	=	Safety Factor

**2.3.1.2** Alternative MAVs to those in the Drinking-water Standards for New Zealand may be chosen by the purchaser to reflect their individual requirements (eg, fluoride). The purchaser may also vary the SF to suit.

**2.3.1.3** The MD (maximum dosage) of the inorganic coagulant shall be based on the maximum dose used at the purchaser's treatment plant in the previous 12 month period. However, if the previous 12 months are not deemed to be representative of usual conditions, the purchaser may refer to other time periods deemed to have had usual conditions to find the maximum dose to be used in SIL calculations.

**2.3.1.4** The SF (safety factor) to be used shall be less than or equal to 10, which reflects the view that no more than 10% of a MAV should be contributed by a given impurity in a water supply chemical.

**2.3.1.5** Specific impurity limits shall be given as weight of impurity by weight of inorganic coagulant.

**2.3.1.6** Specific impurities that may be of importance to test for are: antimony, arsenic, barium, boron, cadmium, chromium, copper, fluoride, iron, lead, manganese, mercury, molybdenum, nickel, selenium, and zinc.

## **2.3.2 General Impurities**

In addition to the above specific impurities, the PolyAC may not contain any other impurities that may be deleterious to health or aesthetically objectionable as determined in the 2005 Drinking-water Standards for New Zealand (revised 2008). General impurity limits shall be based on the maximum dosage of inorganic coagulant as determined in section 2.3.1.3, the MAV of determinands in the DWSNZ 2005 (revised 2008), and a minimum SF of 10.

## 3 DELIVERY

### 3.1 Packaging and Shipping

- 3.1.1 Solid and liquid forms of the inorganic coagulant may be transported in the quantities described in their individual sections within Section 1.6.
- 3.1.2 Tanks for transporting PolyAC shall comply with all conditions as required under the Transport Act 1998 (see link below) and shall not contain any substances that might affect the quality of the liquid inorganic coagulant in treating water supplies.

<http://www.legislation.govt.nz/act/public/1998/01/10/latest/DLM433613.html>

### 3.2 Labelling

Each shipment of material shall comply with the New Zealand Standard NZS 5433:1988, *Code of Practice for the Transport of Hazardous Substances on Land* and specifically must be clearly identifiable and be marked and/or accompanied by clear means of giving the following information:

Contents:	Proper Shipping Name for coagulant
Net weight	
Name of manufacturer:	
Hazardous Chemical Classification:	

Additionally, a date of manufacture and/or 'use by' date should be attached to the product to enable identification of expired product.

### 3.3 Unloading and Storage

- 3.3.1 The purchaser shall provide an appropriate receiving vessel for the bulk liquid coagulant, and the supplier shall provide an appropriate "camlock" or other type of coupling as agreed with the purchaser for connection to the storage tank inlets if required, in order to prevent discharge to incorrect tanks.
- 3.3.2 Empty bulk trucks shall not be washed out at the delivery site without the express approval of the purchaser's representative or operating personnel.
- 3.3.3 Bags or drums shall be unloaded with a forklift or by hand. Bags shall be stored in a designated dry storage area. PolyAC absorbs moisture from the air so the storage area should be covered and bags shall be stored on wooden pallets.
- 3.3.4 Bags damaged prior to delivery will be the responsibility of the supplier and bags damaged during unloading at the purchaser's premises will be the responsibility of the agent undertaking the unloading.
- 3.3.5 The condition on delivery of the paper outers of the bags shall not have deteriorated to any extent so as to impede handling or emptying of the bags. Bags with deteriorated paper outers on delivery shall be replaced by the supplier at no cost to the purchaser.



## 4 SAFETY

### 4.1 Health and Safety

4.1.1 Suppliers of PolyAC must comply with the requirements of the Health and Safety in Employment Amendment Act 2002 and take all practicable steps to protect the purchaser and others from hazards arising from the transportation, delivery and supply of the product.

4.1.2 Within two weeks of award of a contract to supply product and prior to delivery the supplier shall provide to the purchaser the following information:

- (a) an updated copy of the Material Safety Data Sheet, which as a minimum, shall follow the Approved Code of Practice for Material Safety Data Sheets (see link)

[Safety Data Sheets - Code of Practice for the Preparation of](#) and

- (b) Evidence that drivers have been adequately trained and have adequate knowledge and experience in the handling and delivery of the inorganic coagulant being delivered.

4.1.3 Prior to the commencement of the contract, a copy of the purchaser's Health and Safety Management Plan (H&SMP) shall be made available to the supplier of the inorganic coagulant, as will the supplier's H&SMP be made available to the purchaser. Any contradictions or conflicts, relevant to the supply of the named inorganic coagulants, between the two H&SMP's shall be modified to the satisfaction of both parties before the commencement of the contract. Each party shall otherwise comply with the H&SMP of the other party, and any practices by either party which do not comply with the Health and Safety Management Plans may be grounds for the termination of a supply contract. Health and Safety Management Plans are discussed in the National Guidelines for Occupational Health and Safety in the New Zealand Water Industry, second edition (2001).

[http://www.waternz.org.nz/Category?Action=View&Category\\_id=199#waternzguidelines](http://www.waternz.org.nz/Category?Action=View&Category_id=199#waternzguidelines)

### 4.2 Protective Equipment

The purchaser and the supplier will be responsible for providing their respective personnel or agents with any necessary safety and protective equipment identified in their Health and Safety Management Plans and ensuring it is used as required.

### 4.3 Spills

The supplier, their agent, or the authorised purchaser's representative responsible for unloading the inorganic coagulant, shall immediately attend to and report any spills within the grounds of the property in which the inorganic coagulant reception point is located. Clean-up and reporting procedures should be specified in Health and Safety Management Plans; they may also be specified in the water treatment plant consent issued by the regional council.

## 5 TESTING METHODS

### 5.1 General

- 5.1.1 The manufacturer or supplier shall test the materials at their own cost in order to provide a certificate of compliance as required in Section 6.1.
- 5.1.2 The purchaser may randomly take samples (see section 5.2) of the material and have these samples analysed for conformance with this Standard, at the cost of the purchaser. These samples may be taken at the place of manufacture and/or at the delivery point, as may be agreed upon by the manufacturer or supplier and the purchaser.
- 5.1.3 When inspection and sampling are to be conducted at the point of manufacture, the manufacturer shall afford the inspector representing the purchaser all reasonable facilities for inspection and sampling of finished material, which shall be so conducted as not to interfere unnecessarily with the operation of the plant. When on site, the purchaser must follow the manufacturing site's safety policies and procedures when taking the sample, or allow the manufacturer to take the sample itself while under supervision of the supplier's representative.
- 5.1.4 Analytical testing methods shall be as specified in this Standard in Section 5.3.
- 5.1.5 If the analysis of a sample taken at the place of manufacture shows the material does not comply with the requirements of this Standard, the purchaser may require that the manufacturer provide a certified analysis from a suitably accredited testing laboratory for successive deliveries.
- 5.1.6 If the analysis of a sample taken at the point of delivery shows the material does not comply with the requirements of this Standard, a notice of non-conformance must be provided by the purchaser to the supplier in accordance with Section 6.4.

### 5.2 Sampling

- 5.2.1 All samples taken for testing purposes must be stored in sealed containers and be appropriately labelled. A suitable sampling procedure is set out in Appendix B of this Standard, but shall be agreed upon by the purchaser and supplier, prior to the award of a contract to supply product, to provide a sample properly representative of the supplied material.

### 5.3 Standard Tests

- 5.3.1 For the standard test methods for the following properties of liquid PolyAC refer to ANSI/AWWA Standard B408-10, section 4, pp 3 – 16.
- specific gravity
  - polyaluminium chloride content in liquid PolyAC as % by mass Al or Al<sub>2</sub>O<sub>3</sub>
  - percent basicity
  - turbidity.
- 5.3.2 A similar standard does not exist in ANSI/AWWA standards for solid PolyAC chemicals. Samples of solid material should be taken and a solution of the concentration used in processing prepared for analysis as described in section 5.3.1.
- 5.3.3 Test methods for specific impurities are found *in Standard Methods for the Examination of Water and Wastewater*, 22<sup>nd</sup> Edition, 2012 (by subscription online or hard copy). Methods for some parameters are given under the following codes at [Standard Methods Online](#):

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Antimony	3500-Sb
Arsenic	3500-As
Barium	3500-Ba
Boron	4500-B
Cadmium	3500-Cd
Chromium	3500-Cr
Copper	3500-Cu
Fluoride	4500-F <sup>-</sup>
Iron	3500-Fe
Lead	3500-Pb
Manganese	3500-Mn
Mercury	3500-Hg
Molybdenum	3500-Mo
Nickel	3500-Ni
Selenium	3500-Se
Zinc	3500-Zn

Maximum acceptable values (MAV) for determinands of health significance and guideline values for aesthetic determinands (iron and zinc) can be found in Table 2.2 and Table 2.5 respectively of Drinking Water Standards for New Zealand 2005 (Revised 2008) using the link provided.

[Drinking-water Standards for New Zealand 2005 \(Revised 2008\)](#)

## **6 QUALITY ASSURANCE**

### **6.1 Certificate of Compliance**

**6.1.1** The manufacturer or supplier shall provide the purchaser with a certificate of compliance that states that the material furnished in accordance with the purchaser's order complies with all applicable requirements of this Standard.

**6.1.2** The purchaser may require that the supplier provide a certified analysis of the material, from a mutually agreed upon laboratory at the commencement of the contract and thereafter at three monthly intervals or as agreed between purchaser and supplier. The purchaser may also require that the supplier provide a certified analysis for insoluble matter or particular impurities, from a mutually agreed upon laboratory, for each delivery.

### **6.2 Method of Manufacture**

**6.2.1** The quality of a water treatment chemical is greatly influenced by the method of manufacture and quality of raw material used. If other than recognised methods of manufacture, or if unusual raw materials are used, the potential may exist for impurities to be present, or poor quality chemical to be produced, that may be inconsistent with good water treatment practice.

**6.2.2** If the method of manufacture, source and/or quality of raw material used is changed during the period of the contract, then additional samples shall be analysed at the manufacturer's or supplier's cost, to demonstrate that the changes have not affected compliance with this Standard.

### **6.3 Weight Certificate**

Delivered bulk product shall be weighed over certified weighbridges and the docket produced on delivery.

### **6.4 Rejection**

#### **6.4.1 Notice of Non-conformance**

If the inorganic coagulant delivered does not meet the requirements of this Standard or the specific impurity limits notified by the purchaser, a notice of non-conformance must be provided by the purchaser to the supplier within 10 working days after receipt of the shipment at the point of destination. The results of the purchaser's tests shall prevail unless the supplier notifies the purchaser within five working days after receipt of the notice of complaint that a retest or inspection is desired. On receipt of the request for a retest, the purchaser shall forward to the supplier one of the sealed samples taken in accordance with Section 5. In the event that the results obtained by the supplier upon retesting do not agree with the results obtained by the purchaser, the other sealed sample shall be forwarded, unopened, for analysis to a referee laboratory agreed upon by both parties. The results of the referee analysis or inspection shall be accepted as final.

The cost of the referee analysis shall be paid by the supplier if the material does not meet the requirements of this Standard, and shall be paid by the purchaser if the material does meet the requirements of this Standard.

## **6.4.2 Material Removal**

- 6.4.2.1** If the material does not meet the impurity limit requirements of this Standard, the supplier shall remove the material from the premises of the purchaser. Removal of material shall be at no cost to the purchaser.
- 6.4.2.2** If the material meets the impurity limits but not the water soluble aluminium or water insoluble matter content requirements of this Standard, a price adjustment may be agreed between the supplier and the purchaser. In the event that a price adjustment cannot be agreed, the supplier shall remove the material from the premises of the purchaser if required by and at no cost to the purchaser.
- 6.4.2.3** The material that shall be removed shall include the rejected material and any other material the rejected material may have contaminated, for example contents of a tank into which a bulk delivery has been unloaded, if required by the purchaser.
- 6.4.2.4** All material removed shall be concurrently replaced with material conforming to this Standard with an appropriate compliance certificate at no cost to the purchaser.

## Appendix A: Conversion Factors for Coagulant Concentrations

### A1 Conversion factor table between weight of Al and the coagulant compound

	$\text{Al}_2(\text{OH})_5\text{Cl}_{2.6}$ (ie. PolyAC <sup>1</sup> )	$\text{Al}_2(\text{OH})_3\text{Cl}_4(\text{SO}_4)_{1.5}$ (ie. PolyAC sulphate <sup>2</sup> )	$\text{Al}_2\text{O}_3$
Molecular weight (g/mol)	231.18	391.07	101.96
Al to PolyAC conversion factor	4.28	7.25	1.89

<sup>1</sup> Polyaluminium chloride has a variable chemical formula, the formula cited being an example of the empirical formula  $\text{Al}(\text{OH})_a\text{Cl}_b$  where  $(a + b) = 3$ , with  $a > 1.05$

<sup>2</sup> Polyaluminium chloride sulphate has a variable chemical formula, the formula cited being an example of the empirical formula  $\text{Al}(\text{OH})_a\text{Cl}_b(\text{SO}_4)_c$  where  $(a + b + 2c) = 3$ , with  $a > 1.05$

## Appendix B: Sampling Procedure

### B1 Sampling Method

#### B1.1 General

- B1.1.1 Sampling and preparation shall be conducted as expeditiously as possible in order to avoid undue exposure of the material to the air, thus avoiding contamination and evaporation.
- B1.1.2 The sampling method must give a gross sample that is representative of the material, and which may be divided to provide representative samples for analysis. The quantity of sample required by the testing laboratory to carry out the desired tests must be known prior to the sample being taken.
- B1.1.3 Samples for analysis shall be provided in triplicate. One sample is for the immediate use of the purchaser for testing of the shipment. The other two samples shall be retained until it is known from the results of the laboratory examination that the shipment meets the requirements of this Standard. The second sample shall be delivered to the supplier if requested within five days of notification of the examination results of the first sample. The third sample is for the use of a referee laboratory if there is a controversy over the analyses.
- B1.1.4 Samples shall be sealed in airtight, moisture-proof containers which are of a material known not to interfere with, or be degraded by, the product to be stored in it.
- B1.1.5 Each sample shall be labelled with the minimum information as follows: the material name, the name of the purchaser, the name of the sampler, package number, date sampled, and date received.

#### B1.2 Solid Inorganic Coagulant

- B1.2.1 If the coagulant is packaged, 5% of the number of the packages shall be sampled. No sample shall be taken from a broken package.
- B1.2.2 Care shall be taken to include a proportional amount of lumps and fines, to obtain representative material.
- B1.2.3 Ground coagulant shall be sampled using a sampling tube or other effective device that measures at least 2 cm in diameter.
- B1.2.4 The gross sample, of at least 8 kg or as agreed, shall be mixed thoroughly and quartered and quartered again to provide eight 0.5 kg samples. Six of these samples shall be sealed in containers as in Section B1.1.4. Two samples (a duplicate) shall be for use by the purchaser. The other four, representing two duplicate samples, shall be retained to be used for retesting as provided for in Section B1.1.3.

To quarter the sample, tip it on to a clean surface so that it forms a conical or hemispherical pile. With a clean knife, cut the pile vertically, dividing the pile into four equal parts. Make up a new pile with one of these four parts, and repeat the quartering process.

**B1.3 Liquid Coagulant**

- B1.3.1 Equal portions shall be taken at four equally spaced time intervals during the unloading of the tank truck. The total sample volume shall equal 2 litres, or as agreed. Special sampling arrangements may be necessary at unmanned water treatment plants, particularly if a new load is pumped into a tank that still has some coagulant in it.
- B1.3.2 The gross sample (2 litres) should be thoroughly mixed, and three 0.5 litres samples retained.



## BIBLIOGRAPHY

*ANSI/AWWA Standard for Polyaluminium chloride.* ANSI/AWWA B408-10, 2010.

*Drinking-water Standards for New Zealand 2005 (revised 2008).* Ministry of Health, Wellington.

*National Guidelines for Health and Safety in the New Zealand Water Industry.* New Zealand Water and Wastes Association, Auckland, 1997.

*Standard Methods for the Examination of Water and Wastewater.* 22<sup>nd</sup> Ed. APHA, AWWA, WEF, 2012.

## REFERENCES

*I Helmboldt et al. Aluminium Compounds, Inorganic. In Ullmanns Encyclopedia of Industrial Chemistry.* 2007.