
**Carbonaceous materials for use in the
production of aluminium — Green and
calcined coke — Determination of trace
elements by flame atomic absorption
spectroscopy**

*Produits carbonés utilisés pour la production de l'aluminium — Coke cru et
calciné — Détermination des éléments-traces par spectrométrie
d'absorption atomique dans la flamme*

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8658 was prepared by the British Standards Institution (BSI) (as BS 6043: Part 2: Section 2.3:1989) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 47, *Chemistry* in parallel with its approval by the ISO member bodies.

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Carbonaceous materials for use in the production of aluminium — Green and calcined coke — Determination of trace elements by flame atomic absorption spectroscopy

1 Scope

This International Standard describes a method for the determination of trace elements in green and calcined coke with an ash content of not greater than 1 % (m/m) and with individual concentrations not greater than the following:

Calcium	0,025 % (m/m)
Chromium	0,005 % (m/m)
Copper	0,025 % (m/m)
Iron	0,030 % (m/m)
Lead	0,010 % (m/m)
Magnesium	0,010 % (m/m)
Manganese	0,001 % (m/m)
Nickel	0,050 % (m/m)
Silicon	0,100 % (m/m)
Vanadium	0,100 % (m/m)
Zinc	0,004 % (m/m)

NOTE — A method for the determination of ash of cokes is given in ISO 8005:1984, *Carbonaceous materials used in the production of aluminium — Green and calcined coke — Determination of ash*. However, it is essential that the ash produced by that method not be used in the procedure of this International Standard because of the risk of contamination by trace elements.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 385-1:1984, *Laboratory glassware — Burettes — Part 1: General requirements*.

ISO 835-1:1981, *Laboratory glassware — Graduated pipettes — Part 1: General requirements*.

ISO 1042:1983, *Laboratory glassware — One-mark volumetric flasks*.

ISO 3696:1987, *Water for laboratory use — Specification and test methods*.

ISO 6375:1980, *Carbonaceous materials for the production of aluminium — Coke for electrodes — Sampling*.

3 Principle

A test portion sample is heated in a muffle furnace at 700 °C for 10 h and the ash produced is fused with a mixture of sodium carbonate and orthoboric acid. The melt is dissolved in dilute hydrochloric acid and the trace metal content is analysed by flame atomic absorption spectrometry.

4 Reagents

Unless otherwise stated, use only reagents of recognized analytical grade and water complying with grade 2 of ISO 3696.

4.1 Sodium carbonate, anhydrous.

4.2 Orthoboric acid.

4.3 Hydrochloric acid, concentrated, $c(\text{HCl}) = 36\%$ (m/m), $\rho = 1,16$ g/ml.

4.4 Lanthanum chloride solution, 100 mg La/ml, atomic absorption grade, $c(\text{LaCl}_3 \cdot 7\text{H}_2\text{O}) = 267$ g/l.

4.5 Standard calcium solution, 0,1 mg/Cal.

Dry calcium carbonate (reagent grade) at $110\text{ °C} \pm 5\text{ °C}$ for 1 h and cool in a desiccator containing diphosphorus pentoxide. Weigh $2,497\text{ g} \pm 0,001\text{ g}$ into a 250 ml beaker. Add 50 ml of water, then, a little at a time, 50 ml of concentrated hydrochloric acid (4.3). When the solution is clear, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

Using a one-mark pipette (5.8), transfer 10 ml of this solution to a 100 ml one-mark volumetric flask (5.6). Add approximately 20 ml of water and 5 ml of hydrochloric acid (4.3). Dilute to the mark with water and mix.

4.6 Standard chromium solution, 0,1 mg Cr/ml.

Wash, by decantation, approximately 1,2 g of chromium metal of minimum purity 99,9 % (m/m) with dilute hydrochloric acid [$c(\text{HCl}) = 1\text{ mol/l}$], then wash with water and dry in an air-circulating oven maintained at $110\text{ °C} \pm 5\text{ °C}$ for 10 min. Weigh $1\text{ g} \pm 0,001\text{ g}$ of the dried chromium into a 250 ml beaker containing about 50 ml of water. Slowly add 50 ml of concentrated hydrochloric acid (4.3). After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

Using a one-mark pipette (5.8), transfer 10 ml of this solution to a 100 ml one-mark volumetric flask (5.6). Add approximately 20 ml of water and 5 ml of concentrated hydrochloric acid. Dilute to the mark with water and mix. Store in a polythene bottle.

4.7 Standard copper solution, 1 mg Cu/ml.

Wash, by decantation, approximately 1,2 g of copper metal of minimum purity 99,9 % (m/m) with dilute nitric acid [$c(\text{HNO}_3) = 2\text{ mol/l}$], then wash with water and dry in an air-circulating oven maintained at $110\text{ °C} \pm 5\text{ °C}$ for 10 min. Weigh $1\text{ g} \pm 0,001\text{ g}$ of the dried copper into a 250 ml beaker containing about 25 ml of water. Slowly add 35 ml of concentrated nitric acid ($\rho = 1,42$ g/ml). After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

4.8 Standard iron solution, 1 mg Fe/ml.

Weigh $1\text{ g} \pm 0,001\text{ g}$ of iron of minimum purity 99,9 % (m/m) into a 250 ml beaker and add 25 ml of water. Carefully add 50 ml of concentrated hydrochloric acid (4.3). After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

4.9 Standard magnesium solution, 0,01 mg Mg/ml.

Weigh $1\text{ g} \pm 0,001\text{ g}$ of magnesium of minimum purity 99,9 % (*m/m*) into a 250 ml beaker and add 50 ml of water. Carefully add 50 ml of concentrated hydrochloric acid (4.3). After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

Using a one-mark pipette (5.8), transfer 10 ml of this solution to a 1 000 ml one-mark volumetric flask (5.6). Add approximately 50 ml of water and 45 ml of concentrated hydrochloric acid (4.3). Dilute to the mark with water and mix.

4.10 Standard manganese solution, 0,1 mg Mn/ml.

Wash, by decantation, approximately 1,2 g of manganese metal of minimum purity 99,9 % (*m/m*) with dilute nitric acid [$c(\text{HNO}_3) = 2\text{ mol/l}$], then wash with water and dry in an air air-circulating oven maintained at $110\text{ }^\circ\text{C} \pm 5\text{ }^\circ\text{C}$ for 10 min. Weigh $1\text{ g} \pm 0,001\text{ g}$ of the dried manganese into a 250 ml beaker containing about 25 ml of water. Slowly add 35 ml of concentrated nitric acid ($\rho = 1,42\text{ g/ml}$). After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

Using a one-mark pipette (5.8), transfer 10 ml of this solution to a 100 ml one-mark volumetric flask (5.6). Add approximately 50 ml of water and 3 ml of concentrated nitric acid ($\rho = 1,42\text{ g/ml}$). Dilute to the mark with water and mix.

4.11 Standard nickel solution, 1 mg Ni/ml.

Weigh $1\text{ g} \pm 0,001\text{ g}$ of nickel of minimum purity 99,9 % (*m/m*) into a 250 ml beaker and add 25 ml of water. Carefully add 35 ml of concentrated nitric acid ($\rho = 1,42\text{ g/ml}$), and heat to dissolve. After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

4.12 Standard lead solution, 1 mg Pb/ml.

Weigh $1\text{ g} \pm 0,001\text{ g}$ of lead of minimum purity 99,9 % (*m/m*) into a 250 ml beaker and add 25 ml of water. Carefully add 35 ml of concentrated nitric acid ($\rho = 1,42\text{ g/ml}$), and heat to dissolve. After dissolution, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6). Dilute to the mark with water and mix. Store in a polythene bottle.

4.13 Standard silicon solution, 1 mg Si/ml.

Into a platinum dish or large platinum crucible, weigh 2,139 g of silica of minimum purity 99,9 % (*m/m*) and 6 g of anhydrous sodium carbonate (4.1), and mix well with a platinum spatula. Carefully fuse the mixture over a flame until a transparent melt is obtained. Allow to cool, add warm water, heat gently until completely dissolved and transfer quantitatively to a 400 ml PTFE beaker. Allow to cool. Dilute the solution to about 300 ml with water, transfer quantitatively to a 1 000 ml one-mark volumetric flask (5.6), dilute to the mark with water and mix. Immediately transfer this solution to a screw-cap polythene bottle.

Discard this solution after one month.

4.14 Standard vanadium solution, 1 mg V/ml.

Heat vanadium(V) oxide of minimum purity 99,9 % (*m/m*) in a covered platinum crucible (5.9) at $500\text{ }^\circ\text{C} \pm 10\text{ }^\circ\text{C}$ for 30 min and cool in a desiccator. Weigh 1,785 g of the dried material and dissolve in a slight excess of sodium hydroxide solution [$c(\text{NaOH}) = 1\text{ mol/l}$] in a PTFE beaker, then dilute to about 250 ml with water. Carefully add, a little at a time, concentrated sulfuric acid [$c(0,5\text{ H}_2\text{SO}_4) = 9\text{ mol/l}$], until the solution is just acid to litmus paper, then add a further 5 ml. Cool to room temperature, transfer to a 1 000 ml one-mark volumetric flask (5.6), dilute to the mark with water and mix.

4.15 Standard zinc solution, 0,1 mg Zn/ml.

Weigh $1 \text{ g} \pm 0,001 \text{ g}$ of zinc of minimum purity 99,9 % (*m/m*) into a 100 ml beaker and add 25 ml of water. Carefully add 25 ml of concentrated hydrochloric acid (4.3) and heat to dissolve. After dissolution, transfer the solution quantitatively to a 1 000 ml one-mark volumetric flask (5.6), dilute to the mark with water and mix.

Using a one-mark pipette (5.8), transfer 10 ml of this solution to a 100 ml one-mark volumetric flask (5.6), add about 20 ml water and 5 ml of concentrated hydrochloric acid (4.3). Dilute to the mark with water and mix.

5 Apparatus

Ordinary laboratory apparatus and the following are required. All glass and plastics apparatus shall be cleaned before use by washing in concentrated hydrochloric acid (4.3) and rinsing with water (see clause 4, introductory paragraph).

5.1 Spectrometer, atomic absorption type, fitted with a burner fed from cylinders of acetylene, dinitrogen oxide (nitrous oxide) and compressed air. The emission wavelength and slit width shall be variable.

5.2 Electric muffle furnace, capable of being maintained at $700 \text{ }^{\circ}\text{C} \pm 10 \text{ }^{\circ}\text{C}$.

5.3 Meker burner.

5.4 Sieve, with a polythene frame and polyester mesh having an aperture size in the range 500 μm to 1 000 μm .

5.5 Pestle and mortar, made from sintered alumina or from ferrous metal with a tungsten carbide liner.

NOTE — Pestles and mortars made from other materials are not suitable.

5.6 One-mark volumetric flasks, complying with ISO 1042, class A.

5.7 Burettes, 25 ml, complying with ISO 385-1, class A.

5.8 One-mark pipettes, complying with ISO 835-1, class A.

5.9 Platinum crucibles, with covers, 40 ml capacity.

To clean, place about 2,5 g of anhydrous sodium carbonate (4.1) and 1 g of orthoboric acid (4.2) into each crucible and mix. Replace the covers, then fuse the mixture over a Meker burner (5.3). Cool, dissolve the solidified melt in concentrated hydrochloric acid (4.3) and rinse with water (see clause 4, introductory paragraph). Dry in an oven at $110 \text{ }^{\circ}\text{C} \pm 5 \text{ }^{\circ}\text{C}$ and cool in a desiccator.

5.10 Platinum rod or spatula.

6 Sampling

Prepare a crushed representative sample in accordance with ISO 6375, ensuring that the milling procedure utilizes a jaw crusher faced with tungsten carbide and a 5 mm aperture sieve with a polythene frame and a polyester mesh (see ISO 6375).