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**NONFERROUS METALS INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

YS/T 1006.2-2014

**Methods for Chemical Analysis of Lithium Nickel Cobalt Manganese Oxide - Part 2:
Determination of Lithium, Nickel, Cobalt, Manganese, Sodium, Magnesium, Aluminum,
Potassium, Copper, Calcium, Iron, Zinc and Silicon Content - Inductively Coupled Plasma
Atom**

(English Translation)

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Foreword

YS/T 1006-2014 Methods for Chemical Analysis of Lithium Nickel Cobalt Manganese

Oxide is divided into 2 parts.

---Part 1.Determination the Total of Nickel Cobalt Manganese Content - EDTA

Disodium Salt Titration;

---Part 2.Determination of Lithium, Nickel, Cobalt, Manganese, Sodium,

Magnesium, Aluminum, Potassium, Copper, Calcium, Iron, Zinc and Silicon

Content - Inductively Coupled Plasma Atomic Emission Spectrometry.

This is Part 2 of YS/T 1006.

This Part shall be under the jurisdiction of National Technical Committee on Non-ferrous Metals of Standardization Administration of China (SAC/TC 243).

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1 Scope

This Part of YS/T 1006 specifies the method for the determination of lithium, nickel, cobalt, manganese, sodium, magnesium, aluminum, potassium, copper, calcium, iron, zinc and silicon content in lithium nickel cobalt manganese oxide, which is the cathode material for lithium ion batteries.

This Part is applicable to the determination of lithium, nickel, cobalt, manganese, sodium, magnesium, aluminum, potassium, copper, calcium, iron, zinc and silicon content in lithium nickel cobalt manganese oxide, which is the cathode material for lithium ion batteries. The range of determination is shown in Table 1.

2 Method Summary

Use hydrochloric acid to dissolve the specimen. In the hydrochloric acid medium, in accordance with the optimized operating conditions of the instrument and the recommended analytical spectrums, adopt the working curve method and an inductively coupled plasma atomic emission spectrometer to determine the lithium, nickel, cobalt, manganese, sodium, magnesium, aluminum, potassium, copper, calcium, iron, zinc and silicon content, in which, the determination of the lithium, nickel, cobalt and manganese content is conducted by adding yttrium standard solution as an internal standard.

3 Reagents

Unless it is otherwise specified, only reagents of top-grade purity and Grade-2 (and above) water are used in the analysis.

3.5 Internal standard solution. weigh-take 2.5400 g of yttrium trioxide [$w(Y_2O_3) \geq 99.99\%$]

in a beaker; add 30 mL of hydrochloric acid (3.3). Heat it up to dissolve it, then, remove it and cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains 2 mg of yttrium.

3.8 Cobalt standard stock solution. weigh-take 1.0000 g of pure cobalt [w(Co) >= 99.99%]

in a beaker; add 50 mL of hydrochloric acid (3.3). Heat it up to dissolve it, then, remove it and cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 500 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains 2.0 mg of cobalt.

3.9 Manganese standard stock solution. weigh-take 1.0000 g of pure manganese [w(Mn)

>= 99.99%] in a beaker; add 50 mL of hydrochloric acid (3.3). Heat it up to dissolve it, then, remove it and cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 500 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains 2.0 mg of manganese.

3.10 Sodium standard stock solution. weigh-take 2.5420 g of dried reference sodium

chloride [w(NaCl) >= 99.99%] in a beaker; slowly add 100 mL of water and cover the watch glass. Conduct low-temperature dissolution, then, cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up; immediately transfer it to a dry plastic bottle. 1 mL of this solution contains 1.0 mg of sodium.

3.11 Magnesium standard stock solution. weigh-take 1.6580 g of dried magnesium

oxide [w(MgO) >= 99.99%] in a beaker; slowly add 50 mL of hydrochloric acid (3.3) and cover the watch glass. Conduct low-temperature dissolution, then, cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains 1.0 mg of magnesium.

3.13 Potassium standard stock solution. weigh-take 1.9068 g of dried reference potassium chloride [w(KCl) $\geq$ 99.99%] in a beaker; slowly add 100 mL of water and cover the watch glass. Conduct low-temperature dissolution, then, cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up; immediately transfer it to a dry plastic bottle. 1 mL of this solution contains 1.0 mg of potassium.

3.16 Iron standard stock solution. weigh-take 1.0000 g of pure iron [w(Fe) $\geq$ 99.99%] in

a beaker; slowly add 50 mL of hydrochloric acid (3.3) and cover the watch glass. Conduct low-temperature dissolution, then, remove it and cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains

3.17 Zinc standard stock solution. weigh-take 1.0000 g of pure zinc [w(Zn) $\geq$ 99.99%] in

a 400 mL beaker; slowly add 50 mL of nitric acid (3.4) and cover the watch glass. Conduct low-temperature dissolution to drive off nitrogen oxides, then, remove it and cool it down. Use water to wash the watch glass and the wall of the beaker; transfer it into a 1,000 mL volumetric flask. Use water to dilute it to the scale, then, mix it up. 1 mL of this solution contains 1.0 mg of zinc.

3.18 Silicon standard stock solution. weigh-take 2.1395 g of pure silicon oxide [w(SiO₂)

$\geq$ 99.99%] in a platinum crucible; add 15 g of anhydrous sodium carbonate; mix it up and cover it. Then, transfer it into a 400 °C muffle furnace; raise the temperature to

900 °C and melt it for 1 h; take it out and cool it down. Use water to wash the inner wall

of the crucible; place it in a PTFE plastic beaker. Add 100 mL of hot water; conduct low-temperature dissolution, then, cool it down. Transfer it into a 1,000 mL volumetric flask. Use water to dilute to the scale, then, mix it up; immediately transfer it to a dry