Unit 15 zinc metallurgy

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isotope ['aɪsətoʊp]n. 同位素

sphalerite ['sfælə,raɪt] n. [矿物] 闪锌矿ZnS

lode /ləud/ n. 矿脉；丰富的蕴藏

galvanizing ['gælvənaɪzɪŋ] n. 镀锌; v. 给…镀锌

Cadmium ['kædmiəm] 镉

Germanium鍺 [dʒɜːr'meɪniəm]

Thallium铊 ['θæliəm]

Cobalt钴

Zinc dust锌粉

Thickener ['θɪkənər]增稠剂，浓缩机

['mæliəbl]

A New words and expressions

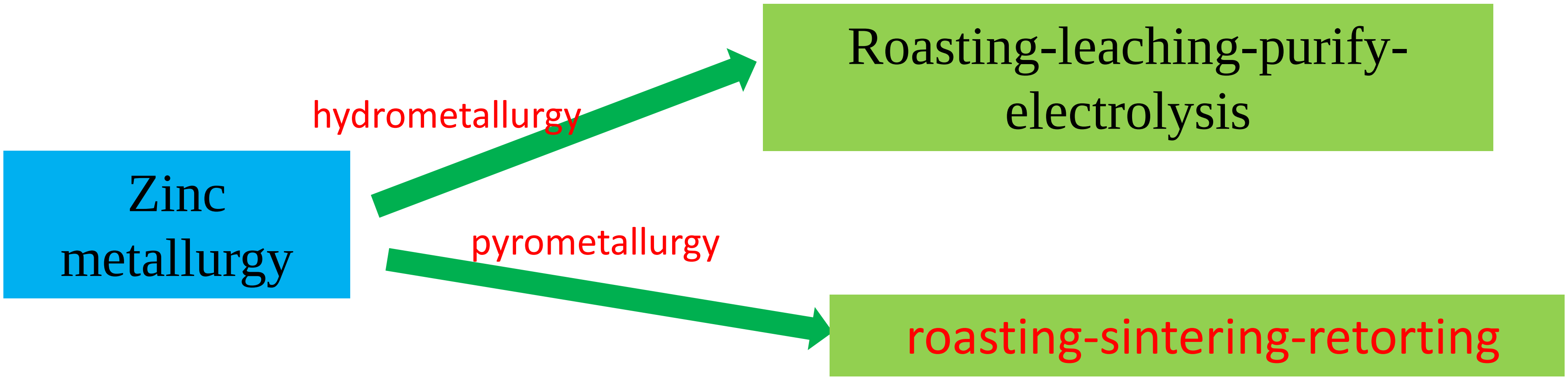
- diethyl [daɪ'eθɪl] adj. 二乙基的
- bluish ['blu:ɪʃ] adj. 带蓝色的；有点蓝的
- hexagonal[heks'ægənl]adj. 六边的，六角形的
- malleable ['mæliəbl] adj. 可锻的；适应的
- pulverize ['pʌlvəraɪz] vt. 粉碎；使成
- chalcophile ['kælkəfaɪl] [地质] 亲铜
- smithsonite/ ʻsmiθsənait /n. 菱锌矿
- hemimorphite/ ,hemi'mɔ:faɪt / n. [矿
- wurtzite/ ʻwərt,saɪt / n. [矿物] 纤维
- hydrozincite [矿物] 水锌矿[,haɪdrc
- weathering/ 'weðərɪŋ / n. [地质] 风化作用

New words and expressions

chalcophile /'kælkəfaɪl/ 亲铜的
sphalerite /'sfælərait/ *n.* 闪锌矿
smithsonite /'smɪθsənaɪt/ *n.* 菱锌矿
hemimorphite /ˌhemɪ'mɔːfaɪt/ *n.* 异极矿
wurtzite /'wɜːtsaɪt//'wərtˌsaɪt/ *n.* 纤维锌矿
hydrozincite /haɪdrəʊ'zɪŋkaɪt//haɪdroʊ'zɪŋkaɪt/ *n.* 水锌矿
pulverize /'pʌlvəraɪz/ *vt.* 粉碎；使成粉末；研磨
weathering /'weðərɪŋ/ *n.* 风化作用
primordial /praɪ'mɔːdiəl//praɪ'mɔːrdiəl/ *adj.* 原始的；根本的；原生的
goethite /'gəʊθaɪt//'goʊθaɪt/ *n.* 针铁矿
retort /rɪ'tɔːt//rɪ'tɔːrt/ *n.* 反应罐
briquette /brɪ'ket/ *n.* 煤球；团块；坯块；煤饼

rinse /rɪns/ *vt.* 冲洗
die casting 压铸，拉模铸造
lead bullion 粗铅
copper dross 铜浮渣
activated charcoal 活性炭

- primordial[praɪ'mɔːrdiəl]adj. 原始的；根本的；原生的
- goethite ['goʊθaɪt] n. [矿物] 针铁矿
- jarosite ['dʒærəsaɪt] n. [矿物] 黄钾铁矾
- hematite ['heməˌtaɪt]n. [矿物] 赤铁矿
- retort [rɪ'tɔːrt]反应罐
- briquette[brɪ'ket] n. 煤球；团块；坯块；煤饼
- rinse/rins/vi. 冲洗掉
- die casting 压铸，拉模铸造
- lead bullion ['bʊlɪən]粗铅
- copper dross铜浮渣



- Roasting
  - multiple-hearth roaster
  - Suspension roaster
  - Fluidized bed roaster
- purifying
  - Iron, cadmium, copper, arsenic, antimony, cobalt, germanium, nickel, and thallium in the leach product.

- Pyrometallurgy
  - Aim:reduction-distillation
  - St. Joseph Minerals Corporation's process, 约瑟夫
  - the blast furnace process,
  - the New Jersey Zinc continuous vertical-retort process,
  - the Belgian-type horizontal retort process.比利时
  -

Language points

- In association with与。。。伴生
- Beyond that除此之外
- Rang from
- With 结构

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Zinc is a chemical element with the symbol Zn and atomic number 30. It is the first element in group 12 of the periodic table. In some respects, zinc is chemically similar to magnesium: both elements exhibit only one normal oxidation state (+2), and the Zn^{2+} and Mg^{2+} ions are of similar size.

occurrence

Zinc, the 24th most abundant element, makes up about 75 ppm (0.0075%) of Earth's crust. Soil contains zinc in 5–770 ppm with an average 64 ppm. Seawater has only 30 ppb and the atmosphere, 0.1–4 µg/m^3. The element is normally found in association with other base metals such as copper and lead in ores.

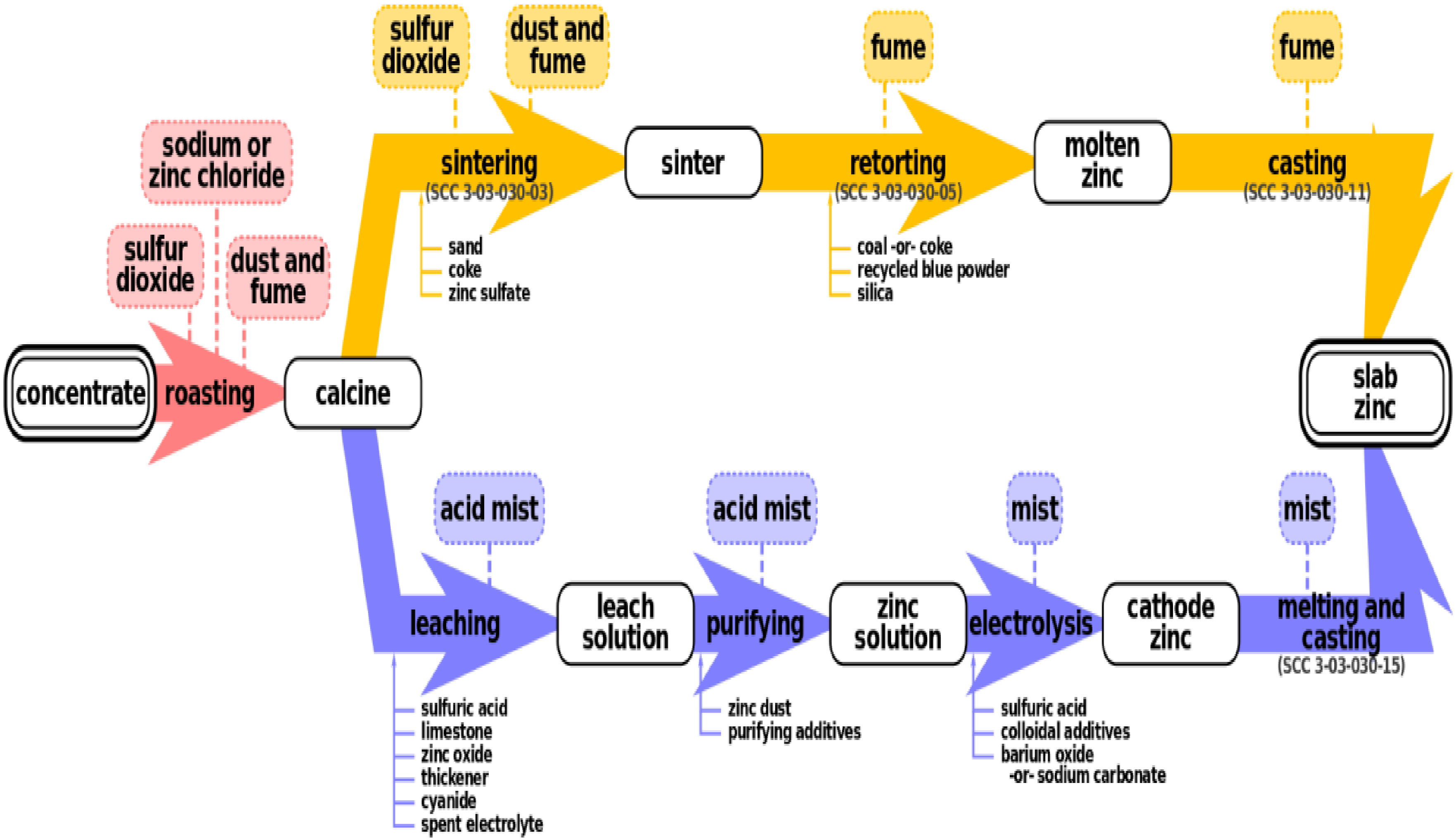
Zinc is a chalcophile element, meaning the element has a low affinity for oxides and prefers to bond with sulfides. The chalcophile element formed as the crust solidified under the reducing conditions of the early Earth's atmosphere. Sphalerite, a form of zinc sulfide, is the most heavily mined zinc-containing ore because its concentrate contains 60–62% zinc.

1. occurrence

Other zinc minerals include smithsonite (zinc carbonate), hemimorphite (zinc silicate), wurtzite (another zinc sulfide), and sometimes hydrozincite (basic zinc carbonate).

With the exception of wurtzite, all these other minerals were formed by weathering of the primordial zinc sulfides. Identified world zinc resources total about 1.9–2.8 billion tons. Large deposits are in Australia, Canada and the United States, with the largest reserves in Iran.

Zinc production flowsheet



roasting

Roasting is a process of oxidizing zinc sulfide concentrates at high temperatures into an impure zinc oxide, called "Zinc Calcine". The chemical reaction during the process is.

Approximately 90% of zinc in concentrates is oxidized to zinc oxide. However, at the roasting temperatures around 10% of the zinc reacts with the iron impurities in the zinc sulfide concentrates to form zinc ferrite. A by-product of roasting is sulfur dioxide, which is further processed into sulfuric acid.

$2ZnS+3O_2 \rightarrow 2ZnO+2SO_2$ $2SO_2+O_2 \rightarrow 2SO_3$

multiple-hearth roaster

In a multiple-hearth roaster, the concentrate drops through a series of 9 or more hearths stacked inside a brick-lined cylindrical column. As the feed concentrate drops through the furnace, it is first dried by the hot gases passing through the hearths and then oxidized to produce calcine.

The reactions are slow and can be sustained only by the addition of fuel. Multiple-hearth roasters are unpressurized and operate at about 690° C. Operating time depends upon the composition of concentrate and the amount of sulfur removal required. Multiple-hearth roasters have the capability of producing a high-purity calcine.

尼龙内衬的夹克

suspension roaster

In a suspension roaster, the concentrates are blown into a combustion chamber very similar to that of a pulverized coal furnace. The roaster consists of a refractory-lined cylindrical steel shell, with a large combustion space at the top and 2 to 4 hearths in the lower portion, similar to those of a multiple-hearth furnace. Additional grinding, beyond that required for a multiple-hearth furnace, is normally required to ensure that heat transfer to the material is sufficiently rapid for the desulfurization and oxidation reactions to occur in the furnace chamber. Suspension roasters are unpressurized and operate at about 980 ° C.

With+名词+介词短语，分词，动词不定式，形容词，副词

Fluidized-bed roaster

In a fluidized-bed roaster, finely ground sulfide concentrates are suspended and oxidized in a feedstock bed supported on an air column. As in the suspension roaster, the reaction rates for desulfurization are more rapid than that in the older multiple-hearth processes. Fluidized-bed roasters operate under a pressure slightly lower than atmospheric and at temperatures averaging 1,000 ° C. In the fluidized-bed process, no additional fuel is required after ignition has been achieved. The major advantages of this roaster are greater throughput capacities, greater sulfur removal capabilities, and lower maintenance.

Electrolysis process

The electrolysis process, also known as the hydrometallurgical process, Roast-Leach-Electrowin (RLE) process, or electrolytic process, is more widely used than the pyrometallurgical process. The electrolysis process consists of 4 steps: leaching, purification, electrolysis, and melting & casting.

The key steps are the neutral leaching and acid leaching that transfer zinc from solid concentrate and sludge, respectively, into an aqueous solution. Thereafter, electrowinning (EW) is used to obtain metal zinc which is then cast into ingot. Meanwhile, the ZnO recovered from bottom mine by acid leaching is recycled back to neutral leaching.

Leaching

This is achieved in practice through a process called double leaching. The calcine is first leached in a neutral or slightly acidic solution (of sulfuric acid) in order to leach zinc out of zinc oxide. The remaining calcine is then leached in a strong sulfuric acid to leach the rest of the zinc out of the zinc oxide and zinc ferrite. The result of this process is a solid and a liquid; the liquid contains zinc and is often called leachate; the solid is called leach residue containing precious metals (usually lead and silver) which are sold as by-product.

Zinc production process

leaching

There is also iron in the leachate from the strong acid leaching, which is removed in the form of goethite, jarosite, and hematite. There are also still cadmium, copper, arsenic, antimony, cobalt, germanium, nickel, and thallium in the leachate. Therefore, it needs further purification.

Purification

The purification process utilizes the cementation process to further purify the leaching solution of zinc. It uses zinc dust and steam to remove copper, cadmium, cobalt, and nickel, which would interfere with the electrolysis process.

After purification, concentrations of these impurities are limited to less than 0.05 mg/L. Purification is usually conducted in large agitated tanks.

Purification

The process takes place at temperatures ranging from 40 to 85 °C, and pressures ranging from atmospheric to 2.4 atm. The by-products are sold for further refining. The zinc sulfate solution must be very pure for electrowinning to be at all efficient. Impurities can change the decomposition voltage enough to where the electrolysis cell produces largely hydrogen gas rather than zinc metal.

Zinc production process

electrolysis

Zinc is extracted from the purified zinc sulfate solution by electrowinning, which is a specialized form of electrolysis. The process works by passing an electric current through the solution in a series of cells. This causes zinc to deposit on the cathodes (aluminum sheets) and oxygen to form at the anodes. Sulfuric acid is also formed in the process and reused in the leaching process.

Every 24 to 48 hours, each cell is shut down, the zinc-coated cathodes are removed and rinsed, and the zinc is mechanically stripped from the aluminum plates.

电解的描述

electrolysis

Electrolytic zinc smelters contain as many as several hundred cells. A portion of the electrical energy is converted into heat, which increases the temperature of the electrolyte. Electrolytic cells operate at temperature ranges from 30 to 35 °C and at atmospheric pressure.

A portion of the electrolyte is continuously circulated through the cooling towers both to cool and concentrate the electrolyte through evaporation of water. The cooled and concentrated electrolyte is then recycled to the cells. This process accounts for approximately one-third of all the energy usage when smelting zinc.

electrolysis

There are two common processes for electrowinning the metal: the low current density process, and the Tainton high current density process.

The former uses a 10% sulfuric acid solution as the electrolyte, with a current density of 270-325 A/m^2. The latter uses 22-28% sulfuric acid solution as the electrolyte with a current density of about 1000 A/m^2.

The latter gives better purity and has higher production capacity per volume of electrolyte, but has the disadvantage of running hotter and being more corrosive to the vessel in which it is done. In either of the electrolytic processes, each metric ton of zinc production expends about 3,900 kW·h(14 GJ) of electric power.

Pyrometallurgical process

There are also several pyrometallurgical processes that reduce zinc oxide using carbon, then distill the metallic zinc from the resulting mixture in an atmosphere of carbon monoxide.

The major downfall of any of the pyrometallurgical processes is that it is only 98% pure; a standard composition is 1.3% lead, 0.2% cadmium, 0.03% iron, and 98.5% zinc. This may be pure enough for galvanization, but not enough for die casting alloys, which require special high-grade zinc (99.995% pure). In order to reach this purity the zinc must be refined.

Pyrometallurgical process

The four types of commercial pyrometallurgical processes

- the St. Joseph Minerals Corporation's (electrothermic) process
- the blast furnace process
- the New Jersey Zinc continuous vertical-retort process
- the Belgian-type horizontal retort process.

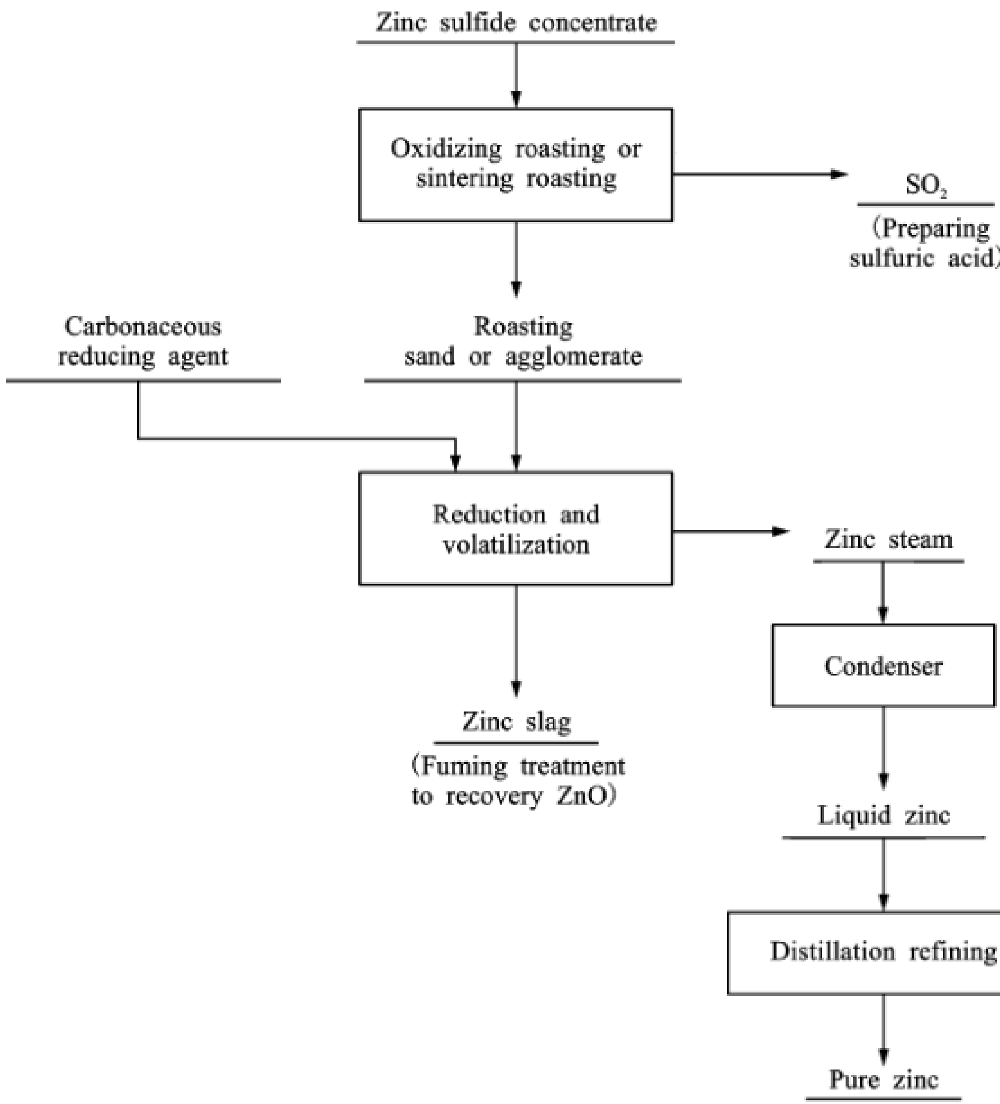


Fig. 15-4 Zinc pyrometallurgy process

Blast furnace process (Imperial Smelting Process)

This process was developed by the National Smelting Company at Avonmouth Docks, England, in order to increase production, increase efficiency, and decrease labor and maintenance costs. L. J. Derham德勒母 proposed using a spray of molten lead droplets to rapidly chill and absorb the zinc vapor, despite the high concentration of carbon dioxide. The mixture is then cooled, where the zinc separates from the lead. The first plant using this design opened up in 1950. One of the advantages of this process is that it can co-produce lead bullion and copper dross. In 1990, it accounted for 12% of the world's zinc production.

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Blast furnace process (Imperial Smelting Process)

The process starts by charging solid sinter and heated coke into the top of the blast furnace. Preheated air at 190 to 1050 ° C is blown into the bottom of the furnace. Zinc vapor and sulfides leave through the top and enter the condenser. Slag and lead collect at the bottom of the furnace and are tapped off regularly. The zinc is scrubbed from the vapor in the condenser via liquid lead. The liquid zinc is separated from the lead in the cooling circuit. Approximately 5,000 metric tons 公吨(5,500 short tons) of lead are required each year for this process. However, this process recovers 25% more lead from the starting ores than other processes.

1 ton=1.1 short ton

THANKS

End

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