

TECHNICAL CONDITION AND DEVELOPMENT TREND OF CHINA COPPER PROCESSING^①

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ABSTRACT

This paper mainly presents the processing technique of various copper products and copper base alloys, including its melt and cast facilities as well as the production of plate, strip, tube, bar and wire, which prove that the processing technique and facility in China have already been entered a new period and that the variety and quality have been raised to a new level. This paper also points out that China copper processing industry should further devote itself to the technical development, increase the variety, improve the quality, make good use of resources, develop processing products, and improve the management level.

Key work: copper and copper base alloy, processing, melting, casting, facility.

China is one of the earliest nations of using copper and its alloys. Ten centuries B. C. China widely used tin copper alloy and tin Bronze to make products-facility, daily necessities, weapon and money. During the Ming Dynasty, "Chingtai Blue" was very famous owing to its beautiful colour etc. However before 1949 China's copper processing did not have many improvements. Since then its development has been sped up with the result that, by the end of 1980's China had built a number of large copper working plants such as Luoyang Copper Processing Factory, Shanghai Copper Processing Factory, Shenyang Non-Ferrous Metals Working Plant etc. as well as a large number of middle and small working plants all over the country, and its productivity in 1980 was 130 times as that in 1949; the variety and quality of copper material can also satisfy the

need of domestic economic and defence building, especially since 1979 both the technique and equipment of copper processing have greatly been improved via importing and absorbing foreign advanced technology and equipment. The quantities, kinds and qualities of some products have already reached a new levels and have been exported all over the world. Now China's copper processing has been developed to an independent industrial system outfitted with advanced equipment. China copper processing industry has also many qualified scientists and engineers.

1 VARIETY OF COPPER AND COPPER BASE ALLOY AND ITS PRODUCTION

China's ability to process copper is continuously being enlarged and its production is increasing at a stable rate, for example, from

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1970 to 1979 China's copper processing production has increased 4.8% each year, while from 1980 to 1989 it is increased 6.9%. About 300 varieties of copper alloy and 1,000 wrought products are manufactured. There is a wide range of alloys including electric vacuum alloys, high strength and conductivity alloys, corrosion resistance alloys, instrument and meter alloys, temperature measuring alloys as well as various tubes and strips including condensation tube, air condition tube, wave guide tube, flat tube for water tank, cable strip, special shaped materials and so on.

The range of product size is

Plate: $0.2 \sim 120 \times 600 \sim 3,000$ mm

Foil: $0.01 \sim 0.1 \times 20 \sim 120$ mm

Strip: $0.1 \sim 1.2 \times 20 \sim 1,000$ mm

Pipe: $d 0.3 \times 0.03 \sim d 530 \times 80$ mm

Bar: $d 5 \sim d 280$ mm

Wire: $d 0.02 \sim d 6$ mm

The product rate of various materials in 1980 is

Copper 25.95%

Brass 68.9%

Bronze 4.9%

Cupro-Nickel 0.25%

The rate of various kind of products is:

Plate 13.8%

Strip 34.3%

Pipe 17.0%

Bar 21.01%

Wire 11.89%

The consumption rate of Copper material in 1980 for the following industrial fields is

Machine manufacturing 47%

Light industry 18.1%

Powergeneration and Communication 8.7%

Electronic industry 14.7%

Instrument and meter manufacturing 2.88%

The others 8.57%

National and international standards are now used for various copper products in most of copper processing plants. Typical size of main products are listed as Table 1.

Table 1 Typical size of main Copper Processing materials

Materials	Typical size:mm
Copper plate	$4 \times 2,000 \times 2,450$
T ₂	$2.5 \times 910 \times 1,860$
Tin-brass plate H ₈₀ 62-1	$45 \times 3,000 \times 7,000$
Cupro-nickel plate	$7 \sim 15 \times 2,300 \times 2,300$
B _{Fe} 30-1-1 B ₁₀	$55 \sim 60 \times 2,000 \times 2,000$
Silver-copper plate T _{Ag} 0.1	$10 \sim 75 \times 1,000 \times 2,000$
Tin-Bronze strip.QSn 6.5-0.1	$0.5 \sim 0.5 \times 120$
High-precision Brass strip	$0.2 \sim 1.2 \times 305$
Condensation tube	
B _{Fe} 30-1-1	$d 25 \times 1 \times 8,500$
H ₈₀ 70-1	
Phosphorous deoxidized copper tube,Tup	$d 250 \times 5 \times 6,500$
Wave guide copper tube	$7.112 \times 3.356 \sim 165.11 \times 82.55$
T ₂ , H96	
Special-shaped tube	$12 \times 12 \times d 4 \sim 20 \times 20 \times d 6$
Square copper tube,T ₂	$16 \times 16 \times 4.5 \text{ m} \times 120 \text{ m}$
Drawing brass tube	$d 42 \times 2 \times 3,000$
H62	$d 102 \times 4 \times 3,000$

There are both specific copper processing plants and synthetic factories in China. Among others Luoyang Copper Processing Factory is the largest comprehensive copper processing plant with main products of electrolytic refined copper, various cupro-nickel alloys, aluminum-copper and magnesium-copper alloys etc. The facilities of this plant are getting more modern and its products are of high quality, many products, e. g., the exported brass strip are widely used in domestic and over sea markets.

2 THE MELTING AND CASTING TECHNIQUES FOR COPPER AND ITS ALLOYS

The melting and casting techniques for copper and its alloys have been developed from conventional method to inductive furnace melting and parallel casting, vacuum melting and horizontal continuous casting, continuous copper pipe rolling, up-down continuous casting of oxygen-free copper pipe etc. Many advanced and modern techniques have been widely adopted such as vibration casting, graphite tubular moulds, gas safeguard etc which have improved the ingot quality and the working conditions.

Ingot sawing has been mechanized, which results in the raising of productive efficiency. The casting machines mentioned above adopt pressure casting under inert gas and automatic control of melt level. In regard to the production of tin-phosphorous bronze strip, the size is 650×15 mm, the coil weight is 4.5 t, the producing process is controlled with computer which shortens the process line and increases the productive efficiency and improves the product quality. Oxygen-free copper was successfully produced using 5 t inductive

furnace with $180 \times 640 \times 1,100$ mm in slab dimension and 420 mm in diameter of ingot. To meet the needs for electric vacuum copper, an oxygen-free copper producing line was also set up. In order to strengthen the corrosion-resistivity of condensation tube $H_{sn}70-1$ alloy contains a little As which solves the problem of Zn taken off when it is used. Above all both melting and casting technique of Cupro-Nickel and the research results of strengthening service durability are quite good.

3 STRIP AND PLATE PRODUCTION TECHNIQUE

Great changes have been taken place in strip and plate production technique. A lot of new equipments and techniques have been adopted, such as loop heating furnace, bloom hot rolling, coil automatic milling, high-speed and high-precision continuous rolling, automatic measuring of thickness, computer control, vacuum annealing, continuous bright annealing, bell type annealing, gas cushion bright annealing, strip automatic cutting etc. The largest copper roll in China is $d 450 / 1,150 \times 1,250$ mm four-high reversing roll. In 1989 a high-precision automatic copper strip and plate production line was put into use via exporting advanced facilities. Ingot heating adopts walking gas furnace with ability of 50 t/h, in which gas and air are heated with waste heat and the temperature and pressure and air / combustion ratio as well are controlled by computers. Heat-roll is a $d 850 \times 1,500$ mm two-high reversing one with AGC thickness controlling system and the roller gap can be adjusted automatically. Its coils are taken out by coiler and then milled by double surface three-high miller. The penetration of it's horizontal and side milling is 0.25–0.15 mm

and 3–6 mm respectively. The precision tolerance of longitudinal thickness is less than 0.15 mm, transversal thickness is less than 0.1 mm. The middle roller is a $d 450 / d 1,150 \times 1,250$ mm automatic one which roller gap is automatically adjusted so that the precision and geometry of the products can be very fine. The precision roll is $d 260 / d 700 \times 750$ mm four-high reversing one, its thickness finished is 0.1 mm and precision is high up to 0.1 ± 0.0015 mm, and its product surface is clean and bright with corrosion resistance. In addition there is carbon dioxide fire-free device for safety production. Bell type annealing furnace and cushion furnace are adopted in intermediate and finished annealing. The temperature of bell type annealing furnace can be controlled using a protective atmosphere consisted of hydrogen and nitrogen so that the products of copper and its alloys keep brightness and corrosion resistance. The main usage of air cushion furnace is for finished annealing of product which size is $0.1 \sim 1.5 \text{ mm} \times 500$ or $1,050 \text{ mm}$.

4 TUBE AND BAR AND WIRE PRODUCTION TECHNIQUES

Currently the dominant production techniques of copper tube are: ingot heating with gas or induction furnace, seamless tube and bar producing with extrusion press, intermediate rolling with periodic cold roll, continuous annealing under protective atmosphere etc. Many advanced techniques are being adopted such as large extrusion ratio, high-speed tube rolling, non-destructive inspection for inner defects, continuous casting and rolling and annealing of wire production, producing of condensation tube and air condition tube and large diameter tube with

specialization production line etc.

5 DEVELOPMENT TREND

The main trend of copper processing in China is actively to import and use advanced techniques, promote technical progress, satisfy the requirements of the markets at home and abroad, and increase the benefits for enterprise and society.

(1) Continually enlarge product varieties and improve product quality. The purpose of the copper processing industry in the 1990's in China is to improve its product quality and increase the product quantity exported. Among others the following products will be developed preferably such as condensation pipes for power stations, copper materials and water pipes for building, super-thin flat tube for water tank of automobiles and tractors, high precision strip for electronic industry. At the same time, China will pay more attention to the production of copper materials which are widely needed for the markets at home and abroad, and further import and incorporate advanced technology to develop new alloy varieties, improve size precision and surface qualities and usage characters of the products.

(2) Reasonably make good use of our resource and further develop deep processing.

(3) Raise the management level of copper processing enterprises.

China will raise the management level of copper processing enterprises via adopting modern management methods, such as analyzing the management activities of enterprises by computers etc. The copper processing enterprises will also make a careful investigation to the markets at home and abroad so as to serve them better.