SMS group

Copper and copper alloys –
how to roll them cost-effectively

Copper

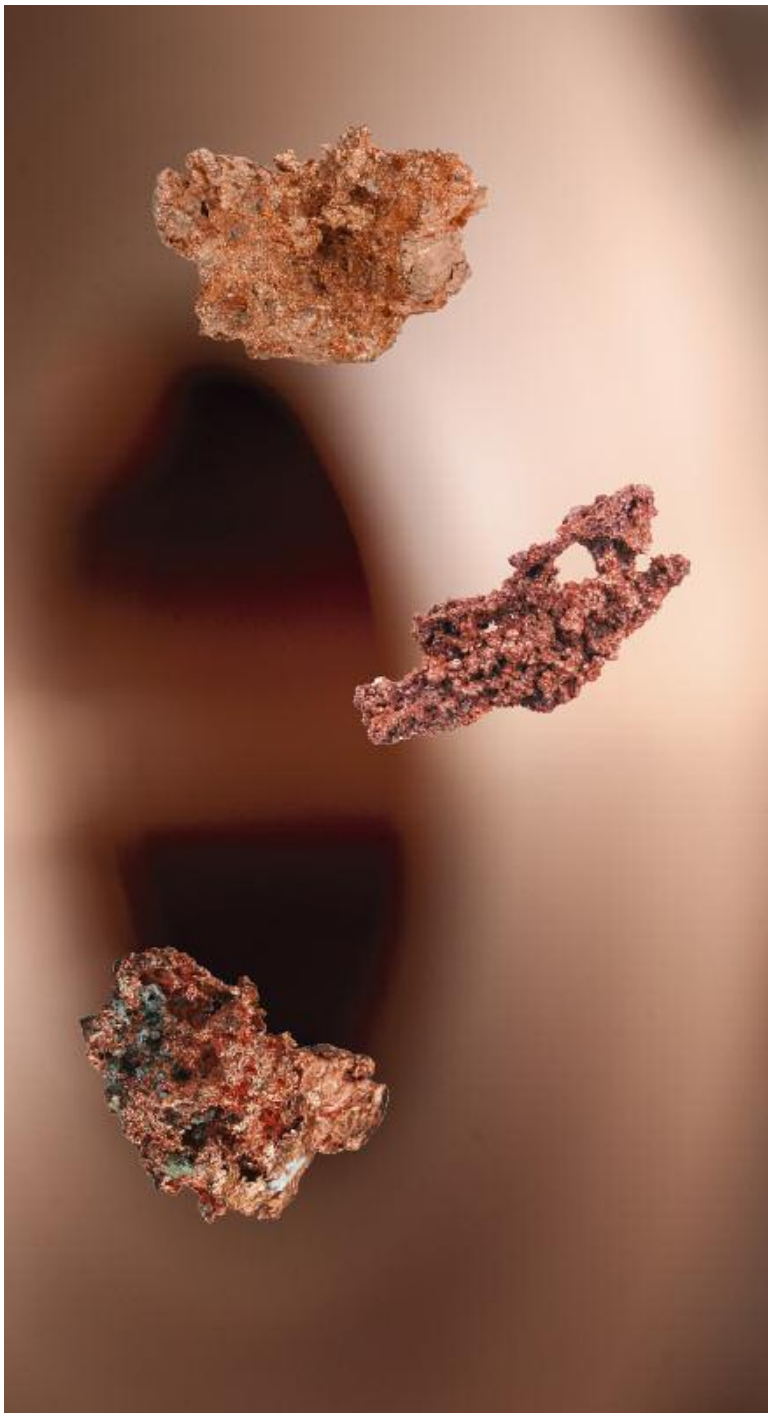
a material with a great past and a brilliant future...

The first metal used by humans comes with special properties that make it extremely valuable and almost universally useful. Counting among them are: heat conductivity, electrical conductivity, formability, and toughness.

So, without copper, we wouldn't be able to use renewable energies such as solar power. That's because 90 percent of the absorption surfaces on solar collectors consist of 0.2 mm thin copper plates, usually coated with black chrome or titanium oxide. Or think of automotive technology. Cars wouldn't run without copper. Installed in a typical passenger car today is more than a half mile of copper cabling. There are even more copper and copper alloys in electric and hybrid vehicles: some 25 kg each.

Equally inconceivable would be the ever-higher power and smaller dimensions of computers and smartphones without copper's fast signal transmission capability. It's also the ideal material whenever semiconductor chips require ultra-thin, ultra-compact wiring. Parallel to these developments, copper has become scarcer on the global market. That makes it correspondingly coveted and expensive.

Considering current copper prices, you – as a manufacturer and processor of copper strip and plate products – need to save every gram. Therefore, you prioritize these requirements for your production plants: low rate of rejects, reliably high productivity, plus constantly high precision and quality.



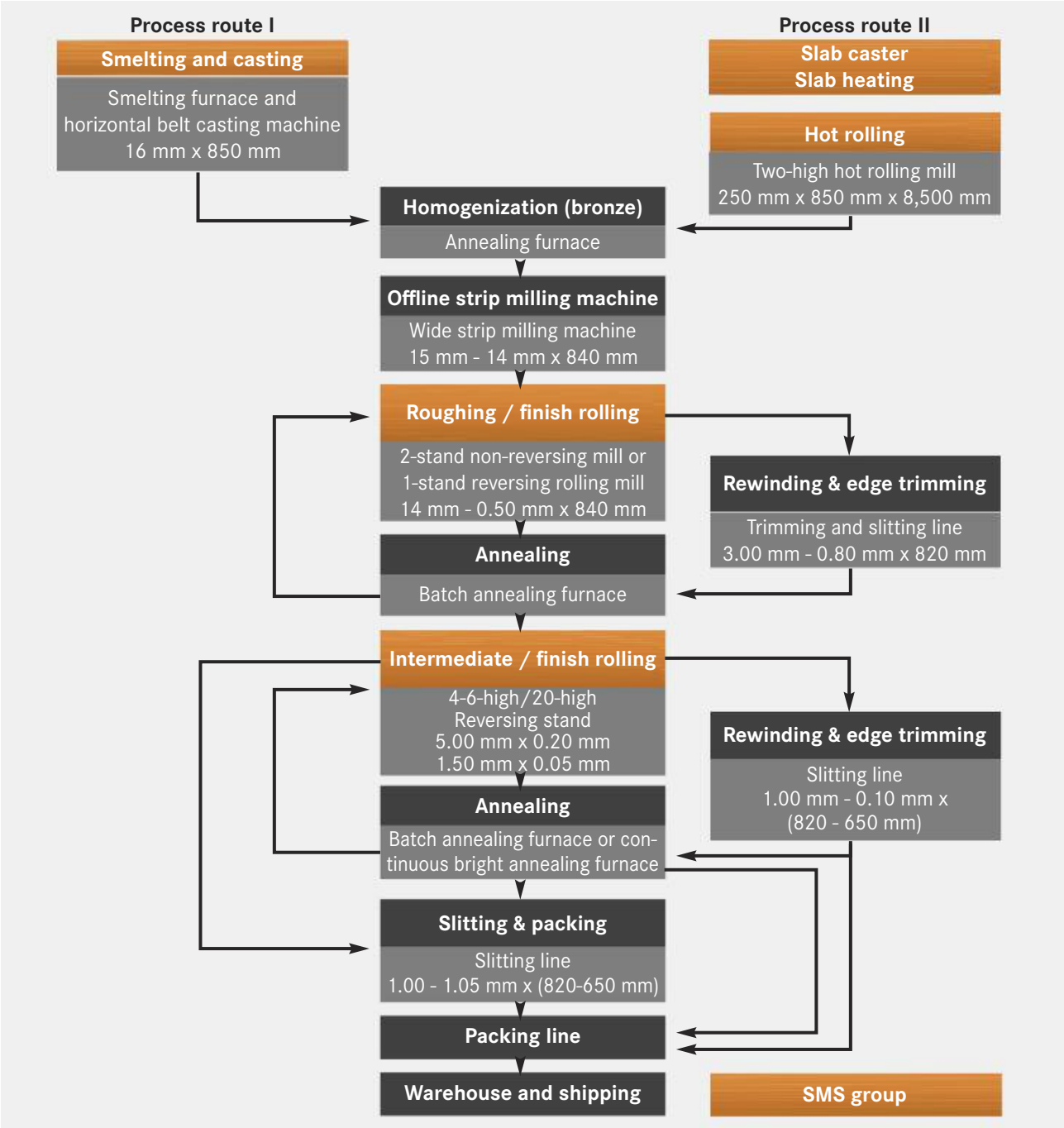
...and the challenge
of processing it.

Contents

Our solution

Available to you from SMS group are all the plants and know-how you need for the industrial production of high-quality copper semi-finished goods. Our portfolio covers almost the entire production chain of metallurgical plants.

The graphic below illustrates the process routes for copper strip. Stretching right up to transfer to the cold mill, our supply range covers smelting furnaces, strip casters, and hot mills.



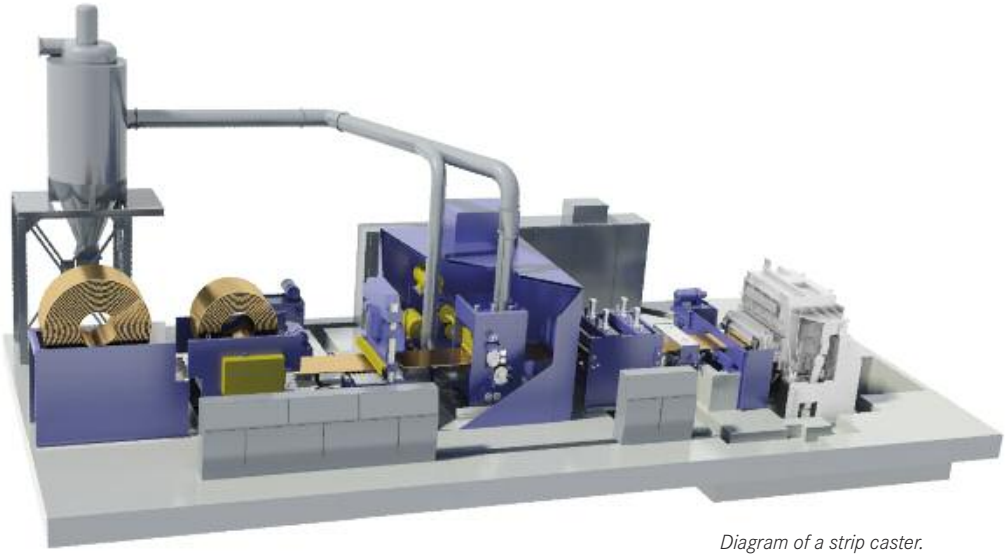


Diagram of a strip caster.

The Tongling strip caster.

The horizontal continuous strip caster supplied by SMS group to Tongling JinVi in China has been in operation since 2012. Its key units are:

- Holding furnace
- Primary cooler
- Drawing unit
- Inline wide strip milling machine
- Flying saw
- Strip coiler

SMS group thoroughly revamped the hot rolling line of Wieland Werke AG in Germany. The core unit is the two-high reversing hot rolling mill.

Our solution for cold strip

Here is how copper cold strip – as its name suggests – is produced in cold rolling mills. Depending on your product range, for instance copper, brass, or bronze, and your required annual capacity, we develop and erect the right mill type for you.

That means you benefit from our expertise in advanced mechanical engineering and from our X-Pact® automation. This solution controls the rolling process fully automatically. Fundamental to our calculations are mathematical and tribological models. They take account of the properties of copper and all its alloys. What makes this so crucial is the constant development of new materials – especially for electronics applications.

Our automation is essential because it fully automatically adjusts the rolling process to altered material conditions and strip dimensions. So, whatever alloy you process, we guarantee you'll achieve consistently high strip standards in terms of flatness, gauge tolerances, and surface quality.

Commissioning the RCM at Chinalco Shanghai Copper, China.

Design of a six-high reversing cold rolling mill with CVC® plus and Multi-Plate® filter for copper strip.

Technologies for efficient rolling

It depends on your product mix and required capacity whether the best solution for your copper and copper alloy strip is a tandem non reversing or a reversing mill. Here you can choose between these two mill stand types from SMS group: CVC® plus four-high and CVC® plus six-high as well as 20-high versions.

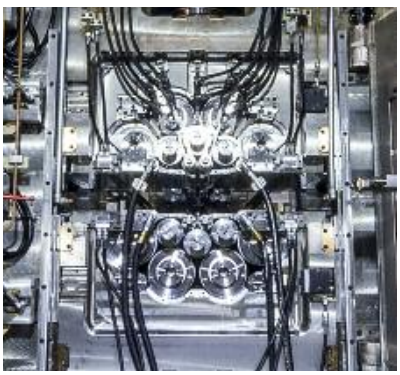
What's special about the tried-and-tested control elements and technologies we install in our X-Roll® cold mills is, that they ensure high production, stable and resource-saving operations. Even more: you achieve excellent strip quality in terms of gauge, flatness, and surface quality.

T-roll process technology precisely records the processes in the roll gap. This enables you to design more energy-efficient cold rolling – thanks to exact advance calculation of rolling temperature, rolling force, lubrication behavior, and surface roughness. As a result, you can reduce friction in the roll gap by precisely adjusting the application of cooling lubricant. Just as ideal for your specific needs are innovative, high-precision measurement systems such as our X-Shape flatness measuring roller and our system for measuring residual oil on the strip. They guarantee the strip quality you want and help you save operating materials.

X-Roll technology	Four-high	Six-high	20-high
Hydraulic roll adjustment (HGC)	x	x	x
Hydraulic crown adjustment	–	–	x
CVC®plus	x	x	–
Hydraulic axial shifting of the inner intermediate rolls	–	–	x
Work roll bending	x	x	–
Intermediate roll bending	–	x	–
Multizone cooling	x	x	–
Dry-Strip system	x	x	–
High-performance oil wiper (Nipco®)	–	–	x
X-Shape flatness measuring roller	x	x	x
Automatic roll changing systems	x	x	–
Multi-Plate® filter	x	x	x

Four-high mill stand.

Six-high mill stand with CVC®plus.



20-high mill stand for ultra-thin strip.

Technologies for efficient rolling

Sophisticated mechatronic systems

It's always on the basis of our holistic system competence in engineering as well as electrics and automation that we develop for and with you flexible, low-cost, tailor-made solutions. Key elements are:

- X-Pact® modular automation packages
- Energy distribution and drive systems
- Hardware design
- Central control stations
- Plug & Work integration testing

Innovations that give you the competitive edge

Now there is a fresh, smart generation of X-Roll® cold mills – with numerous optimizations and innovations. These new features help you upgrade your production to more flexible, efficient, and greener levels.

Here are some examples:

- Sieflex-HT® drive spindles for transferring high rolling torques even with small roll diameters
- Emulsion Compact Unit (ECU) – our new space and energy-saving compact emulsion system
- TRC® – threading assistant for fast rolling start and low incidence of off-gauge lengths
- ECO-Mode and Energy Advisor create the energy consumption transparency you need to ensure efficient plant operation

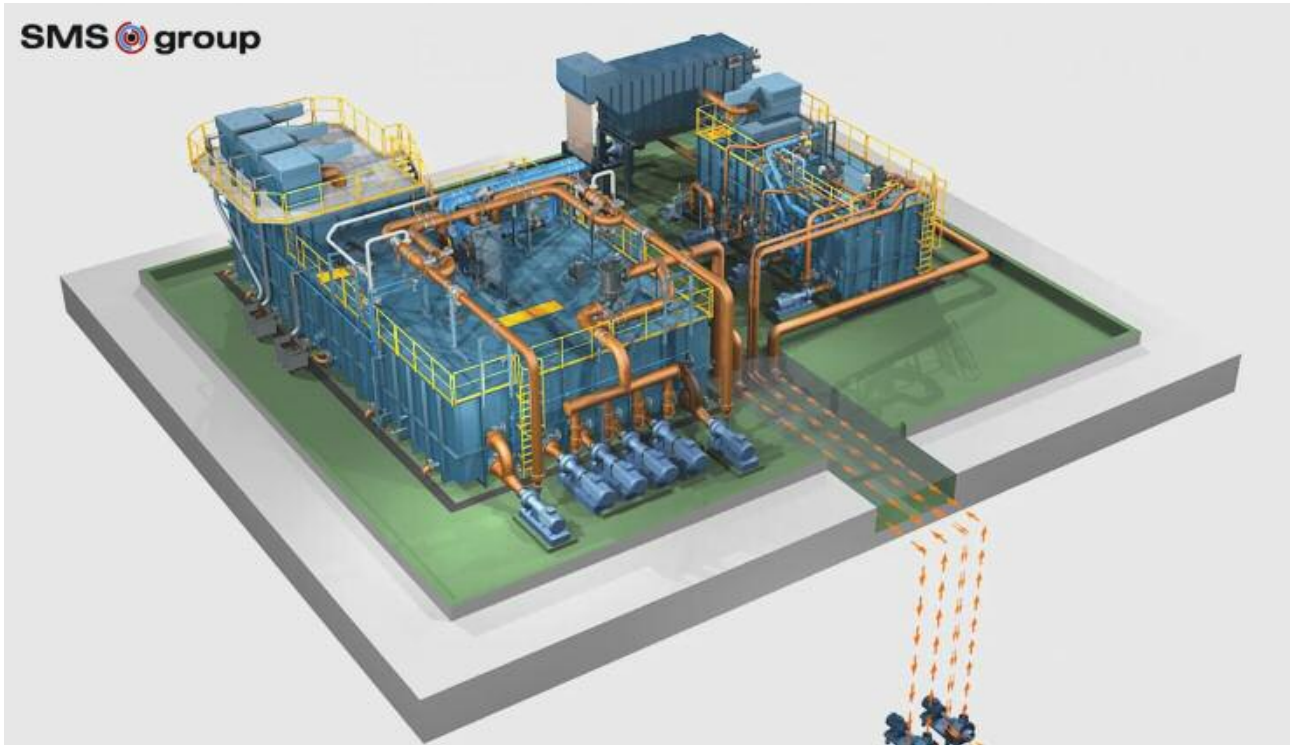
All these systems are capable of retrofitting at low cost. Once installed in your existing machines, they boost the flexibility and cost-effectiveness of your production.

Engineered for high rolling force transfer plus high reductions at minimum wear: the new Sieflex-HT® drive spindle.

You can use our Energy Advisor monitoring system to track and control energy consumption along the entire process chain.

Robust design and precision measurement for excellent strip flatness: the X-Shape flatness measuring roller from SMS group.

State-of-the-art control centers are hubs where all the relevant information about the fully automated rolling process comes together and is visualized.



Due to its multi-level layout, the new ECU (Emulsion Compact Unit) has a small footprint. Its intelligent use of process heat ensures massive energy savings. This figure shows the ECU design for a pickling tandem mill.

Technologies for efficient rolling

Compact design – efficient cleaning: Multi-Plate® filters

You want to save resources and achieve eco-friendly plant operation. That's where our proven Multi-Plate® filter (MPF) makes all the difference. It cleans cooling lubricants during the rolling process.

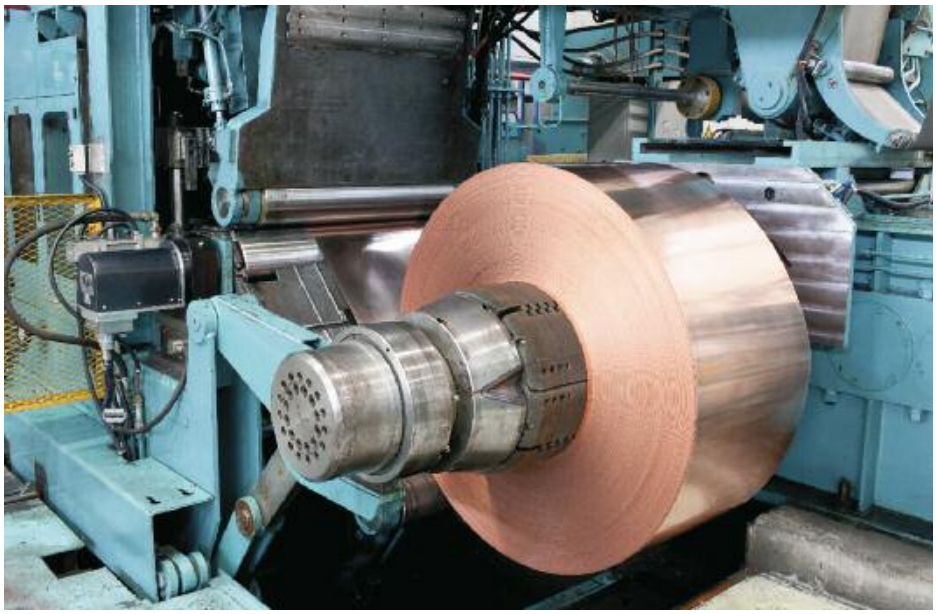
We manufacture our filter plates from high-quality synthetic material that withstands even the toughest mechanical and chemical stresses. Also featured here is an all-round vacuum seal on the underside of the plate. Combined with the constant pressure of the hydraulic closing system, this ensures absolute tightness. Yet, although it requires little space, the MPF packs a high cleaning punch.

What also stands out is the low-cost, modular design. We produce, pre-assemble, and fully test our filters exclusively in SMS workshops.

Furthermore, it benefits you that the individual components are pre-assembled on a solid base frame. So the filter plant is transported in one piece. That means you get fast, easy installation and commissioning.

Compact, reliable, operator-friendly, economical, and eco-friendly: our Multi-Plate® filter for rolling oil cleaning.

References



Here you can see an overview of reference plants. It's broken down according to tasks in the copper strip production process.

Task	Plant type	Customer	Strip widths	Strip gauges	Commissioning
Roughing	Four-high RCM	Ningbo Xingye, China	420 – 680 mm	0.5 – 16.0 mm	2014
Roughing and intermediate rolls	Six-high TCM	MKM, Germany	720 – 1.250 mm	0.5 – 15.5 mm	1999
	Four-high TCM	Wieland Werke, Germany	620 – 840 mm	1.0 – 10.5 mm	2002
Intermediate and finish rolling	Six-high RCM	Europa Metalli, Italy	500 – 1,100 mm	0.2 – 4.5 mm	2000
	Six-high RCM	Chinalco Shanghai Copper, China	600 – 880 mm	0.15 – 3.00 mm	2010
Finish rolling	20-high RCM	Ningbo Xingye, China	420 – 680 mm	0.05 – 2.50 mm	2015

Roughing

Ningbo Xingye, China

Four-high design for thick copper strip

Ningbo Xingye Copper contracted SMS group in late 2012 to supply two reversing cold mills for copper and copper alloys. It was an order for one four-high and one 20-high type mill. The company is a member of the Xingye Copper International Group Limited, a leading manufacturer of top-quality copper strip and plate products in China.

Copper is a valuable material whose resource-saving processing tests the limits of plant technology. Ningbo Xingye Copper's customers in turn expect high-quality products. What's more, the producer rolls a wide variety of materials. They include not only copper and copper alloys such as brass and bronze, but also alloys with exotic elements such as copper beryllium and copper iron. All of these materials are rolled on the new cold mills at Ningbo Xingye Copper.

To be able to process the valuable material cost-effectively, the SMS rolling mills were designed to ensure maximum material utilization and minimum off-gauge lengths.

Four-high reversing mill

The input stock for the four-high reversing mill comes from semi-continuous casting plants or from the hot rolling mill. The strips, which are up to 16 mm thick, are wound into loose coils with variable inner diameters, then transported to the cold mill, where they are transferred to the payoff station.

To handle the large strip gauge variations, the entry and exit stations consist of a combined payoff gear and payoff drum with various reel diameters. Whatever its gauge, the strip to be rolled is coiled under tension. Finished strip is finally wound onto a payoff drum, before transport to downstream processing stations.

The RCM in four-high design with a combination of payoff gear and payoff drum in the entry and exit sections.

The four-roll mill stand processes strip between 420 and 680 mm wide with entry gauges of 9 to 16 mm. It's a special feature of the rolling process that the strip is fed into the closed roll gap so that the mill rolls the thick, relatively short strip completely from end to end. Then the strip end leaves the roll gap and is re-threaded for the reverse pass. This is how it can be rolled to the target gauge across its entire length.

That minimizes off-gauge lengths at the strip ends for maximum material utilization.

Integrated here are proven control elements such as hydraulic adjustment, positive as well as negative work-roll bending, and multi-zone cooling. All this ensures compliance with the required strip flatness and gauge of 0.5 to 4.0 mm. The annual capacity of the rolling mill is some 75,000 t. In November 2014, the reversing cold mill started operation in Ningbo City, Zhejiang Province.

Type 4-high reversing cold mill

Commissioning: 2014

Production data

Rolled stock	copper, brass, bronze, copper-nickel-silver alloys, copper-beryllium, copper- iron, copper-nickel-silicon alloys
Strip width	420 to 680 mm
Strip gauge	
ingoing	9.00 to 16.00 mm
outgoing	0.5 to 4.0 mm

Technical data

Stand type	4-high
Rolling speed	max. 400 m/min
Capacity	75,000 t

Technical features

- Hydraulic roll adjustment
- Work roll bending
- Multizone cooling
- X-Shape flatness measuring and control system
- Combined payoff gear and payoff drum on the entry and exit sides
- Paper winder

Roughing and intermediate rolling in a single plant

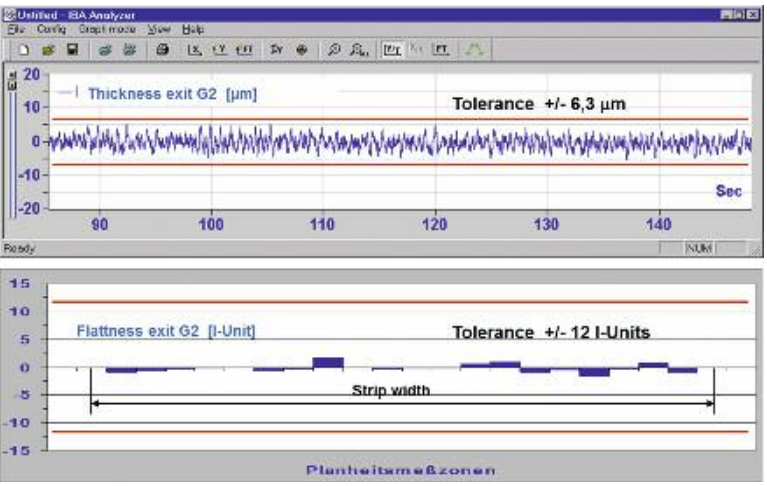
MKM GmbH, Germany

Mansfelder Kupfer und Messing GmbH (MKM) is a leading European manufacturer of primary and semi-finished products made of copper and copper alloys. It draws on the experience it has banked over more than 100 years. That's why it has long been known for its high-quality products.

MKM produces copper hot strip in one of the world's most modern roughing mills. There, the large coils measuring up to 1,250 mm wide and weighing as much as 25 t are conveyed to the company's cold rolling line for further processing. What distinguishes MKM is the variety of its products. The wide range of alloys and dimensions available are suitable for many applications and industries.

In 1999, SMS group supplied MKM with a two-stand tandem mill in six-high design including CVC® plus. Equipped with most advanced rolling technology, the plant rolls high-quality copper and copper alloy strip to widths of between 700 and 1250 mm. Special to this tandem mill is the very large range of gauges it handles. The spectrum starts with a maximum input gauge of 19.0 mm and goes down to a minimum final gauge of 0.5 mm. Roughing and intermediate rolling take place in the same plant. Furthermore, the integrated Edge Drop Control (EDC®) reduces trimming losses at the strip edges to boost output. Today, applying the experience from a good 15 years of operation, MKM achieves minimum final gauges of down to 0.3 mm on the tandem mill.

The two-stand tandem mill at MKM rolls a wide range of materials and gauges.



Top gauge and flatness results for excellent strip quality.

MKM
WIR LEBEN KUPFER

Type CVC®plus 6-high tandem cold rolling mill

Commissioning: 1999

Production data

Rolled stock	copper, brass, and bronze
Strip width	700 to 1,250 mm
Strip gauge	
ingoing	1.0 to 19.0 mm
outgoing	0.5 to 15.5 mm

Technical data

Stand type	CVC®plus 6-high
Rolling speed	max. 600 m/min.
Capacity	250,000 - 300,000 t

Technical features

- Hydraulic roll adjustment
- CVC® plus intermediate roll shifting
- Work roll and intermediate roll bending
- Edge Drop Control (EDC®)
- Multizone cooling
- DS system

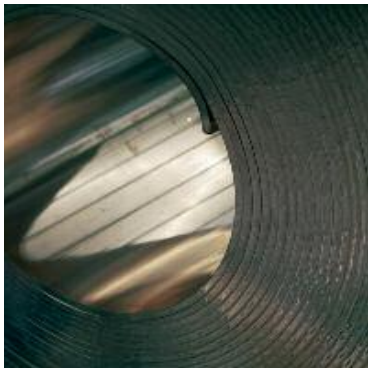
Roughing and intermediate rolls in a single plant

Wieland Werke AG, Germany

Today's Wieland group evolved from an artwork and bell foundry established in 1820. Meanwhile, it has developed into a global leader in copper and copper alloys. The product range covers more than 100 types of copper and copper alloys. As a result, the Wieland group supplies the entire modern application spectrum of these materials. You can find products made from Wieland copper strip in automotive electronics, electric vehicles, air conditioning and heating systems, mechanical engineering, and many more areas. That explains why the company demands high standards from suppliers of its own production plants.

The Wieland facility in Vöhringen near Ulm operates a two-stand tandem mill for roughing and intermediate rolling of cold strip supplied by SMS group in 2000. Fully geared to our customer's requirements, the two mill stands come in a four-high type and proven modular all-in-one design. They feature hydraulic adjustment, work roll bending, multi-zone cooling, and Dry Strip System. All this ensures the tandem mill meets every possible product requirement in terms of gauge, flatness, and surface dryness. Due to the rolling force of up to 20 MN, the mill can roll even very thick strip from a maximum entry gauge of 20 mm. The minimum achievable final gauge is just 1.0 mm. The strip widths range from 620 to 840 mm. Wieland uses the tandem line for both roughing and intermediate rolling.

The Wieland tandem mill rolls a large spectrum of strip gauges.



The tandem line rolls thick strip ...

... just as effectively as thin strip. The material is then precisely wound into coils weighing a maximum of 5 t.

The two four-high roll stands comprise the technological core unit of the line.

Standout qualities of SMS plant technology are reliability, clear layout, and good accessibility. This also applies to the stand platform with hydraulic equipment.

Wieland

Type 4-high tandem cold rolling mill

Commissioning: 2000

Production data

Rolled stock	copper and copper alloys
Strip width	620 to 840 mm
Strip gauge	
ingoing	2.5 to 20.00 mm
outgoing	1.0 to 10.5 mm

Technical data

Stand type	Quarto
Rolling speed	max. 350 m/min.
Capacity	200,000 t

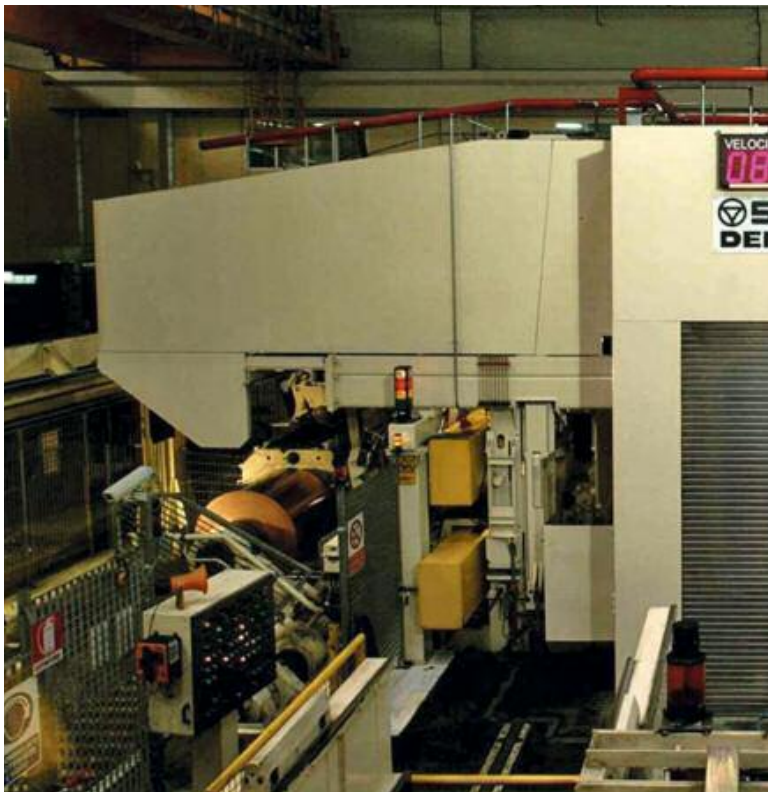
Technical features

- Hydraulic roll adjustment
- Work roll bending
- Multizone cooling
- DS system (Dry strip system)

Intermediate and finish rolling

KME Italy S.p.a. (Europa Metalli), Italy

European industrial group KME, headquartered in Florence, occupies a global leading position in the manufacture and marketing of copper and copper alloy products (especially semi-finished products). KME Italy S.p.A., formerly Europa Metalli S.p.A. until its renaming in May 2007, is the Italian subsidiary of KME. At its location in Fanarci di Barga, the company produces rolled material for construction and industry. SMS group supplied a reversing cold rolling mill to this location. It has been in operation since 2000.



Special to the rolling line is the integrated side trimmer installed in the entry area between the payoff station and the mill. Here, untrimmed strip can be trimmed prior to the first pass, then rolled directly. That saves KME Italy a separate trimming line. To protect the sensitive strip surfaces, the entry and exit areas come with paper winders. A belt winder on the exit-side reversing reel ensures damage-free coiling of the finished strip.

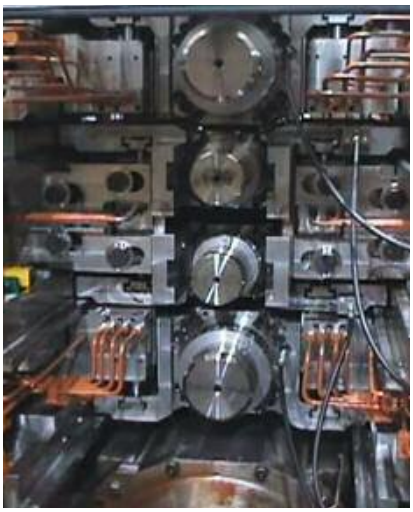
The six-high mill stand features small, directly driven work rolls in the diameter range of 275 to 300 mm. Equipped with excellent technology, the RCM rolls strip measuring 500 to 1100 mm wide and with entry gauges of up to 5 mm down to minimum final gauges of 0.2 mm. They are primarily destined for the semiconductor industry. The rolling process achieves a maximum rolling speed of 1,000 meters per minute.

This is the first RCM for copper to feature Level 2 automation from SMS. Included here is online pass schedule calculation which applies measured plant data to automatically optimize operation. That ensures high output and efficient production.

The finished coils weigh a maximum of 20 t. It is vital to protect the plant operators from oil vapors given off by the finished coils. Furthermore, KME Italy has to meet strict regional emission regulations. That's why we equipped not only the mill stand, but also the stationary coil store with their own extractor systems. SMS supplied the rolling oil system with advanced filter technology to meet our customer's high requirements for resource-saving, green production.

The first copper cold rolling mill from SMS with a system for sle
that ensures high horizontal stabilization of the output. It is ope

nder work rolls and Level 2 automation rated by KME Italy.



The six-high mill stand features especially slender work rolls.

KME
DIE EVOLUTION DES KUPFERS

Type 6-high reversing cold rolling mill

Commissioning: 2000

Production data

Rolled stock	copper and copper alloys
Strip width	500 to 1100 mm
Strip gauge	
ingoing	0.22 to 5.0 mm
outgoing	0.20 to 4.5 mm

Technical data

Stand type	six-high
Rolling speed	max. 1,000 m/min.
Capacity	150,000 t

Technical features

- Inline side trimmer
- Hydraulic roll adjustment
- Intermediate-roll shifting
- Work roll and intermediate roll bending
- Multizone cooling
- Polastrelli wiping system
- Extractor systems for mill stand and stationary coil store
- Automatic coil binding machine

Intermediate and finish rolling

Chinalco Shanghai Copper, China

China's first RCM with CVC®plus for copper strip

As from January 2011, Chinese copper manufacturer Chinalco Shanghai Copper has been operating a single-stand reversing cold mill supplied by SMS group. It comes complete with mechanical equipment, X-Pact® electrics and automation, and process know-how. Part of the supply package was a tailor-made pass-schedule calculation system.

Apart from the fluid systems, SMS also supplied cooling lubricants manufactured to suit the Chinalco Copper process requirements. Also included in the plant is an MPF 1-16-type Multi-Plate® filter from SMS that cleans the cooling lubricant.

The six-high cold mill stand with CVC® plus technology was integrated into the Chinalco plant in Shanghai. Equipped with all our advanced rolling technology, it rolls copper and copper alloy strip from a starting gauge of up to 4.0 mm down to final gauges of as little as 0.15 mm. The annual capacity exceeds 100,000 t.

Mr. Wang Yuejin, General Manager of Chinalco Shanghai Copper, commented: "Our reversing plant from SMS group can roll strip widths of up to 880 mm. Here in China, only very few manufacturers have this capability. Most of them process strip in narrow and medium formats up to a width of 650 mm."

Asked about his experience with the RCM, he replied: "With the six-high RCM, we are proud owners of a state-of-the-art cold mill. In terms of product mix, gauge tolerances, and flatness tolerances, the strip we produce here is exactly what the international market wants."

The compact Multi-Plate® filter cleans extremely effectively and stands out for its assembly and maintenance-friendly design.

Top-level rolling of copper.

CHINALCO
www.chinalco.com.cn

Type CVC®plus 6-high reversing cold mill

Commissioning: 2011

Production data

Rolled stock	copper and copper alloys
Strip width	600 to 880 mm
Strip gauge	
ingoing	0.40 to 4.0 mm
outgoing	0.15 to 3.0 mm

Technical data

Stand type	CVC®plus 6-high
Rolling speed	600 m/min
Rolling force	max. 8,000 kN
Capacity	107,000 t

Technical features

- Hydraulic roll adjustment
- CVC® plus technology with axial intermediate-roll shifting, work-roll and intermediate-roll bending
- Multizone cooling
- Pass schedule calculation with set value input
- Automatic work-roll and intermediate-roll changing
- Paper winder
- PrimeLub C80 rolling oil
- Multi-Plate® filter

Finish rolling

Ningbo Xingye, China

20-high reversing cold mill for thin copper strip

Ningbo Xingye Xintai New Metal Materials Co. Ltd. is a member of Xingye Copper International Group Ltd., a leading Chinese manufacturer of high-quality copper strip and other copper products. SMS group supplied the company with two reversing cold rolling mills. They consist of one four-high and one 20-high plant. The 20-high mill is a Split-Block design, type SB 23-26". Specializing in ultra-thin strip, this cold rolling mill has been in production since January 2015.

There is a reversing reel with a belt wrapper at both the entry and exit ends so that thin strip can also be wound onto reels. The strip measures 400 to 660 mm wide and has a maximum entry gauge of 2.50 mm. Rolling takes place at a maximum rate of 800 meters per minute. Using the control elements hydraulic roll adjustment, crowning adjustment of the A-D axes, and intermediate-roll shifting, the rolling mill ensures the strip complies with all required gauge and flatness tolerances. After processing, the minimum final gauge is 0.05 mm.

A practice-proven wiping system reliably removes rolling oil residues from the thin finished strip without damaging the sensitive surface. Furthermore, paper winders are integrated to protect the strip surface. The annual production capacity of the rolling mill is some 55,000 t.

SMS group supplied equipment and services for both rolling mills. That comprised the entire scope of engineering, the mechanical components, X-Pact® electrics and automation for control and monitoring of the entire rolling process, plus all the measuring devices and drives. Also included in the four-high plant is our X-Shape flatness measuring system and a pass schedule calculation system perfectly geared to this plant type. It is based on technological experience gained from other SMS copper rolling mills as well as insights from our own research and development department. The 20-high mill stand is also equipped with a Level-2 offline model. It comes with green, resource-saving technology from SMS in the shape of a Multi-Plate® filter with top filter fineness for cleaning the rolling oil.

The auxiliary equipment of the thin strip cold rolling mill operated by Ningbo Xingye.

20-high cold mill in split-block design.

20-high SB23-26”reversing cold mill

Commissioning: 2015

Production data

Rolled stock	copper, brass, bronze, copper-nickel-silver alloys, copper-beryllium, copper-iron, copper-nickel-silicon alloys
Strip width	400 to 660 mm
Strip gauge	
ingoing	max. 2.50 mm
outgoing	0.05 to 2.50 mm

Technical data

Stand type	20-high SB23-26“
Rolling speed	max. 800 m/min
Capacity	55,000 t

Technical features

- Hydraulic roll adjustment
- Crown adjustment of axes A-D
- Intermediate-roll shifting
- X-Shape flatness measuring and control system
- Reversing reel with belt wrapper
- Winding mode
- Paper winder
- Multi-Plate® filter, type MPF

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