continuouscasting.com

New Ultra High Precision Rod Withdrawal Control

Rautomead introduce a new ultra high precision withdrawal drive and control system for wire rod production.

This new system features "real time" auto-tuning (during operation) to ensure that the performance of the actual pulse movement of the continuous cast rod exactly matches the input pulse waveform data entered into the production programme.

The input data, stored and recalled within pre-set Operating Programmes according to rod diameter, alloy and target production output, includes:

- Target Pulse movement speed
- Acceleration (time to reach the target pulse movement speed)
- Time of pulse movement
- Deceleration (can be different from the acceleration rate)
- Dwell time (time between pulse movements)

The Operator/Supervisor has the ability to change or amend these inputs during a production run if required.

The system automatically increases the production casting speed from a pre-set start-up speed to a pre-set production speed.

The accuracy of the system can be observed by comparing the target and actual pulse waveform pattern.

This new UHP withdrawal drive system will be available:

1 As an optional up-grade on **8.0mm CuOF** wire rod production machines as a replacement for the standard high speed indexing system for specialist high quality rod applications.

2 To **increase the range of brass alloys** that can be produced at 8.0mm.

3 For production of **larger diameter rods** where precise, accurate and consistent control of the withdrawal pulse waveform is desired.

This new UHP withdrawal drive system is available as an up-grade option for new machines and will be available as a retro-fit option for existing machines where superior rod quality control is a requirement.

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Casting Technology Options for Copper Wire Rod Producers

By Sir Michael Nairn, Chairman, Rautomead Limited

In this extract from a paper presented at the 2008 International Copper Conference, Sofia, entitled 'Adding Value and Growing Markets through Wire Rod Production', Sir Michael Nairn, Chairman of continuous casting technology specialists, Rautomead Limited, reviews the various copper wire casting technology options available to producers. The presentation of the paper was arranged via Metal Bulletin.

Development of Casting Processes: an overview

In the1960s, when static casting of 100 kg wire bars represented the accepted technology and practice of the day, a wire break in drawing operations each of 100 kg, coinciding with the welded joint between wire bars was a real risk. Casting technology has advanced a long way in the intervening years and modern casting processes can be distinguished into two fundamental types:

Semi-Continuous Casting

This is where copper is cast vertically downwards from a tundish, solidified in moulds and cut into discreet "log" lengths. The downwards vertical semi-continuous casting process is a convenient and efficient means of producing large section extrusion billet, which is subsequently cut again to extrusion billet lengths, re-heated and fed to an extrusion process.

Continuous Casting

As the name implies, continuous casting machines can continue to cast without interruption, so long as molten metal is fed to the casting die or until the die itself is eroded or worn. The continuous casting process has been developed to cast downwards, horizontally and upwards. Each orientation of the process has been developed to suit different applications and these are usually not interchangeable.

Variants of the continuous casting process include: Continuous Cast and Roll (CCR)

The CCR process has been developed as the successor to the earlier technology of casting and hot rolling of copper wire bars. CCRs are large, capital intensive plants with annual capacity in the range 40,000 tonnes up to 300,000 tonnes. The commonly produced product is HC copper which is far the most widespread copper specification used in the wire and cable industry and also for motor, generator, transformer and instrument windings; radio and television parts; switches, terminals, earthing rods, commutator segments and anodes for electroplating.

Certain alloyed coppers, including CuAg can also be produced by the CCR process. The Krupp-Hazelett Contirod™ system of Germany, Continuus-Properzi™ of Italy and Southwire™, of USA, are the leading European/USA brands. Essential features of these processes are that the copper cathode is melted in a gas fired shaft furnace and transferred to a holding furnace, where metal temperature and oxygen level are carefully controlled, normally in the range 120-300ppm.

In the CCR process, the conditioned copper is continuously cast either between moving steel belts (Contirod) or around a wheel (Continuus-Properzi and Southwire) as a continuous single strand of bar 1,500 to 9,500 sq mm section, according to plant capacity. The cast bar is hot-rolled in line to finish as a single strand of wrought rod, normally 8mm diameter, though larger sizes may also be made.

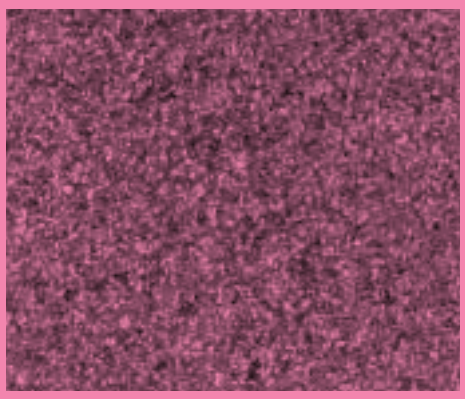
Additionally, the plants can incorporate an acid pickling stage, as well as washing and waxing to protect the rod surface. Many of this type of plant are operated by the leading copper refiners themselves who prefer to sell their copper as wire rod or as drawn wire, rather than as cathode sheets. Such large-scale plants operate at their most efficient when making a single rod product day-in-day-out.

Upwards-Vertical Casting

The upwards-vertical casting process was developed in the 1970s. The process casts multiple strands, either at 8mm or larger rod sizes up to 30mm diameter. The process has the great convenience of enabling the casting dies to be changed quickly and safely, without disturbing the bath of molten metal below and with minimal interruption to the production process.

In its modern versions, the process for oxygen-free copper involves no rod rolling. The cast rod is available directly for drawing to wire. Certain low-alloyed oxygen-free conductor coppers can also be produced by the upwards-vertical casting process, including CuAg, CuSn, CuMg and CuCd. Rautomead™ and Upcast™ are the leading European and Scandinavian brands.

Comparison of hot-rolled HC copper and as cast Oxygen-free 8mm copper metallurgical structures:



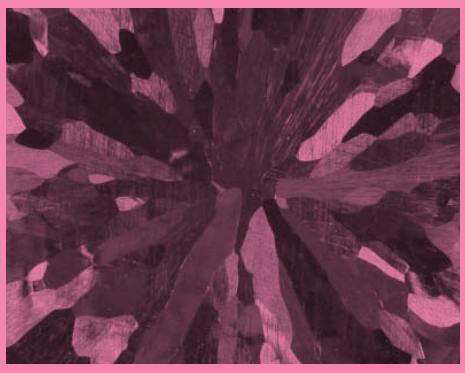


Image 1 - Hot Rolled HC Copper
Image 2 - As-Cast Oxygen-Free Copper.

Oxygen-Free

It is an essential distinction of the upwards-vertical process that the cast copper is oxygen-free, compared with HC copper produced by the CCR processes described earlier. This is a necessary feature of the upwards-vertical process in order to achieve an economic life for the graphite casting dies through which the metal is cast and solidified. Conversely, it is not possible economically to produce HC copper by the upwards-vertical casting process, on account of the oxygen present and its deleterious effect on the graphite casting dies.

Marked Effect on Electrical Conductivity

One of the consequences of the reduction of oxygen in oxygen-free copper is that impurities will remain in a solid solution in the metal, rather than as insoluble oxides, as is the case in HC copper. The presence of such impurities in oxygen-free copper can, therefore, have a more marked and negative effect on electrical conductivity than in HC copper. Conversely, in its pure form, oxygen-free copper has an inherently greater conductivity than HC copper. Other benefits of oxygen-free copper include better ductility, lower "noise" and the avoidance of the risk of hydrogen embrittlement which can occur in HC copper during annealing, brazing and welding operations.

Significantly Lower Oxides Layer

Upwards vertically cast copper exhibits a significantly lower oxides layer on the surface of the cast rod, compared with HC copper rod. This can be an advantage when the rod is used as a feedstock for the continuous extrusion process, by eliminating the need for a preliminary rod surface cleaning process.

Traditionally Smaller

Characteristically, oxygen-free copper rod plants are smaller than the CCR plants for HC copper rod production and are often installed by wire and cable producers as a form of backwards integration. Plant capacities range from 2,000 tonnes per year to 40,000 tonnes per year. Many oxygen-free copper plants have been installed on the principal ground that the output capacity suited the user's production requirements, rather than for any specific requirement that the copper should be oxygen-free.

Upwards-Vertical Plant Types

Within the range of upwards-vertical casting plants, there are two types.
These are:

Combined Melting, Holding & Casting Plants

In the smaller upwards-vertical casting machines, in the capacity range 3,000 tonnes to 12,000 tonnes/year, cathodes are melted and rods are continuous cast upwards in a single electrically heated furnace, divided internally into graphite casting dies surrounded by water jacket coolers immersed in the molten copper. The copper solidifies as it rises through the die, pulled by an extraction device mounted above. A heavy layer of charcoal or graphite flake is used on top of the melt to reduce the oxygen to less than 0.0005%. This is necessary to ensure a reasonable life for the graphite casting dies. Machines of this type are equipped with three to twelve individual strands, casting into layer wound coils of 4-5 tonnes capacity.

Such plants are compact, inexpensive and relatively simple to operate and maintain. Users have a choice of heating systems in these smaller machines, either electric resistance heating using a graphite crucible, or channel induction heating with a bricked ceramic furnace lining. The copper rod is nominally oxygen-free. In practice, the oxygen content of such rod is likely to be less than 3 parts per million.

Image 3 - Rautomead RS 3000 integrated melting and Casting machine. 6 strands, 5,500 – 6,000 tonnes/year

Use of a single furnace for both melting and casting calls for not only grade A cathode to CU-CATH-1 specification, but also cathode which is clean, free of surface oxidation, surface nodules, residual copper sulphate, trapped electrolyte or other surface moisture. These unacceptable features can arise through operating failures in the refinery tank house or in careless transport and handling. Small amounts of clean mill scrap can also be blended with the cathode.

Separate Melting and Holding Furnace Casting Plants

Larger capacity upwards-vertical casting machines of up to 40,000 tonnes/year use separate furnaces for melting and holding/casting, with a hot-metal transfer between them. These larger furnaces are invariably channel induction heated. The feedstock is CU-CATH-1, but the systems are larger and are more tolerant of minor imperfections in surface quality of the cathode used. Oxygen reduction occurs principally in the melting furnace, using a charcoal cover. Care in the design of the machine must be taken to avoid oxygen pick-up in the transfer of

Casting Technology Options for Copper Wire Rod Producers continued

the molten copper to the holding furnace, as "oxygen-free" copper remains essential for good life in the graphite casting dies. Rod casting technique is very similar to that used in the smaller machines, except that there are more strands – normally up to 32 strands - mounted in individually controlled banks of six or eight. In the larger machines, it is normal to mount the coilers in two tiers to reduce the overall length of the line. Like the smaller plants, copper quality is oxygen-free.

Image 4- Rautomead RDG 360 copper rod casting machine. 32 strands, 28,000 - 30,000 tonnes/year

The theoretical cost of production from a relatively small scale oxygen-free copper rod plant producing say 10,000 tonnes per year will be greater than the equivalent cost of production from a large scale HC copper rod plant with a capacity of 120,000 tonnes per year or more.

High Output Rates for Operating Cost Advantage

The break-even volume for a large HC plant will be relatively high, so that its operating cost advantage is only realised when it is operated at the high output rates of which it is capable. Depending on the competitive situation in the local market, this cost benefit of HC copper may or may not be passed on to the wire and cable producing customer. Often, the justification for a wire and cable producer to invest in his own relatively small-scale oxygen-free copper rod plant will be in cases where a high rod premium demanded by the large HC copper producer makes such an investment attractive.

A further feature of the upwards-vertical casting process is the ability to cast a wide range of tin-bronzes, nickel-silvers and binary brass wire rod. The metals are usually melted, alloyed and the composition checked in a separate melting furnace, before pouring to the casting machine. Such plants commonly cast wire rod at 19-21mm, followed by a succession of rolling/annealing/drawing stages, though more recently, several such plants have been installed to cast binary brass wire rod (60:40, 64:36, 65:35) at 8mm for direct drawing and with no rolling to make Electrical Discharge Machining (EDM) wire.

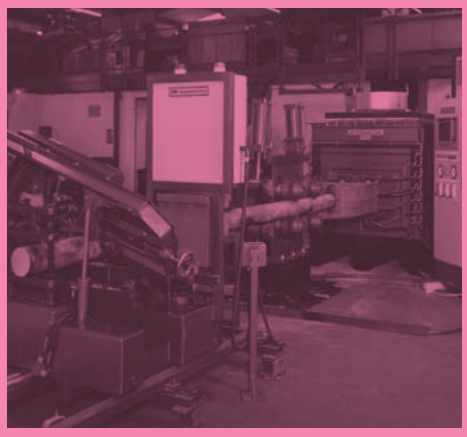
The Showa Dipform™ Process

Until about ten years ago, the Showa Dipform™ process for production of oxygen-free copper rod was extensively used by leading cable companies in Japan, but the majority of these plants have since closed.

Horizontal Continuous Casting

Compared with upwards-vertical continuous casting, the horizontal process is simpler and less expensive from an engineering standpoint. Despite considerable effort and development expenditure, it has not so far proved possible to produce oxygen-free copper wire rod economically by the horizontal process. It is, however, commonly used for continuous casting of large diameter extrusion billet and in the production of smaller diameter (typically 12mm-20mm) copper alloy wire rods.

Image 5 - Horizontal Continuous Casting – Copper Alloy Extrusion Billet



Downwards-Vertical Casting

The picture would not be complete, however, without reference to downwards-vertical casting. Oxygen-free copper wire rod could be produced by such a process, but given the well-developed upwards-vertical process and the inherent safety considerations of downwards-vertical casting, it does not feature in a paper considering options for wire rod production. Downwards-vertical continuous casting is, however, a good and efficient means of production of large diameter extrusion billet and also of hollow bars, with an ability to produce very concentric hollow sections.

Interchangeable Use of HC Copper and Oxygen-Free

Good quality hot-rolled HC and as-cast oxygen-free copper rod may be used interchangeably in most wire drawing operations. Minor adjustment in drafting in the initial rod breakdown stage and in annealing temperatures may be necessary when switching from one to the other. In many instances, the user will be comparing the rod quality available from his commercial source of HC rod with the quality which he makes or could make from his own oxygen-free upwards vertical casting plant. In such cases, caution should be expressed in terms of the HC rod available. Many of the existing plants still in use are now 30+ years old and depending on the history, the management and plant maintenance, may not consistently produce high quality HC rod. In adopting modern multiwire drawing technology and in drawing to fine and superfine wire, the instances of rod breakage may be substantially greater and the cost of operation substantially higher than when using Oxygen-free rod from a modern upwards vertical casting machine.

Oxygen-free is a more ductile material than HC and the favoured copper in such applications as automotive wiring harnesses and control circuits in moving machinery (robotic arms etc). Oxygen-free wire produces less electronic "noise" than HC and is thus the favoured copper in high quality audio systems, aircraft headphones and similar specialist applications.

Rautomead launches new funding programme to assist purchase of continuous casting technologies

Continuous casting technology specialists, Rautomead Limited, of Dundee, Scotland, have launched a funding programme that could significantly assist organisations considering investment in Rautomead machinery.

3 – 5 year opportunities

Designed to provide a complete solution to customers' continuous casting projects, equipment funding opportunities can be provided over 3 – 5 years and negotiated in parallel with other commercial and technical discussions, in conjunction with Rautomead's international financing partner.

Single machine or larger project

Funding can be provided for a single machine, or a substantially larger turnkey project of which continuous casting is only one stage of the process route. Finance is considered on an individual basis and is intended to avoid the need for the customers bank to provide a guarantee for security.

Helping develop viable business opportunities

Comments Rautomead Sales Manager, Guy Henderson, "This financing scheme enables customers to use the value of the Rautomead casting equipment as security for a loan to purchase the equipment. The programme is open to businesses of all sizes provided they comply with the finance companies criteria and wish to arrange a loan to fund the purchase of new Rautomead continuous casting technology."

New entry-level copper rod casting machine

In a further move to assist organisations in benefitting from the capabilities of its continuous casting technologies, Rautomead Limited have developed a range of new entry level RSCC copper rod casting machines that offer users the advantages of the company's proprietary casting technology at an exceptionally competitive price.

The new model has been designed specifically for the production of CuOF and CuAg wire rod. It is available in one, two, three or four strand configuration and can be configured either for 8.0 – 12.7mm or 13 – 22mm diameter rod production depending on whether the requirement is to make rod for wire drawing or larger rod for conversion to strip by continuous rotary extrusion. Output capacity ranges from 1,000 – 4,000 tonnes per year.

The RSCC machines share many of the unique technical features of the larger Rautomead RS wire rod casting machines, and benefits from over thirty years of graphite technology continuous casting experience. The result of a significant market review, and by utilising the company's innovative culture and internal processes, the RSCC model is designed for production of best quality feedstock rod for the continuous extrusion process.

In an effort to minimise customer investment, the RSCC model has been designed to provide users with the option to arrange local manufacture and supply of selected component parts of the continuous casting equipment, according to drawings and information provided by Rautomead.

Rautomead Limited has been building continuous casting machines for over thirty years. One of the company's specialist applications is in machines for production of the highest quality oxygen-free copper rod.

Minimise investment cost by maximising local manufacture and assembly.

As world leaders in continuous casting technology Rautomead Limited of Dundee Scotland have secured a firm order from Elsan Elektrik Gerecieri SA of Denizli, Turkey to supply an RS 3000/6 copper rod casting machine for use in the manufacture of enamelled wires.

Rautomead's expertise in graphite crucible and electrical resistance heating technology is nowhere better illustrated than by its application to copper wire rod production. Crucially, the all-carbon containment system acts as a strongly reducing environment and avoids risk of ceramic refractory contamination of the molten copper. These factors ensure the highest quality oxygen-free copper rod.

To minimise the cost of imported equipment, Elsan will be manufacturing the cathode feed system and the operating platform according to drawings and specifications provided by Rautomead under the contract. Rautomead rod coilers, supplied in kit form, will also be fabricated and assembled locally in Turkey by Elsan.

Complete casting line including water and nitrogen systems supplied by Rautomead.

Elkabel JSC is the largest cable manufacturer in Bulgaria. Elkabel, with no previous experience in melting and casting copper, approached Rautomead to deliver a "turnkey" package of equipment for copper rod production.

With over thirty years experience of supplying continuous casting technology, Rautomead are able to offer customers the choice of buying just the Rautomead casting equipment or to buy a complete installation including all the ancillary items necessary for the operation of a casting line eg: water cooling, emergency power generation, nitrogen gas production, tooling preparation workshop, quality control laboratory and instrumentation.

The RS3000/6 will be used to produce 8.0mm diameter oxygen free copper wire rod.

Rautomead's unique integrated melting and casting graphite crucible is at the heart of the machine's success. Crucially, the all-carbon containment system acts as a strongly reducing environment and avoids risk of ceramic refractory contamination of the molten copper. These factors ensure the highest quality oxygen-free copper rod.

Rautomead has over thirty years experience of graphite furnace technology. In parallel with advances in the properties of materials available, Rautomead seeks to be innovative in this specialised field and to find new applications wherever possible.

RAUTOMEAD BRINGS HOME SILVER DOLLAR

The world's leading continuous casting technology specialists, Rautomead Limited of Dundee, Scotland, have received a firm order from GSM Metals of Cranston, Rhode Island, USA for a RT 650 horizontal continuous casting machine to make 6.5 x 0.75 inch silver strip.

The order derived from GSM's close relationship with Cimini & Associates who had experienced excellent results with their own RT 650 machine supplied by Rautomead in 2008.

A unique feature of Rautomead's casting technology is its use of a graphite crucible furnace with naturally oxygen-reducing characteristics that make it especially suitable for the holding and casting of silver which is notoriously prone to oxygen pick-up in its molten state.

Rautomead has an unrivalled track record in the field, having supplied some 150 continuous casting machines for the processing of blemish-free gold and silver alloys for coinage strip, jewellery, electronics and dental applications in 24 countries.

Significant orders for Precious Metals casting technology *underline Rautomead's expertise*

Continuous casting technologies specialists, Rautomead Limited, are enjoying unprecedented interest in their equipment for the production of gold and silver coinage strip and have recently secured three particularly significant repeat orders from existing customers.

Global investment in precious metals is presently booming. This trend commenced in the third quarter of 2007, when investors increasingly sought out opportunities perceived as less risky to stocks and shares. Comments Rautomead Sales Manager, Guy Henderson, "We have seen a considerable increase in requests for information regarding our precious metals casting models over recent months. In 2008, global sales of gold bars and coins rose by more than 40% and the global mining of silver rose significantly. As reflected in recent orders from Mints in Australia, China and Thailand there is clearly strong demand for our high quality casting machinery for the manufacture of bullion coins and investment bars."

The Perth Mint, Australia

A longstanding Rautomead customer, The Perth Mint have just taken delivery of a new Rautomead RMT 200 model continuous casting machine designed with an output capacity of 80 - 100kg (Ag) per hour for the production of silver-based alloy strips of up to 100mm x 25mm, or round billet for extrusion.

This will be the sixth Rautomead model to be used at The Perth Mint. In addition to other RMT models, the Mint also operates three Rautomead RMJ machines for the production of gold coinage strip. As highly respected producers of investment coins, The Perth Mint also supply coin blanks to other mints, including the Royal Mint in the UK and the USA Mint.

Shanghai Mint, China

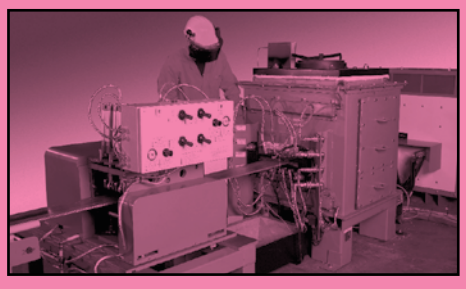
The Shanghai Mint installed their first Rautomead continuous casting machine in 1991, an RMJ/H025 for processing gold and gold alloys. A second, larger, Rautomead RMT model casting machine for processing silver and silver alloys followed in 1994. In 2009/10 the Shanghai Mint will open a new factory facility and relocate both the existing gold and silver continuous casting machines and, in a simultaneous expansion of production capacity, a new Rautomead RMT continuous casting line including in line cut to length saw will also be installed.

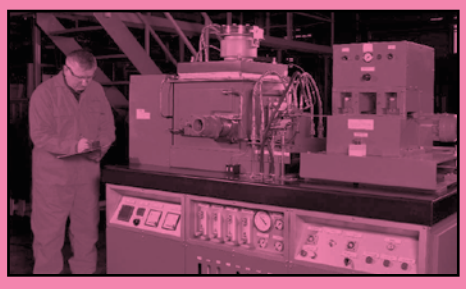
The Royal Thai Mint, Thailand

The Royal Thai Mint installed their first Rautomead RMJ/H 025 model continuous casting machine with in line cut to length shear in 1996. In 2010 a second RMJ/H025 machine will double the installed precious metal continuous casting capacity at the new Royal Thai Mint factory which is located close to the Don Muang airport in Bangkok. The new machine will be supplied complete with an automated ingot feed system as well as an automated cut to length shear. The 2010 model RMJ/H025 features a PLC control system and servo motor driven withdrawal. This enables production operating programmes for different alloy and section size combinations to be recalled by menu from the memory to ensure consistent quality of production each time a specific strip shape is produced.

Understanding Rautomead graphite crucible technology

The Rautomead casting process is based on the use of a graphite holding crucible, surrounded by electric resistance heating elements to provide the power to melt and hold the metal charge. Heating is by thermal radiation and heat convection. The interior of the machine is protected in an inert gas atmosphere to protect the hot-working graphite components.





Robust, reliable and safe to operate

Though many features of the Rautomead process, especially the withdrawal mechanisms and controls, have been developed and refined over the years, the basic furnace design remains as it was originally designed, over twenty years ago. These machines have proved robust, reliable and safe to operate. Many of the early machines are still in daily use today.

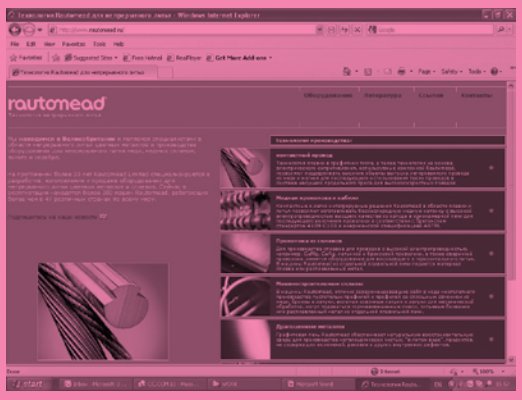
Oxygen-reducing

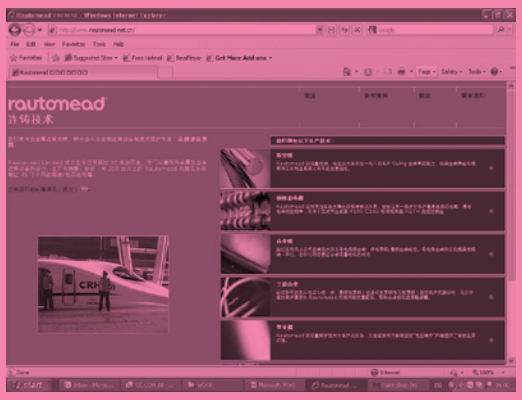
Silver has a strong propensity to attract oxygen in the molten state. The totally enclosed nature of the Rautomead process, where the molten metal is in contact only with the pure carbon surfaces of the holding crucible and casting die, is a particularly suitable process for casting silver and eliminating any residual oxygen present. An additional feature is the still metal bath created by the external resistance heating elements, thus avoiding the turbulence associated with many induction heating systems in close proximity to the casting die.

Natural choice

Rautomead has supplied over 150 continuous casting machines for processing of gold and silver alloys for coinage strip, jewellery, electronics and dental alloy applications around the world. The special features of these machines make Rautomead Limited the natural choice for mints globally.

Rautomead launches Russian and Chinese language websites





UK-based continuous casting technology specialists, Rautomead Limited, have launched both a Russian language and a Chinese language version of their website in order to better present their range of equipment for the casting of non-ferrous metals to these increasingly significant markets. The new websites can be viewed at **www.rautomead.ru** and **www.rautomead.net.cn**

"Comments Rautomead Sales and Marketing Manager, Guy Henderson, "it is our intention to make the website available in various languages. However, the considerable interest we are attracting from both the Russian and Chinese marketplace confirmed in our minds that a Russian language version and a Chinese language version of the website were an absolute priority."

Naturally oxygen-reducing environment

Embracing the company's graphite crucible technology, for a naturally oxygen-reducing environment, Rautomead's compact and easily integrated melting and casting solutions are renowned for the production of the highest quality oxygen-free copper wire and cable, copper alloys and precious metals.

Wide range of models

Fully automated Rautomead casting machines are available for the production of quantities ranging from 5,000 to 30,000 tonnes per year. While for smaller scale CuOF and CuAg wire rod production, a new model range offers from 1,000 to 3,600 tonnes per year. Smaller, specialist 'precious metals' models enable the production of the highest quality gold and silver alloy shapes and sections.

CuMG Trolley Wire

With the increasing demand for high-speed rail travel, Rautomead's graphite crucible, electric-resistance technology is gaining growing international acclaim for the production of CuMg alloy rod for subsequent processing to make catenary wires. CuMG is a non-toxic alloy offering high-tensile strength, high conductivity and good creep resistance.

Rautomead to bring specialist continuous casting expertise to Wire China 2010

At Wire China, Shanghai 21 – 24 September, UK-based continuous casting technology specialists, Rautomead Limited, will be presenting a range of continuous casting equipment and technology for the processing of copper and copper alloys.

High quality continuous cast rod produced by upward casting may be used for the production of copper strips for transformers, enamelled wires, data communication wires, house wiring or power cables. Fully automated Rautomead casting machines are available for the production of quantities ranging from 6,000 to 30,000 tonnes per year.

New lower-cost casting machine

For smaller scale production, Rautomead have introduced the new RSCC range of casting machines for the production of CuOF and CuAg wire rod. RSCC models are designed to minimise investment costs and offer production from 1,000 to 4,000 tonnes per year.

RSCC casting machines are available in either 1, 2, 3 or 4-strand configurations producing either 8mm diameter rod for high quality wire drawing applications or 12mm – 22mm diameter rod to make feedstock for Continuous Extrusion Technology.. RSCC models share many of the unique technical features of the larger Rautomead RS wire rod casting machines and benefit from over thirty years of graphite technology continuous casting experience.

rautomead®

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