rautomead

press release

File name: Raut –WC35/FC43/PM20.doc
Ref: WC35/FC43/PM20 – (11/05)
Draft 1 – Approved 01/11/05

Title: RECENT DEVELOPMENTS IN THE PRODUCTION OF OXYGEN-FREE COPPER ROD

By Sir Michael Nairn of Rautomead Ltd.

Release Date: 31st January 2006

Renowned for its inherently safe, low voltage continuous casting equipment - technology that embraces the use of a naturally oxygen-reducing graphite crucible and high intensity electric resistance heating - Rautomead Ltd. began in 1978 by producing machines for processing bronzes and brasses for the manufacture of various semi-finished rods, bars, strips and hollow sections. A range of smaller precious metals machines then followed, with all models capable of being used as integrated melting/casting or casting-only units. Here, Rautomead Chairman, Sir Michael Nairn, discusses the various advances in the development of the CuOF production process.

Photo 1 : 6000 TPA Copper Rod Casting Machine

In 1994, Rautomead launched the RS series of upwards-vertical casting machines for the production of oxygen-free copper rod. The company's graphite furnace technology was adapted to accept whole cathode sheets as feedstock and take advantage of the naturally reducing characteristics of the graphite system to de-oxygenate the copper. The crucible was partitioned to separate the melting and casting stages and ensure a still bath of molten oxygen-free copper at the casting dies. Today, rod cast by the RS process is normally of 8mm dia., but larger rods up to 32mm dia. can also be produced. The process is designed for long periods of operation without interruption.

Graphite Furnace Technology

An excellent material from which to manufacture crucibles, the thermal conductivity and electrical resistance of graphite corresponds to the characteristics of a metal. Its mechanical properties are similar to a ceramic, but offer substantially higher thermal shock resistance. Additionally, as elemental carbon, graphite forms a naturally oxygen reducing environment.

High Speed Casting
When first launched, the Rautomead oxygen-free copper rod process offered casting speeds of 3.0 metres/minute, or 80 kg/strand/hour for 8mm rod. An eight-strand machine therefore produced 640 kg/hour. Today, casting speeds of 5.0 metres/minute or 133 kg/strand/hour, mean a six-strand machine will produce 750 - 800 kgs/hour.

Optimising of Thermal Balance
Rautomead graphite crucibles have two separate chambers for melting and casting. The company uses a thyristor-controlled low voltage radiant heating system to transfer energy to melt the copper through the walls of the graphite crucible. The mass of the crucible itself plays an important role in the stored energy of the system, enabling very close control of casting chamber temperature (+/- 3 ºC) to be maintained, while cathodes are plunged into and melted in the adjacent melting chamber.
Photo 2 : Graphite Crucible

Mains power is fed to a transformer and stepped down to approx 40 volts. Three-phase secondary power is fed to the furnace through flexible leads and water-cooled graphite busbars to an element chain surrounding the crucible. Heating is biased towards the melt chamber. Typical furnace temperature when melting copper is 1330 ºC, while casting temperature is approx. 1170 ºC.

Optimising Withdrawal Design
Standard Rautomead RS machines are built to accommodate requirements for rod diameters of 8mm to 12.7mm. They can however be designed for the production of rods up to 32mm diameter, with enhanced rod coiler design to accommodate these larger sizes.

Remote Plant Monitoring
Rautomead machines are PLC controlled, with an advanced level of automatic monitoring of approximately 250 production parameters with appropriate alarm signalling and control procedures. Through built-in Plant Monitoring, production and maintenance data is analysed, recorded and reported through the user's own computer network for product traceability. Reports can also be downloaded to Rautomead for diagnostic purposes.

Failsafe Procedures
Any continuous production process requires procedures to deal with unexpected failure of the services required to run it. In the case of the RS upwards vertical casting process, these essential services are: electrical power, cooling water, inert gas and compressed air.

Electrical Power
In the Rautomead process, electrical power is used principally to melt the copper, via high intensity graphite heating elements surrounding the crucible, with power input thyristor-controlled. Electrical power also drives the rod withdrawal mechanisms, the rod coilers, the primary cooling water circulating pumps and the control circuits of the machine.

Rautomead provides a battery-operated emergency device automatically to lift the withdrawal frame with the supercoolers out of the melt, thus making the system immediately safe in the event of mains power failure. A small UPS unit in the control console maintains the control circuits and provides emergency lighting.

Following power failure, the copper in the crucible will begin to cool. Within approximately 45 minutes, power must be restored or the furnace emptied. In areas where mains power is unreliable, therefore, a standby diesel generator, capable of maintaining the copper charge in its molten state, can be provided.

Cooling Water

Each Rautomead RS upwards vertical casting machine is supplied with its own dedicated closed circuit secondary cooling water system, with duplicated circulating pumps heat-exchangers. On mains power failure, the circulating pump stops. The supercoolers are immediately lifted out of the melt by the battery-operated lifting device. As it is necessary to maintain a supply of cooling water to the power terminals, dump valve and furnace body, users are offered a choice of options to achieve this.

Photo 3 : Primary Cooling Water

Inert Gas

Inert gas, usually oxygen-free nitrogen, is used to purge air from the interior of the furnace body and avoid erosion of graphite components at high temperature. It is essential that this inert atmosphere is maintained at all times when the machine is at 400°C or above. Bulk supplies of oxygen-free nitrogen are available in most industrialised areas. Where such supplies are not available, Rautomead can supply a dedicated nitrogen generator.

Compressed Air

Compressed air is used to create the “nip” between the drive and the pressure idler rolls of the rod withdrawal mechanism. The process will not function without it.

Production of Copper Alloys

As a direct result of the development of RS technology, the following production processes have been realised:

• High Copper Alloys

Copper-silver, copper-tin and copper-phosphorous comprise three groups of high copper alloys for which the process has been developed to work satisfactorily.

Photo 4 : 5 Strand Casting Machine in Production of Silver-Bearing Copper

• Brasses and Bronzes

The Rautomead upwards-vertical process has been found to be suitable for production of a range of binary brass and bronze alloys. In these applications, the casting machine is fed from a separate melting furnace where the brass or bronze alloy is prepared and composition checked before pouring to the casting machine.

Cathode Feedstock

The Rautomead RS process for the production of oxygen-free copper is designed to use electrolytically-refined Grade A copper cathode. There are presently over 70 brands of LME-approved grade A cathode. Some brands of cathode which are not presently LME-approved have also been found to perform satisfactorily in the Rautomead process.

Photo 5 : Automatic Feeding of Good Quality Electrolitically Refined Cathode

Electro-refining (ER) vs Electro-winning (SXEW)
LME grade A certification may be given to brands of both ER and SXEW cathode conforming to LME criteria. To date, Rautomead approves only ER cathode. Rautomead does not presently recommend the use of SXEW cathode in the RS copper rod casting process.

Electro-refined Cathode (ER)
In electrolytic refining, the copper is plated onto a copper starter sheet (full deposit type) or onto a stainless steel starter sheet (ISA process). Either process can produce good quality cathode, though Rautomead recommends ISA process cathode, on account of its smooth, clean surface and general absence of nodules.

Faults in ER cathode production and handling can cause processing and rod quality problems and include:

- **Cathode chemistry**
  Iron and nickel contamination through failure to filter and purify the electrolyte. Hydrogen and oxygen gas contamination though the formation of bubbles in the electrolyte.

- **Cathode Surface Quality**
  Presence of nodules on the cathode surface caused by floating slime in the tankhouse, particularly where these nodules contain trapped electrolyte, including hydrogen, sulphur and oxygen.

- **Cathode Handling**
  Severe surface oxidation or the presence of moisture through trapped electrolyte in the suspension lugs, surface condensation or careless handling/storage in wet conditions.

Cathode Selection
With a policy of making the copper rod production process as versatile as possible, via the use of a wide spectrum of cathode brands, Rautomead also provides advice to customers, not only on feedstock quality issues, but also on brands which have proved to be reliable and of consistent quality.

Ends…

For more press information, contact:
Rautomead Limited
PO Box 100
Dundee
DD1 9QY
Tel: +44 1382 622341
Fax: +44 1382 622941