**NOT ONLY EPT ROD**

# FIRE REFINED COPPER FROM 100% SCRAP

## *FRHC copper rod, ingot, billet and other products*

What we are talking about encompasses all types of scrap from bright copper from the drawing shop (near to cathode purity) to old scrap, with a minimum copper content around 93%.

Naturally it is possible to mix many kinds of copper scrap saving hundreds of dollars per ton for the raw metal; this is a promising start towards satisfactory profit on your production of semis.

*Copper scrap before loading.*

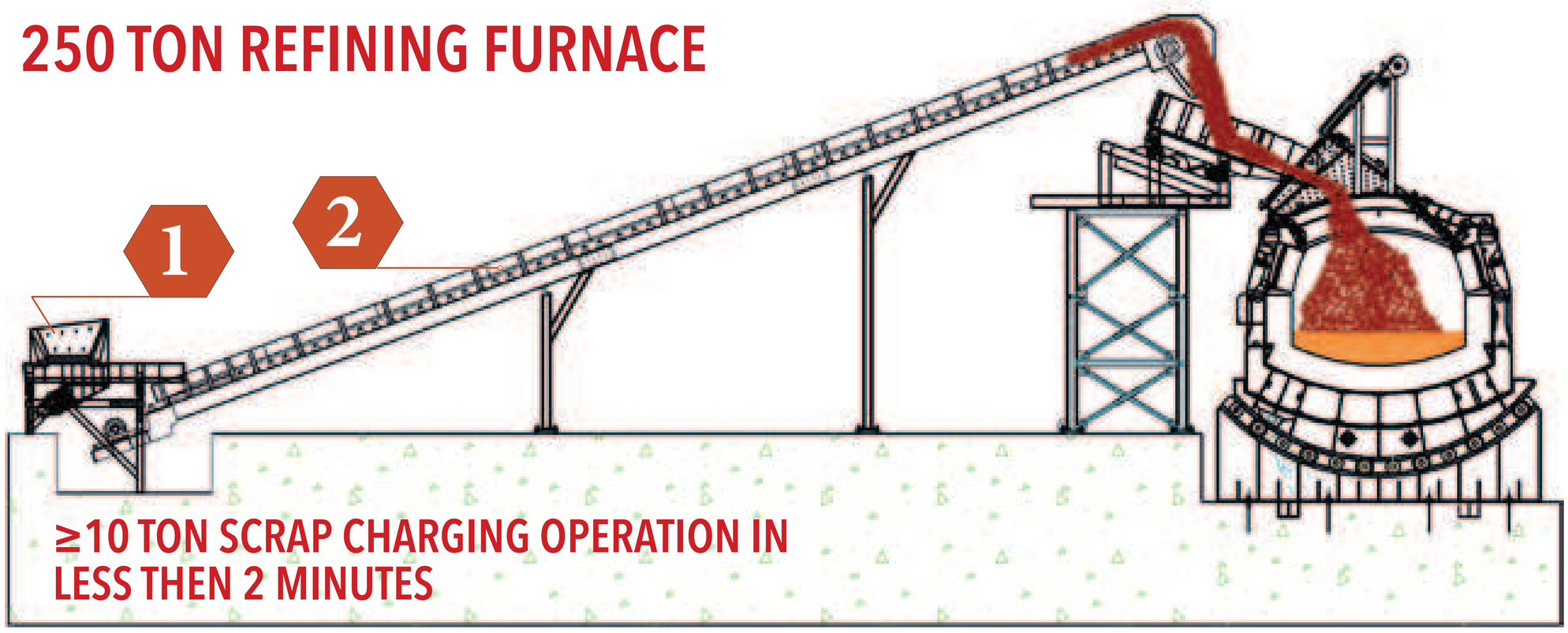
**There are three types of Continuus-Properzi processes for the production of FRHC copper:**

| No. 1<br>Batch Process<br>with maximum refining | No. 2<br>Continuous Process<br>with limited refining | No. 3<br>Batch Process<br>with limited refining |
|---|---|---|
| Copper scrap mix ≥93%<br>40-250 tpd | Copper scrap ≥97%<br>25,000-100,000 tpy | Copper scrap mix ≥96%<br>40-80 tpd |

No. 1 Process is based on one reverberatory furnace usually feeding a rod line or a slab caster during approximately one shift per day.
No. 2 Process is based on a vertical (shaft) furnace and two holding refining furnaces feeding a rod line 24 hours/day.
No. 3 Process is based on a reverberatory furnace for ingot casting into an open-top belt during one shift. Ingots are then diluted with cathodes in a shaft furnace for ETP rod production.

For more than 20 years Continuus-Properzi has delivered and put into operation several dozen refining furnaces for the No. 1 Process mainly followed by copper rod lines around the world including Italy, USA, Korea, Iran, Mexico, Brazil China, India, Ukraine, Russia, Cuba and others.
Most recently Giulio Properzi patented a new design where the furnace is loaded from the top; the first one with, 250 tpd capacity, has been in production since 2012 feeding one 30 tph rod line.
The latest furnace of this kind has been recently installed in Iran with a capacity of 100 tpd followed by a 12.5 tph rod line.
When the charging door is on the top of the furnace body the scrap can be conveyed by a belt through a smaller door, thereby minimizing the escape of heat and pollutant fumes. The belt conveyor can deliver into the furnace, in only one minute, about double the tonnage of scrap compared to prior charging systems, allowing a much shorter cycle, less shock to refractories and less pollutant fumes.

# 250 TON REFINING FURNACE




1 *Chopped or shredded scrap input*

2 *Conveyor Belt*

In several cases the Refining Furnace is completed with a Shaft Furnace for cathodes in a way that the rod line can work almost 24 hours a day, producing about 60% ETP premium rod and 40% FRHC rod. See Table A below.

**Table A**

| No. 1 Process for FRHC rod plus ETP rod from cathodes | | | |
|---|---|---|---|
| Refining Furnace Capacity [t] | Cathodes Furnace and CCR Capacity [tph] | Expected FRHC rod output [tpy] | Expected ETP rod output [tpy] |
| 40 | 6 | 12,000 | 21,000 |
| 60 | 8 | 18,000 | 31,000 |
| 80 | 12 | 24,000 | 42,000 |
| 100 | 15 | 30,000 | 52,000 |
| 150 | 20 | 45,000 | 78,000 |
| 200 | 30 | 60,000 | 100,000 |
| 250 | 35 | 75,000 | 130,000 |

*Note: The above yearly output is based on 300 dpy. It is also possible to install a couple of Refining Furnaces doubling the output of the third column.*

Over the years great work has been done by Properzi and by the Users of such technology so that the FRHC rod of today is an economic commodity which can comply with ASTM-B49-15a standards. It can be processed in high-speed multiwire drawing machines down to 0.3 mm (0.25 mm and smaller for experienced producers) and used in many engineering applications other than fine wire, as has been stated in several papers given on this subject. The number of wire breaks per ton, until reaching this diameter, will be comparable in all respects to the best copper rod available on the market by making minor adjustments during the annealing process.

*Scrap loading from the top of the furnace.*

Table B below displays the typical chemical composition and characteristics of FRHC rod.

**Table B**

| Parameter | Reference | Value |
|---|---|---|
| Chemical composition | Cu+Ag % | >99.90 |
| Oxygen | ppm | 150 – 250 |
| Elongation | $A_{100}$ % | 45 – 51 |
| | $A_{200}$ % | 38 – 43 |
| Tensile strength | $Kg/mm^2$ | 22.8 – 23.5 |
| Conductivity | IACS % | 100.5 – 101.3 |
| Twist test to failure | No | 43 – 50 |
| Best drawability | mm | 0.25 |
| POPS test - surface oxides | Ångstrom | 100 – 200 |
| Re-crystallization temperature | °C | 250 -– 280 |

The level and the kind of impurities in the scrap make a big difference. When it is possible to buy high quality copper scrap with copper content ≥ 97%, such scrap can be processed by using a continuous system of furnaces, including one modified shaft furnace with two refining/holding furnaces.
The loose or baled scrap is charged at the top of the shaft furnace by a front loader using a dedicated ramp. At the bottom of the shaft furnace the melted copper is collected in a basin where it is treated and slagged.

Two launders bring the melt to a couple of holding/refining furnaces which alternate with one another. Refining is generally limited to oxidation and reduction.

This furnace set called CSMR (**C**ontinuous **S**crap **M**elting and **R**efining), corresponding to our No. 2 Process, can feed Properzi rod lines ranging in size from 5 up to 20 tph.
There are cases where the CCR rod line has a combination of furnaces: one CSMR furnace set working about 16 hours per day and one reverberatory refining furnace, for very low grade scrap (≥ 94%), feeding the caster for the rest of the day.
One more system to recycle scrap is available and in use. This is the No. 3 Process, commonly known as “off line” process, and is intended to produce ETP rod in a second step.

In the larger rod systems using consistent amounts of cathodes it is possible to mix a small percentage of FRHC ingots with cathodes and get ETP quality.
Usually the “off line” system recycles internal good purity scrap with some scrap from the market so the required refining is much less intensive than in the No. 1 Process; therefore the tilting furnace is simpler and the ingot caster is a standard open top mould chain.

In summary, regarding the reclamation of copper scrap, Properzi is willing and able to offer and support the following:

- **Complete plants for producing FRHC rod equipped with one or two reverberatory furnaces with daily output ranging from 40 to 250 tons.**
- **“CSMR” (Continuous Scrap Melting and Refining) for clean scrap with output of FRHC rod ranging from 5 to 20 tph.**
- **Combined plants for the production of ETP and FRHC where the CCR line is fed for approximately 14-15 hours with liquid metal coming from a vertical furnace using ETP cathodes and for the remaining time, up to 24 hours, the CCR line is fed with FRHC metal. This system gives the maximum flexibility of using both raw materials (cathodes and scrap) either on a daily basis or on a campaign basis according to the availability of scrap and cathodes.**
- **Last but not least, the “off-line” system for the production of ingots or plates to be blended in with the cathodes charge of existing ETP rod facilities.**

*Properzi is also available to supply such plants on an Engineering, Procurement and Construction (EPC) basis so that the buyer is only minimally involved with the installation of the plant.*