COPPER ROD CLASSIFICATION

During the 70's the vast majority of copper wire rod was still produced using the so-called wire bar (nominal weight 110 kg approx.) as raw material to be processed in the rolling mills know as "belgian loops mills". The copper rod so produced, exhibited very poor quality with very high and non-homogeneous copper oxides in the matrix, metallic and non metallic impurities on the blackened surface that required acid pickling before any further drawing processes.

The quality assessment of this copper rod mainly referred to the measurements of diameter and the visual check of the surface appearance. Very seldom did the laboratory procedures prescribe analisys of chemical composition and oxygen content. Even the tensile strength and elongation values were not standardized.

For these reasons almost one hundred per cent of the copper rod produced with belgian loops and wire bars needed to be shaved prior to the drawing process in order to obtain wire diameters in the range of 0.20 mm. Even for enamelled wires and flat sections, it was absolutely necessary to shave the rod.

During the 80's the continuous casting and direct rolling technology introduced by the Continuus-Properzi company spread worldwide allowing dramatic improvents in the quality of copper wire rod, reaching a quality grade absolutely incomparable to the previous "wirebar's rod". In addition, the raw material switched from poor quality wire bar to high purity cathodes supplied by copper mines using electro-refining and electro-winning processes.

At the same time, the requirements of electrical conductors for the various market applications; from automotive, building wire, electronic cables, energy transmission cables and so on, increased rapidily and the drawing philosophy changed to satisfy the enormous market demands. The new copper rod quality and coil size, allowed an increase in drawing speed from 10-15 m/s up to 30 m/s and even the drawing die's nib changed. Infact, previously the die's nib was made of Tungsten Carbide with a short lifespan (no more than 20-30 t) on drawing. General Electric – U.S.A. developed the Polycrystalline Diamond Die (PCD®) so that it was possible to increase the die's lifespan up to 50,000 t before re-polishing and hence, the die could be used again up to100,000 t and more.

The introduction of multi-wire drawing machinery, as the replacement of the previous single-wire drawing machine, was a natural step to cope with the enormous quantity of copper rod available thanks to the concast systems. The first multiwire machines drew 8 wires simultaneously. A very tall achivement at that time! Very soon thereafter, European machinery manufacturers developed multi-wire drawing lines with 12, 16, 24, 32, 40 and more wires. Usually the speed was 25 m/s, versus the speed of the single wire drawing machine up to a maximum theoretical (mechanical) speed of 30 m/s - 40 m/s. However, the biggest advantage of the multiwire machines is that the productivity increases proportionally to the number of wires. On the other hand, it became vital to have repeatable quality of the copper rod to assure no wire-breaks during the drawing processes, otherwise the advantages of multi-wire machines will be lost; even if only a single wire-break occurs. Well, we can say that the introduction of the multiwire drawing machines in the 80's obliged the copper rod producers to look deeply in the philosophy of the laboratory tests and in the concept of the repeatibility of rod quality. This need brought the rod producers to adopt an internationally approved laboratory test to facilitate a proper assessment of the copper rod products.

The test procedures have been defined by the main standard organizatons of the world and adopted by the whole industry of copper rod manufacturers. The quality assesment procedures for finished copper rod were utilized to develop

Continuus-Properzi's Copper Rod Coils

"Importance of the Test Assessment to Supply Suitable Quality Rod for Final User's Purposes"

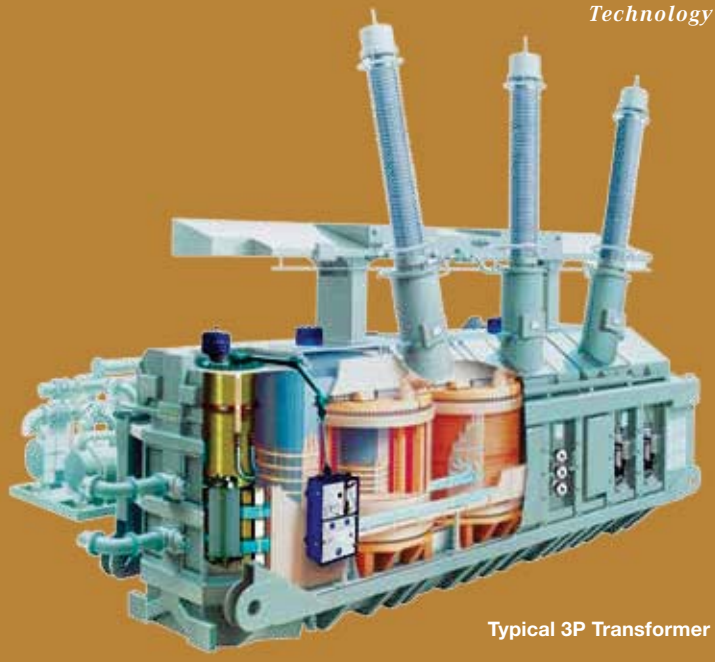
Motor Rotor

the standard tests suitable to make specific classification grades of quality for the different uses. "Each quality grade defines specific peculiarities of the rod and hence, it defines the final products obtainable with the maximum process reliability".

Presently, the quality control and inpsection data are summarized as indicated below:

1 Eddy Current test "in-line" to detect surface flakes
2 Eddy current test "in-line" to detect magnetic inclusions
3 Chemical analysis
4 Oxygen content [ppm] (copper oxides in copper matrix)
5 Twist and Reverse Twist test
6 Diameter and ovality
7 Process conditions / parameters
8 Surface oxide thickness
9 Surface Assessment after the Twist Test

According to the results of the laboratory tests, the copper rod is classified as indicated in the table here below; from 1st Top – to 4th Class. *by Alberto Greppi*



Typical 3P Transformer

Standard Classification: Cu-ETP1-ROD Ø 8,00 mm – Continuous Casting & Rolling Plant

Class	Oxigen max. ppm	Surface Defect Small	Surface Defect Medium	Surface Defect Large	Magnetic Inclusion Small	Magnetic Inclusion Medium	Magnetic Inclusion Large	Twist Test 25 tors.	Twist Test 30 tors.	Diameter Tolerance mm (*)	Note
1	250	10	0	0	0	0	0	≥24	≥15	±0,20	(■)
1 Top	250	5	0	0	0	0	0	≥24	≥18	±0,20	(§)
2	350	20	2	0	5	2	0	≥18	/	±0,20	(□)
3	450	30	8	0	10	5	1	≥18	/	±0,30	(▲)
4	1000	100	50	5	40	20	10	≥18	/	±0,40	(►)

(■) Class 1: Free of flaws & copper dust after T.T. – free of any surface roughness, stains or other surface defects – T.T. ≥18 on the previous rod coil – T.S.O. (**): ≤300Å – Chemical Analysis: (***).

(§) Class 1 Top: maximum of 5 (small) Surface Defects = this copper rod will be suitable for Enameled Wires and for Fine Wire Drawing, up-to: Ø 0,05 mm.

(□) Class 2: Some flaws on the classed A rod samples – light surface roughness – free of stains – very few surface defects T.S.O. : ≤400Å – Chemical Analysis see (***).

(▲) Class 3: Flaws on the rod sample after T.T. at 25 torsion – seams & copper dust on the rod sample after T.T. – surface roughness – free of stains very few surface defects – T.S.O.: ≥400Å.

(►) Class 4: Tundish pin and pour spout cleaning – some problems on wheel's copper level.

(*) Diameter Tolerance
(**) T.S.O. = Total Surface Oxides
(***) Se + Te + Bi < 2; Sb < 3; As < 5; Pb < 4; S < 15