Methods of Rolled Copper Wire Properties Improvement

Zoya Duriagina, Khristyna Dvorianyn,
Sergiy Shvachko, Eduard Pleshakov,
Tetiana Tepla

Chair of applied materials science and treatment of materials
Lviv Polytechnic National University, 79040, UKRAINE,
Lviv, S. Bandery street 12, E-mail: kdvoryanyn@gmail.com

Abstract – Hot cracks of rolled copper are the most wide spread type of discards under continuous casting which are eliminated with difficulty. In industrial production of rolled copper wire at the plants of Ukraine the amount of oxygen in the obtained rods does not exceed the standard values. In this paper it is proposed to subject the melt to ultrasonic treatment to degassing process and the formation of homogeneous, dispersive sub dendrite structure of the rolled copper.

Key words – rolled copper, hydrogen, hot cracks, wire, pores.

I. Introduction

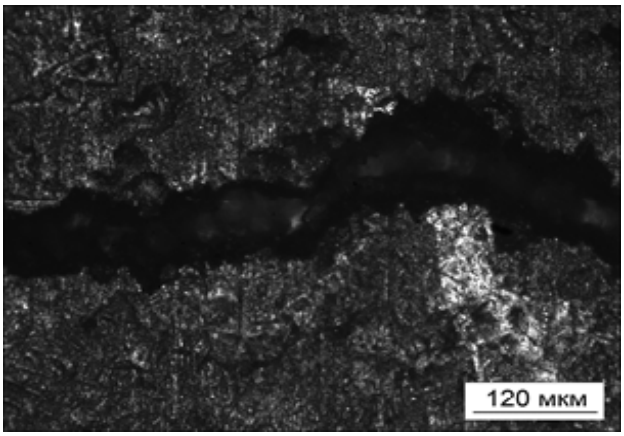
To ensure consumers' demands at the market of cable production the necessity of further investigation and improvement of the technology of copper electrotechnical wire and rolled copper wire production has arisen (Fig. 1).

a

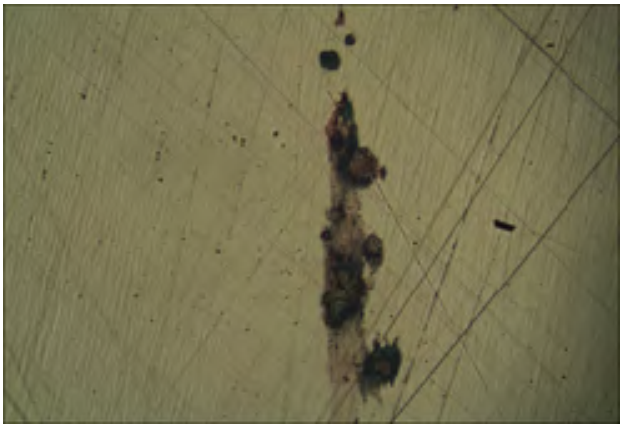
b

Fig. 1. Appearance (a) and fracture (b) of cable production of rolled copper

This is related with initiation of defects, in particular, of hot cracks under continuous casting and at the stage of rolled copper wire production (Fig. 2).



a



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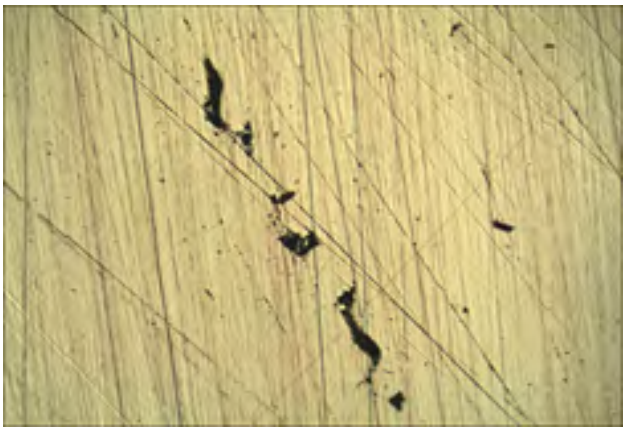

c

Fig.2. Microstructures of rolled cooper: hot cracks (a), non-metallic inclusions (b, c)

It is known that hot cracks are the most wide spread type of discards under continuous casting which are eliminated with difficulty. Hot brittleness depends on the parameters of recrystallization process, level of residual stresses and increased content of admixtures in the melt, especially of oxygen, which solubility in a liquid phase is much higher that in the solid one [1-2].

II. Discussion

In industrial production of rolled copper wire at the plants of Ukraine the amount of oxygen in the obtained rods does not exceed the standard values (Fig. 3).

But in this case hydrogen was present that has a negative effect on the operational properties of the finished product. Hydrogen solubility increases noticeably in the copper melt. In the process of recrystallization a "steam-like" porosity occurs by the reaction $Cu_2O + H_2 = 2Cu + H_2O$ that leads to the change of the cast bar mechanical properties [3]. So, one of the methods of hot cracks elimination in it is the decrease of hydrogen content at the expense of the oxygen concentration increase(according to Alex curve) [4]. It is well known that the increase of oxygen content in the copper melt to 0.06% took place simultaneously with oxidation of other harmful admixtures. Refining is another effective method of gaseous admixtures removal from the melt, however under such conditions the electric conductivity deteriorates.

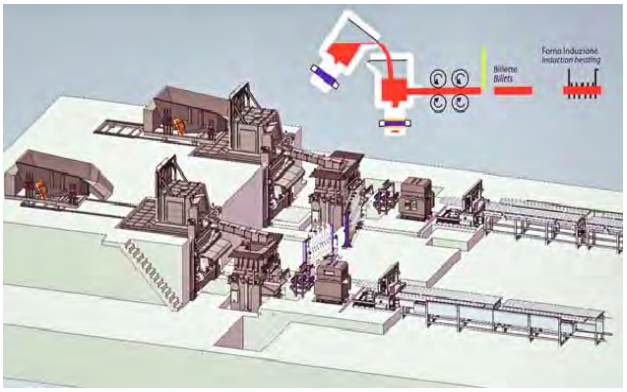

Fig. 3. Scheme of rolled copper production line by horizontal Continuous Casting Process

The significant effect of the structure formation character during crystallization on the rolled copper wire properties must be noted. In particular to remove the dendric inhomogeneity of the cast bar it is necessary to ensure the excess of crystallization centers before its development front. A structure of a real melt is not perfect: there are many submicron particles of oxides and other non-metallic phases, the so called "plankton". Usually it doesn't participate in hardening process. So it is possible to activate this process. For example, during active external action of cavitation treatment on the melt a microheterogeneity level can be decreased and thermodynamic stability of such system can be increased. In this case the main part of solid non-metallic inclusions are not wetted with the melt, since microdefects (pores, cracks) are filled with the gas phase [5].

In our paper it is proposed to subject the melt to ultrasonic treatment. Such an approach foresees a complex action. In particular, in this case the degassing process is more intensive, additional mixing of the melt occurs, thus preventing appearance of dendrite liquation and concentration of non-metallic inclusions along the grain boundaries. Besides, under crystallization this has a positive influence on the formation of homogeneous, dispersive subdendrite structure of the metal.

Conclusion

One of the methods of hot cracks elimination in it is the decrease of hydrogen content at the expense of the oxygen concentration increase. So, it is proposed to subject the melt to ultrasonic treatment. In this case the degassing process is more intensive, additional mixing of the melt occurs, thus preventing appearance of dendrite liquation and concentration of non-metallic inclusions along the grain boundaries.

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