Effect of Damage to the Surface of the Rollers Due to Copper Penetration in the Manufacturing Process of the Cooper Rod Using the Hot Roll Method

E.E.Susanto, F. Rahmadianto

Mechanical Engineering
National Institute of Technology Malang
Industrial Technology Faculty
Jalan Karanglo Km.2, Malang
Email: ekoedys@yahoo.co.id

ABSTRACT

The coiling material, the hot rolling of copper rods, the cooling process and laboratory tests of broken coils were studied. The research was conducted to determine the damage to the surface of the coils and the penetration of copper in the coils used for hot rolled copper rods.
The roller material does not dissipate heat easily, causing small cracks on its surface. There are cracks on the surface of the rollers, and copper penetration is one of the reasons for the increased crack speed in the rollers. The standard cooling system used in the coils used in the hot rolling of copper rods is not optimal, which causes the hardness of the rolled material to be uneven. The difference in the hardness of the roller material will cause unsatisfactory stresses, and therefore will accelerate the roller crack rate.
Once the cause of copper penetration into the coils due to hot rolling is known, radiation can be minimized, so that the life of the rolls can be extended.
Keywords : Rolling, Hot, Cracked, Penetrated, Broken.

INTRODUCTION

The production of straight rods can be carried out by a continuous casting system during the production of wire rods, so that long cables are not cut. The copper in the smelter is continuously poured into the molding machine to form thick castings, then the product is hot rolled. The forming of the copper rod is carried out by rollers, and a gradual reduction in the required diameter is carried out on the hot copper rod.
The sealing of copper rod products is formed in the process of melting raw materials, continuous casting and hot rolling. Therefore, defects in copper rods are caused by irregularities in the rolling process, or damage to the roll surface is cracks or cracks and small holes on the surface. This can damage the roller surface and cause copper to penetrate into the roller material.

METHODOLOGY

The rolled material and specifications of high quality hot work steel or chromium are suitable for hot rolling. This research was conducted on the first coils forming a cast steel rod, the rolled material has a hardness of 185 HB and has undergone heat treatment to a hardness of ± 51-52 HRc and an impact force of 4.5-4.75 kp according to hot rolling standards. m / cm2. Hot copper is reduced at a speed of 0.22 m / s at a temperature of 705 ^{0}C, and a reduction length of 47.36 mm.

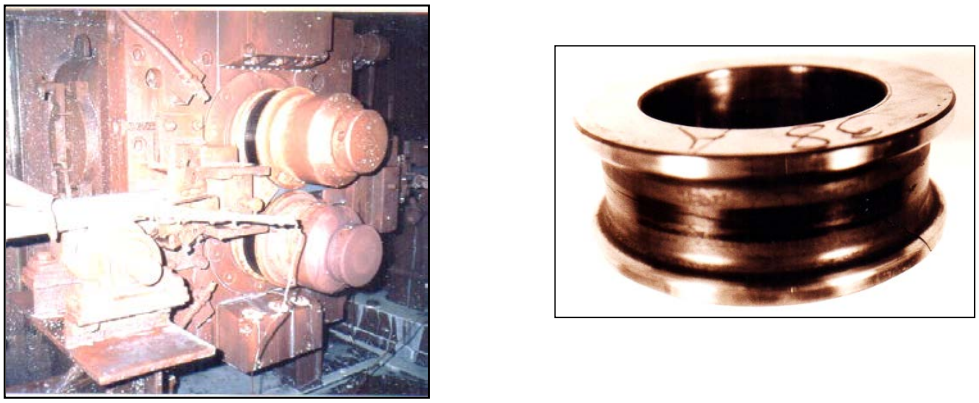

Figure 1. Rollers for reducing hot copper

During the hot rolling process, the water mixture is cooled continuously with 2-2.5% soluble oil. Dissolved oil temperature ± 40 0C and pressure 6 kg / mm2, which are used to cool and lubricate the roller surface. After the rollers are used for hot-rolling copper rods, the hardness distribution is uneven, from the specified hardness of 50-52 HRc to 45 HRc, increasing to 55 HRc The rollers used for breakage after heat treatment are tested in the laboratory to determine the cause of the roller surface damage.

Figure 2. Roll fraction as test sample.

On the surface of the roller in direct contact with hot copper, copper spots are visible on the surface of the roller.

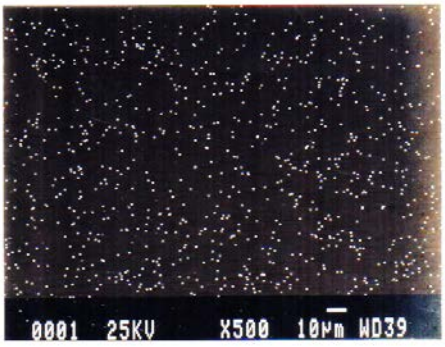

Figure 3.Copper penetration on the roller surface (raised 500 X)

According to the roller's function of reducing hot copper, the result is small cracks or microcracks appearing on the surface of the roller..

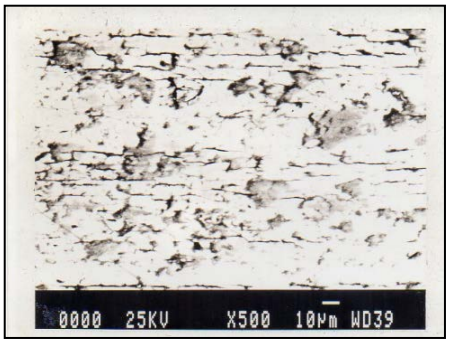

Figure 4.Fine cracks on the roller surface (enlarged 500 X)

Through SEM testing on the roller surface it was found that the soft cracks spread over the entire surface, starting from the shape of the cracks, including the type of thermal fatigue. Small cracks in the roller surface take longer to propagate because the damaged roller is used continuously.

Figure 5. Cracks in the roller surface

Due to hot rolling and reduced pressure on the copper rods, the surface of the roll is smooth and cracked. As a result of hot rolling with coils, small cracks continue to enlarge and expand in all directions irregularly. As a result, small holes are formed on the surface of the coils, and a copper layer is present at the bottom of the holes. The pressure to insert the copper into the roll will increase the crack speed, so the more copper penetration and deposition in the coil will accelerate the roll cracking.

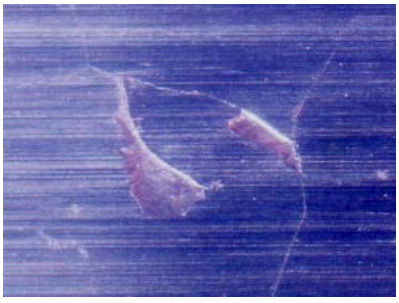

Figure 6. Small holes on the surface of the rollers

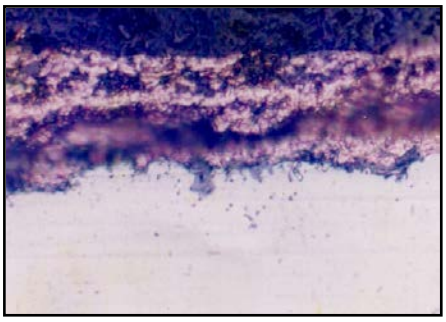

Figure 7. Copper layer at the bottom of the hole.

Since the direction of the crack may be on the right or left, penetration of the copper will result in a copper layer at the bottom of the small hole in the surface of the roll, which will cause the stress applied to the winding material to become unstable.

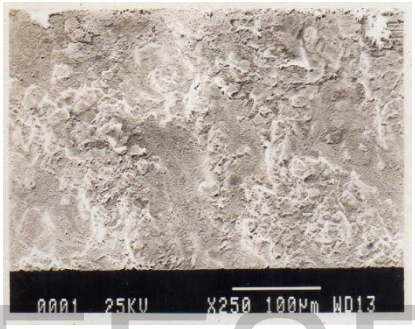

Figure 8. On the crack there is copper (enlarged 250X)

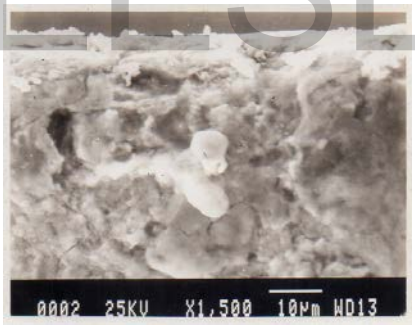

Figure 9. In the roller material there is copper (enlarged 500X)

SEM testing is carried out on the part of the roller that is cracked, the copper traps that enter the crack area below the roller surface will further clarify the effect on the roller surface due to reduction of the copper rod and the direct relationship between the reduction of the roller surface and the hot copper rod. damage.

DISCUSSION

With this cooling, heat transfer from the copper rod to the coiled surface can be reduced, so heat fatigue is reduced, and root surface softness can be reduced. By eliminating the difference in copper volume and penetration rate, this can be treated as one of the causes of root surface cracking. Cooling the roll surface after the rolled copper bar is heated to 705oC can reduce the deceleration time, thereby reducing surface damage.

The hardness of the roller after being used for hot rolling process, the hardness changes there is an increase and decrease. Therefore the effect of heat and cooling on the rollers used for the hot rolling process of copper rods, causes the hardness of the roller material to increase or decrease. From the difference in the hardness of the roller material causes stress which can increase the

rate of propagation of cracks.
The roller material does not dissipate heat easily, causing small cracks on its surface. The presence of cracks on the roll surface will cause the copper to enter into the cracks which is one of the causes of the increased crack speed in the roll. The cooling system used in the coils used in the hot rolling process of copper rods is not optimal, and can cause the hardness of the rolled material to become uneven. The difference in the hardness of the roller material will cause stress which will accelerate the cracking speed of the roller.
During reduction, the heat of the copper rod will cause one of the first cracks in the roll surface. Gentle cracks on the roll surface can cause the copper to diffuse or penetrate into the coils. Copper that enters the crack will cause the crack to propagate to the inside of the coil, and at the same time the crack will propagate to the side, forming a small hole in the surface of the coil and forming a layer of copper.

CONCLUSION

a) Due to the fatigue factor of the roller material used for hot rolling of copper rods, small cracks or microcracks appear on the roller surface.
b) Crack penetration on the roll surface is one of the causes for the formation of holes on the roll surface. Besides, it also speeds up the mapping speed of the crack speed that occurs in the roll due to hot rolling.
c) The roll surface temperature is unstable, due to non-optimal cooling during the hot rolling process for the copper rod, resulting in uneven roll material hardness. Unequal hardness of the rollers will cause cracks to accelerate.

REFERENCES

[1] Alfred Jahr, (1996}, Innovation in Rolling Mill Guides, Metallurgical Pland and Technologi International, Volume 19.
[2] Budi Yuwono, (1995), Quality Improvement of Copper Rod Production for Magnet Wire Application, Wire Journal.
[3] Heinz P. Block, (1991}, Machinery Failure Analysis and Troubleshooting, Gulf Publishing Company, Tokyo.
[4] Gordon W. Powell, (1993), Identification of Typer of Failures, ASM Handbook Failure Analysis and Prevention, Volume 11, ASM International, Ohio, halaman 75-103.
[5] Robinson, (1992),Olin Corporation, Propertis Of Wrought Copper and Copper Alloys, ASM Handbook Propertis and Selection : Nonferrous Alloys and Special-Purpose Materials, Volume 2, ASM International, Ohio, ,halaman 244-345.
[6] Stepen D. Antolovich, (1993), Fatigue Failure, ASM Handbook Failure Analysis and Prevention, Volume 11, ASM International, Ohio, halaman 102-135.
[7] Vander Voort G, F(1993), History Of Factrografi, ASM Handbook Factrografi, Volume 12, ASM International, Ohio, halaman 1-11.