(156) Fine Intergranular Surface Cracks in Bloom Casting

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1. Introduction: In view of substantial energy savings by hot charging, the requirements on bloom surface quality are steeply increasing. One defect type of particular concern are fine intergranular surface cracks. Microsections often reveal a jagged crack path along austenite grain boundaries with decarburized and oxidized surroundings (1, 2). Apart from a network type appearance, crack orientation can be of preferred transverse direction in case of deep oscillation marks (3) or run longitudinally (2, 4) - in the latter case resembling the short longitudinal cracks in slab casting (5).

The most important countermeasures reported are very weak spray cooling (1-3) or even air/mist cooling (4), but also the application of proper mold powder appears important (1). Furthermore, in case of EAF steel making also the content of residuals such as Cu, Sn and Sb plays a vitual role (6).

2. Investigation Procedure: On a curved mold caster with 8 m radius and originally equipped for sections up to 200 x 200 mm, it became desirable for seamless tube making to produce also section 260 x 260 mm with tubular molds. Owing to the reduced casting speed and increased spray cooling intensity, fine intergranular surface cracks became apparent (Fig. 1).

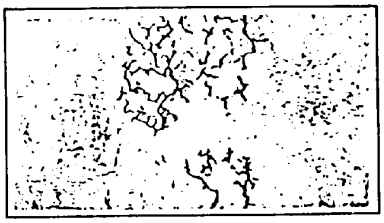

Fig. 1 Network of fine intergranular cracks

Thus an investigation programme was initiated comprising six mold powders and the indirect cooling of strand surface below the mold by Cu-plate extension ("MS-mold"). Also the scrap quality for EAF steel making was monitored. The defect severity is evaluated by a standard rating from index 0 to 4, after pickling of samples in 20% hydrochloric acid.

3. Results: A first improvement was obtained by very soft cooling with the MS-plates in the top zone, and 0.3 l/kg of spray cooling in the subsequent zones of totally 8.3 m length, resulting in 1030 °C strand surface temperature at unbending for 1.0 m/min.

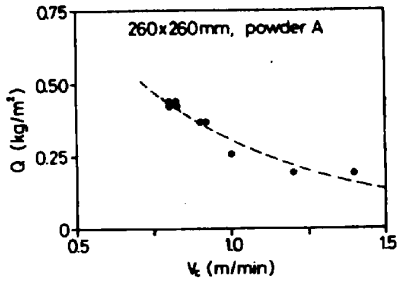

Fig. 2 Mold powder consumption vs. casting speed

However, mold powder selection appeared to be of highest importance. Powder A showed the most stable behaviour over the speed range applied (Fig. 2). Consequently, casting speed was limited to 1.0 m/min to assure the adequate minimum powder consumption of about 0.3 kg/m^2. With such optimized conditions, scrap selection can be controlled accordingly on the basis of a permissible defect rating up to index 2 yielding impurity limits of 0.22 % Cu, or 0.40 % for Cu + 10 Sn (Fig. 3).

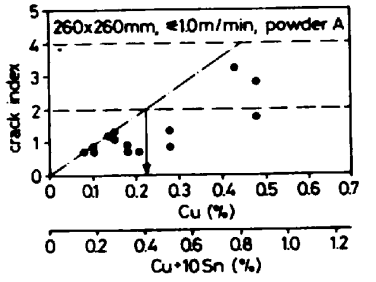

Fig. 3 Crack index vs. impurity content

4. Discussion and Conclusions: The formation of fine intergranular surface cracks in bloom casting is caused by a coarse solidification structure formed in the mold due to locally reduced cooling rate. The resultant coarse austenite grain size has very weak grain boundaries. In case of EAF steel, this behaviour is enhanced by infiltration of Cu, Sn and Sb after preferential scaling of iron. Hence, it is most important - beside control of impurity content - to assure a uniformly fine solidification structure. Secondary cooling has only a propagating effect by controlling the stress level, the scale formation and additional precipitations (Al, Nb) which may enhance grain boundary decohesion.

References: (1) Y. Iida, H. Ooi: Proc. OH-Conf. AIME (1978) 60-69, (2) H. Yasunaka et al: Tetsu-to-Hagané 68 (1982) A165-A168, (3) K. Yoshida et al.: Tetsu-to-Hagané 67 (1981) 1317-1323, (4) S. Noguchi et al.: Tetsu-to-Hagané 67 (1981) S 902, (5) T. Kohno et al.: Tetsu-to-Hagané 68 (1982) 1764-1772, (6) M.H. Burden et al.: Proc. Int. Conf. Casting Solidif. Metals, Sheffield 1977, 279-286.