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(123) Alloy Effects on Mould Heat Extraction and Shell Growth

(On Solidification in Continuous Casting Moulds - Part II)

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1. Introduction: Systematic investigation of the effect of carbon content on mould heat extraction revealed a distinct minimum at 0.12 %C and a high plateau around 0.40 %C; Furthermore, the minimum value was significantly increased by addition of 0.30 %S[1]. Such behaviour is due to shell growth with more or less pronounced surface roughness (rippling). Consequently, these alloy effects should be also apparent from the value of the parabolic solidification constant, k, in eq.(1) of Part I.

2. Investigation Procedure: Mould heat extraction data collected from plant observations (cf. Part I) were evaluated according to steel composition as given by content of C, P and S (resp. Mn/S)[2]. In addition, 58 shell profiles published in literature had also been analyzed according to C-content; thereby, the parabolic solidification constant was derived by considering the superheat effect on the growth exponent as discussed earlier[3].

3. Results and Discussion: In Fig. 1, the ranges for the solidification constant of published shell profiles are plotted as function of steel carbon content (on log-scale). This indicates minimum $\bar{k}$-values down to 22 at 0.12 %C, and maxima up to 34 around 0.40 %C. Considering the average mould heat extraction for corresponding C-contents by use of eq.(3) in Part I, two functions result as indicated by dashed lines: oil casting gives $\bar{k}$-values from 28 to 32 while powder cast conditions center around 25. Generally, powder casting tends to cover the alloy effect. The contents of P and S within the usual ranges of max. 0.06 % each did not yield significant effects on heat extraction and shell growth but, nevertheless, show a positive tendency with increasing content. The alloy effects can be explained by the extent of micro-segregation occuring during solidification, and the resultant changes of strength properties in the strand shell[2].

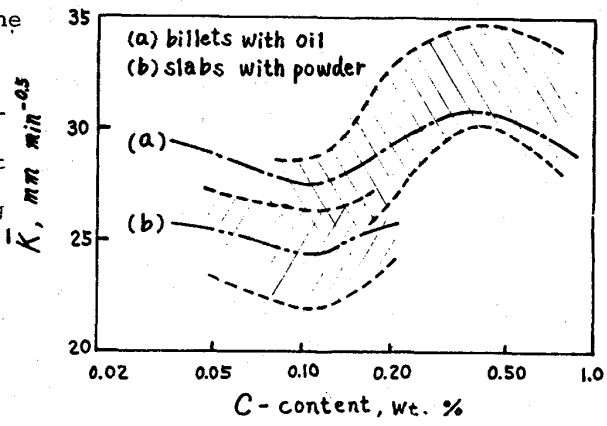

Fig. 1 Empirical relationships between solidification constant and steel carbon content for oil resp. powder casting.

4. Conclusion: Solidification in continuous casting moulds is strongly influenced by steel carbon content in case of oil as lubricant. The minimum in heat extraction and shell growth at 0.12 %C must be respected in view of breakout safety. Higher C-contents show improved growth behaviour but are more crack sensitive.

5. References: 1) S. N. Singh, K. E. Blazek: J. Metals, 26(1974). 17, 2) M. Wolf: Dr. sc. thesis, ETH Lausanne 1978, 3) M. Wolf, W. Kurz: Sheffield-Conf.1977