THESIS ABSTRACT

STUDIES ON ELECTROSLAG REMELTING

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Electroslag remelting (ESR) is a secondary refining process and is being increasingly used for the production of high quality steels and alloys. The present work deals with the design and construction of a laboratory scale fully automated electroslag remelting unit and the investigations carried out with the unit on the following topics of academic interest: (i) The thermodynamic behaviour of manganese and silicon during ESR of steels; (ii) The applicability of the ESR technique for development of a complex heat resistant Al-alloy; (iii) Applicability of the ESR technique for the production of fibre reinforced eutectic composites.

Steels containing manganese and silicon were electroslag refined and the analysis of metal and slag after refining permitted an assessment of the thermodynamic behaviour of manganese during ESR. The results showed that near equilibrium conditions prevailed with respect to manganese transfer between metal and slag. Moreover, the high MnO activities in calcium fluoride slags permitted the transfer of manganese from slag to metal in some cases. A correlation was also established between Mn and Si transfer and the Base-acid ratio.

Recently, the ESR technique has been applied to the development of non-ferrous alloys. In the present work, attempts were made to develop a complex heat resistant aluminium alloy, namely Au_2GN used in aircraft industry. So, a programme on the development of this alloy was implemented, in collaboration with the Chief Metallurgist, (Forge and Foundry Division) Hindustan Aeronautics Ltd., Bangalore. Conventionally cast electrodes of this alloy were electroslag refined and as expected, the product showed considerable improvement in mechanical properties, including forgeability. It was found to be almost isotropic, with comparable properties in the longitudinal and transverse directions.

It has been suggested that ESR technique could be used for producing directionally solidified fibrous composites from eutectic melts. In the present work studies were made on the development of fibre reinforced Al-Al_3Ni eutectic composite. Rusults showed a vertical alignment of grains along the length of the ingot, however, the $NiAl_3$ fibres within the grains had a tendency to fan out and there was only a partial alignment of the fibres. The longitudinal tensile strength of the Al-6wt% Ni higher purity alloy, directionally solidified by ESR was about 2.5 times that of the normally cast alloy of the same composition. This study suggests that with the use of purer starting materials and possibly a seed crystal, it may be possible to get perfect alignment of the eutectic fibres with the consequent maximum improvement in properties.