

Syllabus of Secondary Steel Making and Casting Processes (Group F in place of Welding Metallurgy)

Introduction: Brief review of primary steelmaking processes; composition of crude steel; Need for secondary refining; Objective of secondary steelmaking; Secondary steelmaking equipments and processes. Preheating and recycling of ladles.

Tapping and de-oxidation: Furnace tapping operations; Phenomena during furnace tapping; carry over slag and slag detection devices; slag making in ladles and deoxidation: common de-oxidisers and requirement of deoxidisers; addition methodology; melting and dissolution of de-oxidisers; deoxidation thermodynamics and kinetics; simple vs. complex de-oxidation; De-oxidation products; Elementary de-oxidation calculations.

Ladle Metallurgy Steelmaking ; Inert Gas Stirring in Ladles (objectives, devices, gas flow regimes, stirring energy and stirring intensity); Temperature and Composition Control in Ladles (arcing, alloying addition and aluminium wire feeding) ; Clean steel and definition; Inclusions in Steel and Calcium Treatment (cored wire injection, objectives and devices reactions, calcium recovery and inclusion morphology and composition); Vacuum Degassing: Principles; equipments and degassing Methods and their relative merits and demerits; slag eye area and re-oxidation.

Transfer Operations and Tundish Metallurgy; Tapping and teeming; open vs. shrouded teeming; Tundish Designs and Operations; Tundish preheating, Tundish slag; Tundish furniture and flow control devices (stopper rod and slide gate); Temperature and Cleanliness Control in Tundish; Grade Intermixing, Slag vortexing, Strand Freezing and Residual Metal Losses.

Solidification of steel: Fundamentals of solidification of steel; segregation and constitutional super cooling; solidification rate laws and solidified structure. Defects in solidified products.

Ingot casting: Ingot mold , design, mass and material; casting pit and pouring arrangements, trumpet, runner and spigot; shrouding in the trumpet and mold filling; mold powder and antipiping compounds and their roles; hot top; estimation of solidification time and stripping of solidified ingot; hot charging for superior energy efficiency, Mold cooling.

Continuous casting: Historical development of continuous casting process; continuous vs. ingot casting :Advantages and disadvantages; continuous casting machine types and components, Mold material, design and mold cooling arrangements: heat extraction rate in the mold, secondary cooling zone and spray parameters; radiation cooling zone; machine radius and metallurgical length of the caster; emerging Trends in Continuous Casting (new mold material including coated molds, mist cooling; soft reduction etc.), Near net shaped casting processes (including beam bank, thin slab and twin roll and horizontal belt strip casting processes); defects in continuous casting products.

Books for reference:

- (1) Secondary Steelmaking-Principles and Applications by A. Ghosh, CRC press, USA (2001);
- (2) A first course in Iron and Steelmaking by D. Mazumdar, Universities press, India Pvt. Ltd, Hyderabad (2015);
- (3) Principles of Secondary Processing and Casting of Liquid Steel, by Ahindra Ghosh, Oxford and IBH publishing company, New Delhi (1990);
- (4) NPTEL course on Steelmaking by Prof. S.C. Koria and Dipak Mazumdar

Sadhan Kumar Roy

S K Roy
Secretary General

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