(139) Deoxidation to 0.0001% Oxygen, Desulfurization to 0.0008% Sulphur and Dephosphorization to 0.0007% Phosphorus

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Introduction: This report illustrates how induction furnace melting can be employed to produce a quality product that is highly competitive to other methods of melting. The upgrading of numerous alloy systems depends upon how effectively impurities are removed. Theory of steel deoxidation, desulfurization and dephosphorization is reviewed. Results using conventional slag techniques, calcium metal, calcium alloys, magnesium and magnesium alloys are listed and compared.

Experimental procedure: Using the required conditions presently known for effective deoxidization and desulfurization in the arc furnace, such as a strongly basic and reducing slag, and adding to this the supposition that deoxidization and desulfurization can be more readily accomplished if Ca or CaMnSi which forms a stable oxide, sulfide, carbide and phosphoride is injected directly into the metal bath, such as iron base, nickel-iron alloys and cobalt-iron alloys. This Ca or CaMnSi was injected into the bath by means of an expanded metal screen cage attached to a long weighted bar and manipulated by a crane.

Results: CaMnSi is an example of a more desirable type of deoxidant, for it has been successfully employed in producing relatively clean steel as opposed to that which generally is associated with Al, CaSi, or NiMg deoxidants. It may be desirable to add as much as 1.0/2.0 percent CaMnSi, which will result in silicon residuals between 0.5/1.0 percent in order to affect an oxygen and sulfur reduction. For alloys in which silicon must be kept to a minimum, silicon-free deoxidants must be considered. Good examples of such deoxidizers are elemental Ca and Mg, and Ca has been used to effectively reduce oxygen and sulfur to low levels. By this experiment, sulfur levels as low as 0.0008 percent be obtained with the combination of a highly basic slag and the appropriate desulfurizer. In order to avoid hazards in making these additions, the following must be carefully considered: (1) bath composition, (2) bath temperature, and (3) amount added at any one moment. Therefore, whenever difficulty is encountered in making Ca or Mg additions, the problem can generally be resolved by (1) adding 'tranquilizing' elements such as Al, Si, etc. to the metal bath prior to the Ca or Mg and/or (2) reducing the amount added at one moment, and (3) controlling the bath temperature to the lowest practical limit.

Induction melting can be more readily employed to produce even lower carbon and phosphorous levels consists of using metallic calcium under carefully defined conditions. For making the most efficient use of these alloys is discussed and reasons for choosing calcium metal and all other methods for alloy purification are listed.