One of the most important technical requirements in modern high-speed converter steelmaking is early formation of the furnace slag. Early slag formation helps optimize conditions for the oxygen blow and facilitates thorough refining of the steel in the converter. The main factors that determine the rate of slag formation are the contents of oxides of iron and manganese in the slag, the temperature of the steel, and the conditions under which the lime is added. When converter steelmaking is done on low-silicon, low-manganese pig iron with use of a portion of the slag from the previous heat, the slag tends to form earlier and intensive decarbonization takes place as the blow proceeds in the dynamic regime. Such steelmaking is also more efficient as a whole, since it reduces the amount of silicon and manganese in the pig and shortens the heat.

One of the most important technological requirements in modern high-speed converter steelmaking is a slag-formation process which optimizes the course of the oxygen blow and provides for thorough refining of the steel inside the converter.

To develop a regime for accelerated slag formation in oxygen converters, we studied the mechanisms and kinetics of the processes involved in the dissolution of lime in the primary slag and we determined the phase composition of the slag during the oxygen blow [1].

Results obtained from petrographic studies of the slag formation mechanism showed that the process of lime dissolution in a converter heat entails passage through a stage involving the formation and transformation of the initial structural phase of the slag melt. In the solid state, this phase is iron-manganese monticellite CaO(Mn, Mg, Fe)O·SiO2, and it has a melting point of 1208°C. Monticellite is the only crystalline phase in the primary slag and comprises 88–91% of the latter, the rest of the slag being glass. In the liquid state, the slag apparently consists of cations and simple anions, due to the low stability of silicon-oxygen anions in the presence of cations of iron and manganese. The presence of simple ions may be the reason for the viscous flow of the melt.

An increase in the concentration of the cations Fe2+ and Mn2+ in the melt is accompanied by an increase in the rate of dissolution of lime in the slag. This development is probably connected with the formation of low-melting, low-viscosity solutions of FeO–MnO–CaO (RO-phase) and an improvement in the conditions for the slag’s penetration into the lumps of lime due to better wetting. Oxides of iron and oxides of manganese must be present to ensure intensive interaction between the lime and the slag. This requirement is related to the fact that the initial stage of transformations that takes place in the primary slag melt during the dissolution of the lime is the formation of orthosilicate groups (2CaO·SiO2, 2MnO·SiO2), which involves the participation of manganese oxides. Iron oxides (olivine group and calcium ferrites) are a product of subsequent transformations of the slag melt that result in the formation of free CaO not bound in silicate groups. This conclusion is confirmed by the fact that the formation and precipitation of orthosilicates during solidification has been seen to occur in the slags formed during the earlier periods of the blow when the primary slag melt contains manganese oxides.
Fig. 1. Effect of FeO on the solubility of lime in the slag: ×) 0–3% MnO; ○) 5–7% MnO; ⨿) 9–12% MnO.

Fig. 2. Effect of MnO on the solubility of lime in the slag: ×) 5–8% FeO; ●) 9–12% FeO; ○) 15–18% FeO.

Fig. 3. Combined effect of oxides of iron and manganese on the solubility of lime.