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Mineralogy in process control – Reasons for furnace build-up and metal losses to slag

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Mineralogy is an essential tool in process control. This contribution describes the use of mineralogy to obtain reasons for furnace build-up, as well as metal losses to slag in a ferrochrome smelting operation. Mineralogical techniques used in identifying phases included X-ray diffraction analysis and scanning electron microscopy.

Mineralogical analysis of the furnace build-up, Figure 1, identified a glassy silicate phase, which coats and binds particles, thus forming the build-up. The glassy phase is a typical low melting complex, as observed from the presence of Ca, Mg, Na and K in the composition. In assessing the furnace charge, it was noticed that unscreened pellets were used, comprising an excessive amount of fines. Examination of the fines fraction indicated the presence of abundant silicates such as plagioclase and Fe-rich chlorite. The presence of these fines has thus contributed to the formation of the glassy silicate phase, as the minerals carried in the fines lowered the fusion temperature of the charge, and hence caused the excessive build-up.

Additional to the furnace build-up, chromium losses to the slag were experienced. This followed changes to the composition of the furnace charge over time. Owing to lower Cr_2O_3 content of the ore, flux and reductant additions were decreased, with a substitution of coke with anthracite over time.

Mineralogical analysis of the slag showed the presence of abundant partially altered chromite, secondary Cr-spinel as well as FeCr-alloy prills. The presence of these phases may be attributed to slag basicity. The slag basicity ($CaO+MgO:SiO_2$ ratio) is an important factor that affects the partitioning of chromium between the alloy and slag. A reduction in CaO content caused by the reduction in limestone flux addition, resulted in a decrease in the slag basicity. The effect of this was increased slag viscosity, which negatively affected the separation of alloy from slag. Lowering the slag basicity also lowers the activities of chromium oxides [1], which in turn gives rise to the presence of unreacted or partially altered chromite, contributing to Cr-losses in the slag.

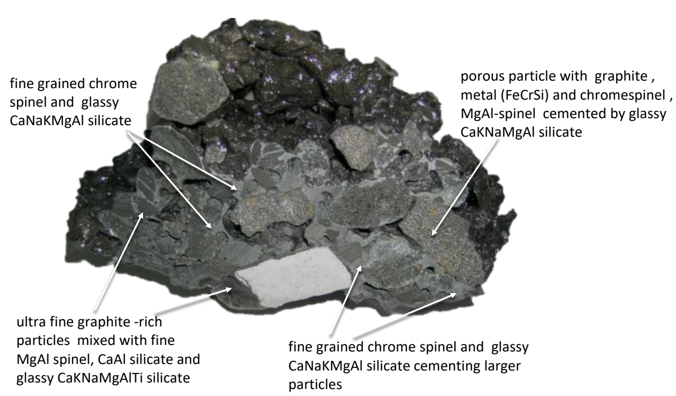

Figure 1. Furnace build-up

Mineralogical analysis of the feed and slag is therefore essential in optimum process control, i.e. optimum furnace function as well as minimal metal losses to the slag.

References:

[1] Xiao Y and Holoppa L (1995). Thermodynamics of slags containing chromium oxides. INFACON 7, Trondheim, Norway.