The main parts of the FRS1600 high temperature rheometer (Figura 1A) are the measuring system consisting of a crucible with bob made from graphite inside of the heating furnace and top-head of unit. For the rheometry tests of slags a perforated side surface of the bob (Figure 1B) was used in order to eliminate possible slippage between the bob and the tested medium [6,7].

The rheological research focused on multi-component synthetic slags of the blast furnace type in the systems: CaO−SiO$_2$−Al$_2$O$_3$−MgO with increased concentration Al$_2$O$_3$ (7–26 mass %) or doped with TiO$_2$ (4-28 mass %) or with solid synthetic TiN (to be comparable with possible products of reductions of TiO$_2$ by C or N$_2$). The range of temperatures was 1310-1500 °C. The heating regime and schema of shear rate were varied [5,6].

b) Additional experiments were performed to study the precipitation of Ti-containing phases, such as Ti(C,N), TiC and TiN, in the freezing slag. The reduction of TiO$_2$ by carbon from the crucible was observed.

c) The next systems CaO−SiO$_2$−Al$_2$O$_3$−MgO with increased concentration Al$_2$O$_3$ (from 7 to 26 mass %) were analyzed and it can be concluded from the nature of the flow curves that the analyzed system (with high concentrations of Al$_2$O$_3$) with fine solids is not a Newtonian body. It may be supposed that this is a system that has been diluted by shearing. This effect is characteristic to polymer solutions or suspensions of solid particles in liquids [8].

d) The amounts of solid particles in the basic slag were changed in the 0.1-0.7 range of volume fraction of TiN. Those values were the results of the theoretical calculations, made by using thermodynamic data bases (Fact Sage) for the analysed TiO$_2$ concentration.

**High-temperature rheometry results**

Totally liquid blast furnace’s slags are systems which show similarity to ideal viscous Newtonian bodies. During temperature or system type changes (for heterogenic) – these systems change their rheological character. A reduction and precipitation study was performed to verify the possibility of the formation and precipitation in certain conditions.

**Figure 2:** Flow curves for slags with an increased TiO$_2$ content

The viscosity curves of tested samples at the selected temperatures were presented in Fig. 2. Presented rheological characteristics reveal that at specific temperatures, and for specific concentrations of TiO$_2$, in the system all tested samples are similar to the Newtonian ideal body. However, at a temperature of 1490°C, the curve shows deviations from perfect viscous fluid. In an almost completely liquid system in which only modest amounts of solids Ti(C,N) exist, titanium plays the role of a network modifier by diagnostically decreasing the dynamic viscosity, and as a result the slag system shows small deviations from the perfect Newtonian body. However, when the temperature decreases, a substantial quantity of solids precipitate in the possible form of perovskite or others fine solids, intensively raising the coefficient of dynamic viscosity of the system but without any significant influence on its rheological nature.

**Conclusions:**

The addition of titanium oxide to the slag at high temperatures does not change its rheological nature and the slag is similar to a Newtonian perfect fluid. This changes for high TiO$_2$ concentrations and at lower temperatures (between 1370–1340 °C) caused shear-thinning or shear-thickening body by turning into a semi-solid system. The addition of TiN solid particles changes the slag nature into time-dependent; at the same values of shear rate the structure recomposes and falls apart.

The type of formed precipitates influences the rheological nature of the semi-solid slag system [24].

It seems necessary to conduct further rheometric research within this area, in parallel to identification of precipitating inclusions in terms of their structure and chemistry. Research in order to identify the size and shape of precipitated solids in particular conditions of temperature and chemical composition of the slag is necessary.