

# Study of Formation and Modification of Inclusions in Al-Killed Ca-Treated Steel

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## ABSTRACT

In the production of special steels, inclusions are considered the factor that more affect the final product quality. Moreover, the need of constant improvement of mechanical and machinability properties – for example, in the production of complex pieces for the automotive segment – is increasing.

These products are Al-killed steels, including sulfur contents above the “normal” level and with an excellent internal cleanliness. In addition, they are also calcium-treated for controlling the type and morphology of inclusions. It is possible to see that the steel elaboration is critical: Al, S, Ca, O contents must be controlled.

The main purpose is the inclusion control to avoid both clogging problems during continuous casting (CC) and the formation of undesirable inclusions.  $Al_2O_3$  and CaS are potential sources of defects during rolling and steel forging.

The specific goals of this work are:

- 1) To obtain the phases and compounds formed in the inclusions as a function of composition and casting temperature adopted for the Al-killed Ca-treated steel grade.
- 2) To establish conditions of steel chemical composition for the formation of less harmful inclusions for the steel castability.

Based on the literature and previous works by the authors, simulations will be carried out using the commercial software FactSage and databases. The simulations are performed by using the steel temperature and chemical composition in the CC tundish.

The results are steel and non-metallic inclusions (oxides and sulfides) composition in the aimed temperature. They also show the formation of different solid oxides and liquid phase in the inclusions as a function of aluminum and calcium content in steel.

It is possible to establish a range of calcium content in which the inclusions are formed by a predominant liquid phase (liquid window), and also the calculation of the percentage of liquid and solid phase in the inclusions, and the composition in terms of oxides as well.

The results of thermodynamic simulation will be compared to industrial results in terms of inclusion composition and casting index. Industrial results confirm and validate that the thermodynamic prediction was validated by industrial results.

**Keywords:** special steels, inclusions, calcium treatment, FactSage.