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ЛАБОРАТОРИЈА ЗА ТЕРМОТЕХНИКУ И ЕНЕРГЕТИКУ

Furnace sorbent injection and effects on furnace operation under reduced boiler load

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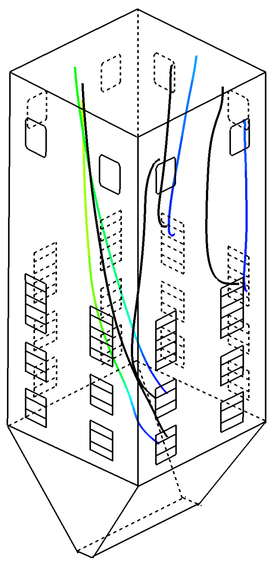
Abstract: Furnace sorbent injection and boiler operation stability are analyzed under reduced boiler load to examine effects boiler load reduction has on sorbent sulfation process and furnace exit gas temperature. Boiler load is reduced by modifying coal and air mass flows through individual burners. Extent of sorbent particles sulfation is analyzed over selected trajectories. Changes in furnace exit gas temperature and SO2 concentration at the furnace exit are monitored. The change in sulfation extent is most noticeable in sorbent particles injected through lower burner tiers under reduced boiler load. This can be attributed to significant drop in local temperatures near flame core, allowing particles to maintain internal particle surface for longer periods of time, influencing the local sulfation rates. The boiler load reduction benefits the sorbent injection process, while maintaining stable furnace operation.

Keywords: full scale boiler furnace, coal combustion, reduced boiler load, sorbent particles injection, sulfation, numerical simulation.

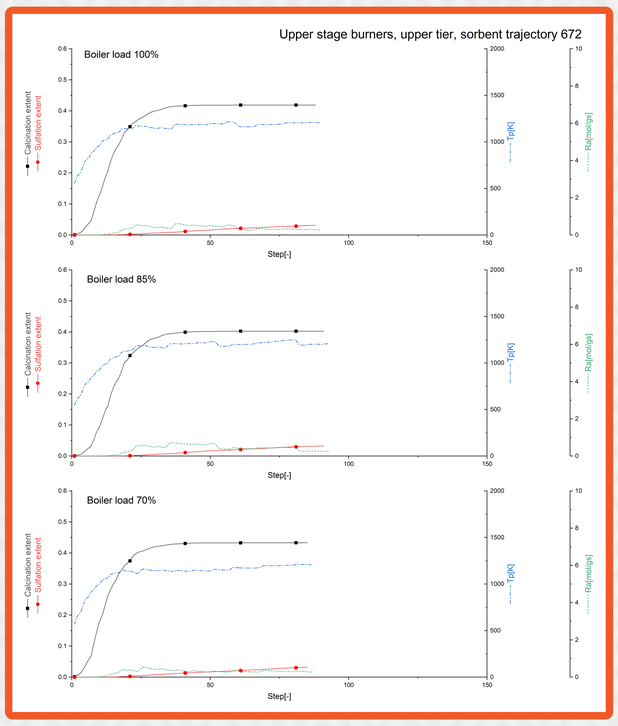
In examined test cases there is no significant drop in furnace exit gas temperature. The sulfation process itself benefit from the load reduction, as the local temperatures near the flame core are usually lower, allowing for less sintering, and due to lower gas velocities, the particle residence times are proportionally increased.

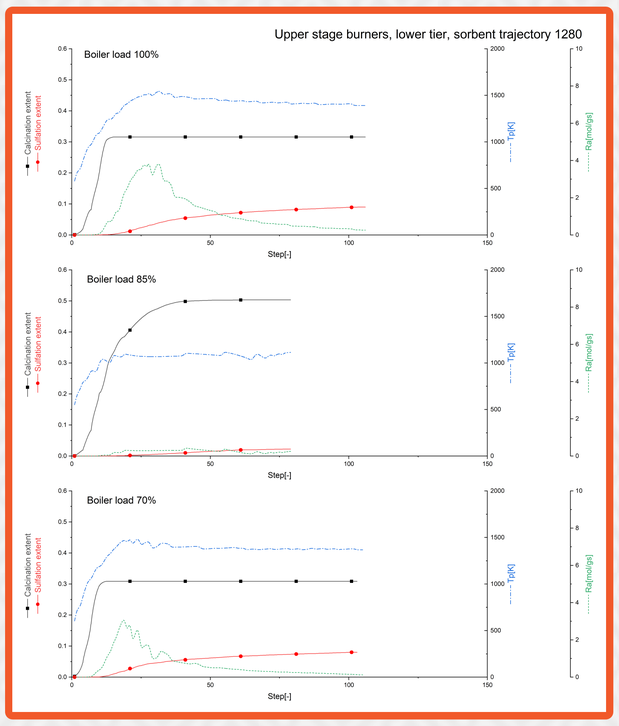
Averaged temperatures and emissions at the furnace exit

Boiler load	-	100	85	70
Furnace exit gas temperature	K	1302	1302	1298
SO_2 concentration	mg/Nm^3	2737	2591	2444



Figures 1 - 4 show the calcination and sulfation extent, particle temperature and calculated reaction rate along the sorbent trajectories 2496, 2688, 1280, and 672 at each time step. Selected trajectories start from different vertical burner tiers, and from different burners. The starting location of each particle is close to the center of the burner it starts from.





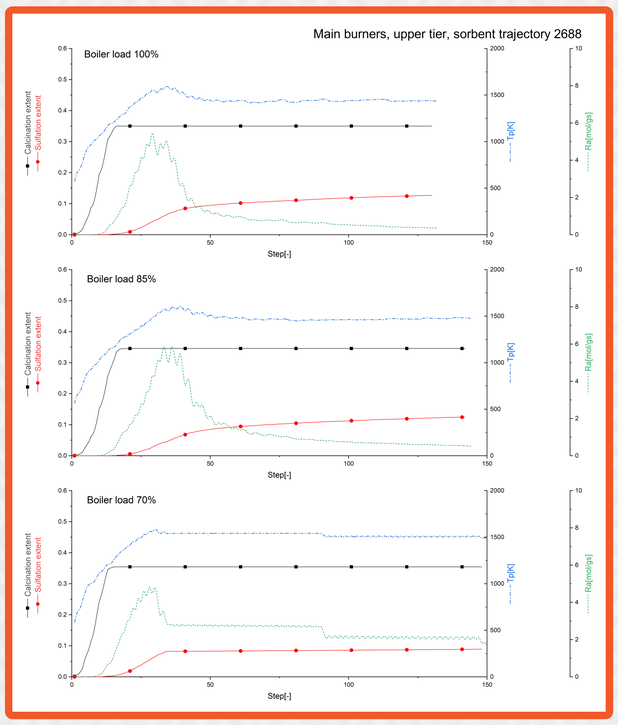
Conclusion

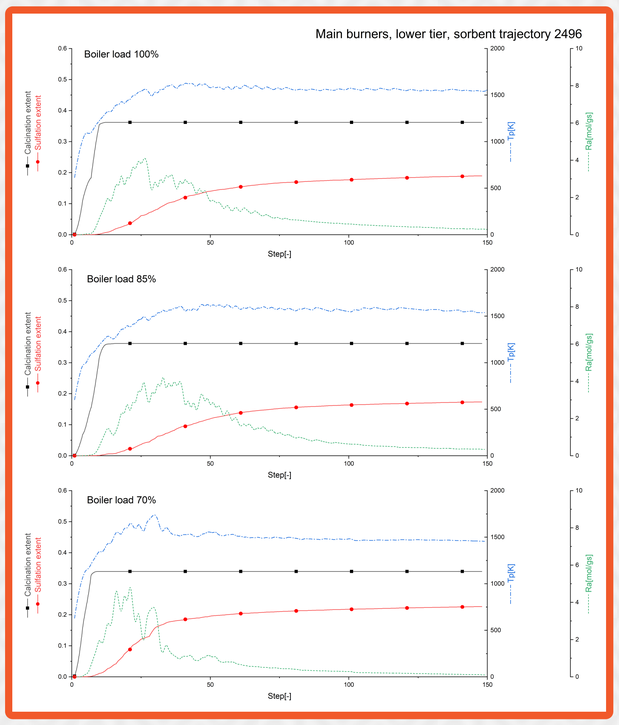
- Considering the boiler operation, the furnace exit temperature show drop of 4 °C when the boiler load is reduced to 70%, but in case of 85% boiler load the temperature remains similar the 100% load.

- Analyzing the individual particle trajectories, can help to better understand the changes in their properties and behavior during the direct furnace sorbent injection. It was shown that slight change in operating conditions can lead to change that would affect the sorbent trajectories and reduce the process efficiency.

- Sorbent trajectories that are exposed to higher local temperatures have initially higher sulfation rates, but it can be observed that initially high rates rapidly drop. Slope at which the rate drops becomes less steep as the local temperatures become lower, but after passing certain temperature zones, even though the reaction rate is almost unaffected by the sintering, the sulfation rate become low due to both low SO 2 concentrations and temperatures.

- Such a detailed numerical analysis under simulated furnace conditions can help to broaden the understanding of the processes the particles undergo, and can help in development and organization of experimental research and measurements, pointing out the potential problems in process organization, and giving the general idea about what kind of behavior should be expected from the boiler if modifications for FSI are introduced.





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