**Case Study**

# ANSYS + Steel Authority of India Limited

*ANSYS Fluent has reduced our cost per ton of steel by reducing refractory consumption in ladles.*

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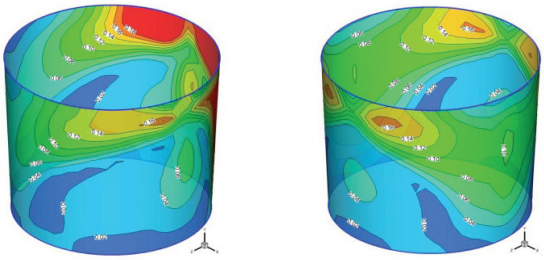
# Analysis of flow-induced shear stress helps improve the lining life of steel ladles



The high level of shear stress on the original ladle (red region on the left) indicates localized regions of high shear stress which lead to very high refractory erosion. Because there is less variation in shear stress in the improved ladle (right), the lining life could be significantly increased.

During secondary refining, steel production requires the use of ladles with refractory linings to hold the molten metal for casting, temperature control, deoxidation, addition of alloys and inclusion floatation. The metal is stirred by purging gases through porous blocks (plugs) in the bottom of the ladle to enhance the reaction rate and homogenize the melt. The flow generated by the rising gases creates a flow-induced shear stress on the refractory lining on the ladle walls. An uneven distribution of flow can cause higher refractory wear (consumption) in certain locations. This wear lowers the lining life of the vessel incurring replacement costs and loss of valuable production time.

## Challenges

Redesigning the porous plugs location as well as optimization of the injected gas flow rates can enhance the reaction rate and evenly distribute the flow-induced shear. Engineering simulation can predict the profile of the wall shear stress to improve the ladle and avoid wear.

## Technology Used

ANSYS® Fluent®

## Engineering Solution

- The coupled discrete phase model (DPM) with standard k-ε turbulence in ANSYS Fluent software was used to simulate the fluid flow in the ladle.
- An unsteady-state species transport model was used to generate the resident time distribution of the ladle.
- The contour profile of wall shear stress on the ladle wall provided a reasonable representation of the refractory wear profile so that the ladle configuration and gas flow rates could be altered to reduce wear.

## Benefits

- An interactive user interface in ANSYS Fluent aided speedy analysis setup and subsequent post-processing.
- The adaptive meshing technique in Fluent added finer mesh where needed to help maintain a smaller overall smaller problem size.
- The average velocity in the vessel could be monitored during the solution to check convergence.
- The software provided the simulation accuracy necessary to understand shear stress and thus refractory erosion on the ladle walls.
- Use of ANSYS CFD software reduced the wear costs and amount of downtime and therefore decreased the refractory cost per ton of steel produced, an important metric in the steel industry.

## Company Description

Steel Authority of India Limited (SAIL) is the leading steel-making company in India. The company is a fully integrated iron and steel maker, producing both basic and special steels for domestic construction, engineering, power, railway, automotive and defence industries and for sale in export markets. The company has the distinction of being India's second largest producer of iron ore and of having the country's second largest mines network. This gives SAIL a competitive edge in terms of captive availability of iron ore, limestone, and dolomite which are required for steel making.

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