

# “Development of High Productivity Process of Ultra-High-Cleanliness Bearing Steel”

## Background of the development

Bearing steel is the material to make bearings for all moving objects, such as automobiles, and Shinkansen bullet trains. Since bearings are used under severe conditions for a long time, bearing steel is required to have high reliability. Specifically, it is necessary to improve the cleanliness of the steel by minimizing the number and size of non-metallic inclusions, which become starting points of fatigue fracture. While it is very difficult to increase productivity with high quality of steel, it is necessary to realize both goals in order for user industries to continuously improve their product quality as well as marketability.

## Points of the development

In the bearing steel manufacturing process, although it is common to secure quality by reducing impurities to the utmost, Sanyo Special Steel utilized sulfur, which possesses a surface-active effect, for the optimization of the refining operation to promote non-metallic inclusions floatation.

In addition, thorough review of the whole process was carried out, such as minimizing residual iron oxides in ladle (molten steel container) which supply oxygen to molten steel and generate non-metallic inclusions at the final stage of the refining operation, blocking entry of oxides into the vacuumed tank at the degassing process, etc., and extremely small number and size

of non-metallic inclusions in molten steel were achieved.

As a result, we have succeeded in producing molten steel with extremely high cleanliness, and preventing the submerged entry nozzle (SEN, through which molten steel is poured into the casting mold) from clogging which is caused by the oxides piled up at its inner surface during casting. Although the outer surface of the SEN melts at the meniscus position (the position of the molten steel surface in the casting mold) during the casting process, more

sequential heats of casting was achieved by controlling the damaged position of SEN and extending the life of SEN. In addition, we run a large cross-sectional vertical bloom caster, which can make slightly stayed-over inclusions in molten steel harmless.

**Extreme reduction of the number and size of non-metallic inclusions in molten steel**



**Thorough prevention of contamination and re-oxidation of molten steel**



**Secure tradition of technology and skills over many years**

**Fulfillment of quality improvement/stabilization and high productivity**

## Accomplishment of the development

Through these comprehensive technological developments, we made it possible to achieve 100 continuous casting heats with no tundish or SEN exchange in the melting-refining-casting process of Ultra-High-Cleanliness bearing steel.

Multi-continuous casting operation greatly contributes to higher production yields as well as increasing efficiency, and the development of this technology has led to extremely large productivity improvements.