

## HOW THE STEELMAKING PROCESS AFFECTS STEEL CLEANLINESS AND BOOSTS RELATED APPLICATION PERFORMANCE



### ABSTRACT

The presence of oxide inclusions in steel has a significant impact on fatigue performance of load-bearing components manufactured from that steel. To understand how cleaner steel can create better products, it is important to establish some understanding of the connection between:

- 1 The steelmaking practice
- 2 The resultant oxide inclusion distribution
- 3 The corresponding effect on fatigue performance

### OBJECTIVES

#### Project Objective 1

##### Given that:

- Large oxide stringers have most frequently been found to cause inclusion-related rolling contact fatigue damage in tapered roller bearings.
- Today's clean steels have lower concentrations of oxide stringers.
- Variations remain in the stringer content between "clean" steel sources.

##### Objective:

- Use the appropriate steel cleanliness measurement tool to determine the effect of steel processing on the macroinclusion population.

#### Project Objective 2

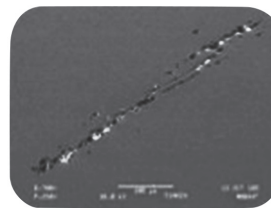
##### Given that:

- While not usually associated with rolling contact fatigue damage in bearings, microinclusions have been found to cause component damage in other applications experiencing other fatigue-loading modes.
- The variation in the microinclusion population in various steel sources is not well understood.

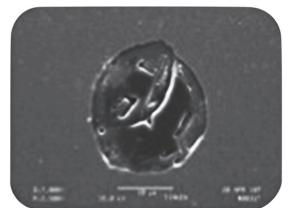
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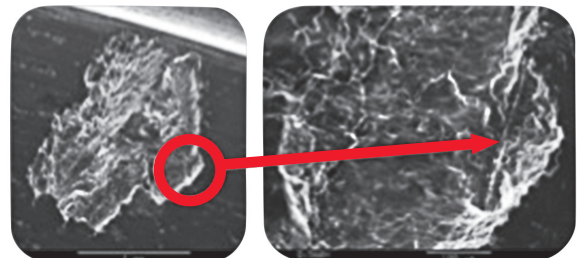
MACROINCLUSIONS



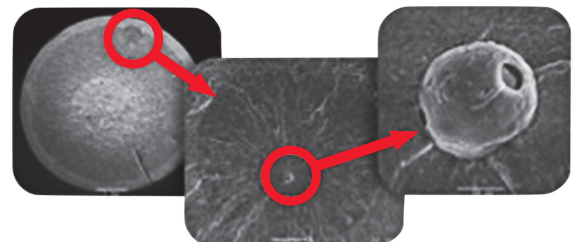
MICROINCLUSIONS



MACROINCLUSIONS



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## RESULTS

### Effect of Steelmaking Process on Macrocleanliness

The Metallus ultrasonic test provided:

- Large inspection volume
- Strong correlation with bearing life

Using the information provided by ultrasonic testing, we implemented process improvements that ultimately produce air melt steels with extremely low concentrations of performance-damaging oxide stringers.

### Effect of Steelmaking Process on Microcleanliness

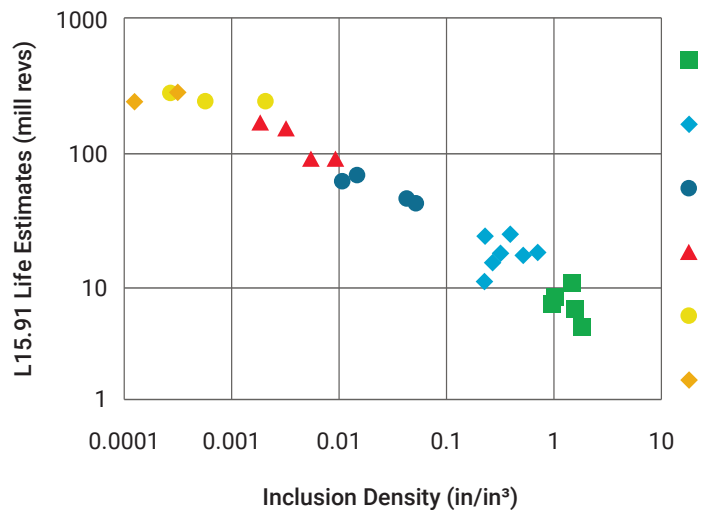
We employed recent steel cleanliness measurement technologies to help make significant reductions in the size of the microinclusion population.

Improvements to air melt 52100 have approached VAR and VIM VAR levels of cleanliness.

## CONCLUSIONS

- Steelmaking process selection has a significant influence on inclusion population.
- Traditional cleanliness evaluation techniques do not adequately measure or screen steel quality to predict component life or reduce damage risk.
- Process development based on advanced measurement methods can enhance air-melt steelmaking processes so that they can produce oxide inclusion populations historically only possible from high-cost (remelt) processes.
- Metallus continues to enhance its world-class methods of analyzing and producing air-melt steel. It focuses on improving cleanliness that can increase gear and/or bearing component life.

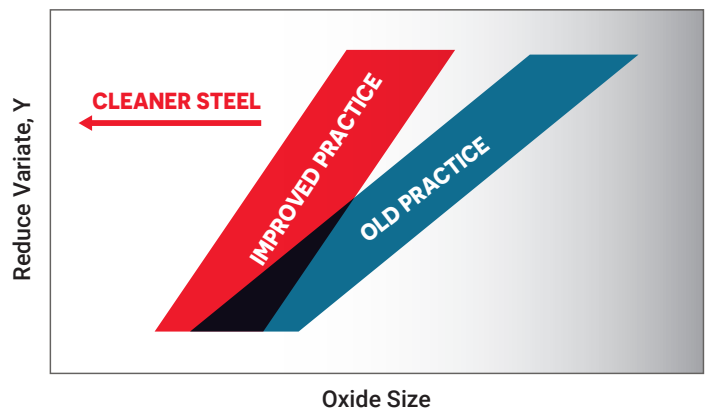
### MACROINCLUSIONS



### MICROINCLUSIONS

#### SEV Analysis Results

Comparison of Improved and Standard Practices



## ANSWERING CUSTOMERS' TOUGHEST CHALLENGES

We customize every product and service we deliver to meet customers' specific needs. Our focus is on improving performance by addressing the toughest challenges, whether that requires a special bar quality (SBQ) steel bar or seamless mechanical tube, a value-added component, honing, drilling or thermal-treatment services or a supply chain solution.

Our engineers are experts in materials, processing and applications, so we can work closely with each customer to deliver flexible solutions related to our products as well as their applications and supply chains. We believe few others in our industry can consistently deliver this kind of breadth, customization and responsiveness.

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