



INDUSTRIAL TECHNOLOGIES PROGRAM

Improving the System Life of Basic Oxygen and Electric Arc Furnace Hoods, Roofs, and Side Vents

New Alloy Slashes Maintenance Downtime and Costs While Increasing Productivity and Revenues

A high-performance aluminum bronze alloy offers unprecedented lifetime improvements in basic oxygen furnace (BOF) and electric arc furnace (EAF) components such as hoods, roofs, and side vents. A cooperative effort between Energy Industries of Ohio, Oak Ridge National Laboratory, Republic Engineered Products, and other Ohio steel manufacturers identified a newly developed aluminum bronze alloy, AmeriBronze®, supplied by AmeriFab, Inc., as a material that can stand up to the harsh steelmaking environment.

Steelmaking generates large amounts of heat, dust, and waste gases in BOFs and EAFs. Furnace hoods, roofs, and sidewall systems are water-cooled components that enable the effluent gases (>3,000°F) to be properly cooled and processed prior to being discharged. In addition to extreme temperatures and corrosive conditions, these components are also subjected to physical erosion caused by slag particulates from the steelmaking process and damage from slag accumulation. This

aggressive environment erodes and corrodes conventional carbon steel furnace components, which necessitates frequent maintenance that wastes energy, reduces productivity, and increases operating costs.

The AmeriFab alloy was initially used to create a BOF skirt at Republic. Republic's BOF uses a skirt system to collect and treat gases discharged from steelmaking operations. As of mid-2007, the aluminum bronze skirt has processed approximately 6,000 batches, or "heats", of steel without requiring process-related maintenance. A traditional carbon steel skirt typically requires maintenance after only 80 heats. The success of the aluminum bronze installation won the 2006 Ohio Governor's Award for Excellence in Energy Efficiency and has led Republic to install a second aluminum bronze skirt and two flux chutes fabricated with the alloy. The company is currently redesigning the entire lower portion of their hood system to accommodate the expanded use of the aluminum bronze alloy.



Photos of aluminum bronze skirt prior to installation (left) and after 4,563 heats (right). As of June 2007, the skirt has processed about 6,000 heats without requiring process-related maintenance, compared with traditional skirts that typically require some maintenance after only 80 heats.



Benefits for Our Industry and Our Nation

- Saves more than 5.3 billion Btu per year in a BOF skirt installation, with an additional 4 billion Btu annual savings projected from installations in other system components
- Host site energy cost savings approximate \$100,000 per year
- Reduces CO₂ emissions by 550 metric tons per year
- Cuts life cycle costs by 20%
- Reduces maintenance costs by 95%
- Eliminates problems associated with slag build-up
- Minimizes equipment shutdowns and subsequent furnace reheating
- Improves furnace productivity
- Increases furnace component lifetime by up to 5 times
- Increases operational safety
- Reduced downtime for maintenance has enabled increased steel production, producing over \$11 million in revenues.

Applications in Our Nation's Industry

The aluminum bronze alloy has been demonstrated successfully in the basic oxygen furnace and has been shown to perform equally well in electric arc furnace applications, even though conditions differ significantly between the two processes.

Project Description

The project objective was to identify alternate materials of construction to extend the service life of tubing used in BOF and EAF hood and roof systems. The major criterion for this selection was a material that was commercially available in tubing form and amenable to fabrication.

Barriers

The technical hurdles overcome by this project were:

- Material compatibility with the exceptionally harsh BOF environment, and
- Commercial availability and ability of material to be fabricated as needed.

Pathways

- Evaluation of candidate material properties by heat transfer, corrosion, and thermal stress modeling
- Full-scale host-site performance evaluation of selected material

The research team determined that a patented aluminum bronze alloy from AmeriFab exhibited superior resistance to thermal stresses and is less reactive. Project partner Republic Engineered Products agreed to install an aluminum bronze skirt at their Lorain Hot Rolled Bar Plant and immediately saw positive results.

Results

- The aluminum bronze skirt was installed in 2004 on Republic's Lorain backup basic oxygen furnace vessel. In initial testing, this vessel ran over 290 heats without requiring a single repair. This was more than a three-fold improvement over carbon steel skirts, which typically last for about 80 heats before needing repairs. Approximately 60% of the heats were for specialty alloys and re-sulfurized steel grades, and the balance was for standard carbon grades.

- Off-gas analyses were conducted on each heat, and the data were combined with periodic infrared imaging to monitor the level of material degradation.
- In August 2005, Republic's Lorain backup vessel with the aluminum bronze skirt was converted into the primary production vessel. As of June 2007, this vessel has run over 6,000 heats without requiring process-related maintenance on the skirt. Oak Ridge National Laboratory estimates the lifetime of the skirt to be five times that of standard carbon steel.
- Researchers found that steelmaking slag does not adhere to the aluminum bronze alloy. This has eliminated all cleaning time, equipment damage, and operational difficulties associated with slag accumulation on the skirt. This was an unanticipated benefit.

Commercialization

The aluminum bronze alloy is currently in commercial use at Republic. The company has already installed a second skirt and two flux chutes made with aluminum bronze. Republic is currently redesigning the entire lower hood portion of their system to accommodate the aluminum bronze alloy.

The current market potential for the aluminum bronze alloy is considered to be large. Energy Industries of Ohio is currently analyzing market dissemination strategies.

BOF and EAF components fabricated from the aluminum bronze alloy AmeriBronze[®], are available from AmeriFab, Inc.

Project Reports

This project was completed in June 2006. The final report is available on the Industrial Technologies Program website: http://www1.eere.energy.gov/industry/steel/completed_rd.html

Project Partners

Energy Industries of Ohio
Republic Technologies, Inc.
AmeriFab, Inc.
ISG Steel, Inc.
Weirton Steel Corp.
The Timken Company
North Star BHP Steel Ltd.
WCI Steel
Babcock & Wilcox
RDI Riggs Distler-IMSI
F.W. Gartner Thermal Spraying Co.
GE Infrastructure, Water & Process Technologies (formerly BetzDearborn)
Wheeling Pittsburgh Steel
AK Steel
Oak Ridge National Laboratory

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



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