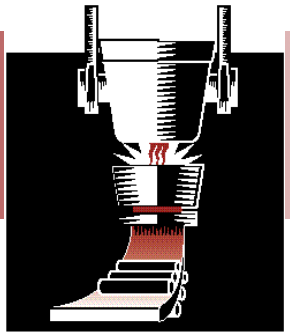
STEEL

Project Fact Sheet



Intermetallic Alloy Development for the Steel Industry

Benefits

- Estimated total energy savings of 32 trillion BTU by year 2010
- Improved productivity and improved environmental benefits from minimization of furnace down-time, continuous-caster down-time, and steel rework
- Improved steel quality by eliminating the marring of plates from blisters on rolls or oxide pickup from the transfer rolls

Applications

- Transfer rolls in steel and austenitizing furnaces
- Transfer rolls in strip annealing furnaces
- Rolls for hot-rolled carbon steel strip
- Slab reheat furnace transfer systems (1100–1250°C)
- Continuous-caster rolls
- Radiant burner tubes

Large energy savings and improvement in productivity and quality of steel can be achieved by use of intermetallic components in steel-manufacturing processes

Large energy savings can be achieved in steel industry by the development and application intermetallic alloys. It is estimated that by 2010 the total energy savings per year will be 32 trillion BTU. Efficiencies result from (a) not having to shut down austenitizing furnaces for frequent grinding of current rolls to remove blisters, (b) not having to shut down continuous casters to grind roll surfaces because of thermal fatigue cracking, (c) not having to replace rolls as frequently in austenitizing furnaces and continuous casters and thus casting significantly fewer rolls, and (d) not having to remelt and process out-of-specification steel plates that were marred by blisters on current rolls in the austenitizing furnaces or continuous-cast systems. Improved productivity can be reached from minimization of furnace down-time. Improved quality is possible by eliminating the chance of scratching the plates. Annealing furnaces in the continuous processing of steel sheet are typically heated by the use of radiant burner tubes. Current tubes fail by creep deformation and oxidation mechanisms. Energy savings in furnaces can be achieved by extending the life and increasing the efficiency of radiant burner tubes.

Ni_3Al rolls in Bethlehem steel

Blister-free Ni_3Al furnace rolls in austenitizing furnaces are operating and being evaluated at Bethlehem Steel.

Project Description

Goal: The goal is to develop intermetallic alloys for use in steel processing and to expand the commercial acceptance of intermetallic alloys for rolls in austenitizing furnaces, annealing furnaces, continuous casters, and radiant burner tube applications.

Issues:

- (1)Testing Ni_3Al alloy IC221M rolls at Bethlehem Steel: 21 of the 101 rolls in this furnace are currently replaced by nickel aluminide (Ni_3Al) alloy IC-221M. (2) Casting process development and evaluation: (a) conduct a production run of long enough duration to eliminate issues related to commercial production, (b) expand use of nickel aluminide rolls into various types of processes, and (c) develop technology enabling fabrication of different roll diameters and lengths. (3) Welding development (dissimilar metal welds): identify weld wire composition, welding parameters, and mechanical properties of the dissimilar metal weldments.

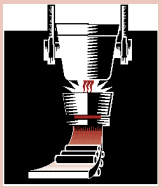
- Higher-temperature intermetallic materials: (1) A new composition of Ni_3Al, IC-438 has been developed and patented to eliminate incipient liquid melting and to increase the use temperature of nickel aluminide by 100°C to 1200°C. Casting trials and machining of IC 438 will be determined, and installation and evaluation of components (including rolls in steel plants) will commence.

- FeAl-based lower-use temperature components: Explore use of FeAl-based alloy for roll-out table applications for transferring hot-rolled carbon steel strip. The specific purpose of using FeAl-based rolls is to minimize pickup of iron oxide, an issue with currently used rolls. Developments include (1) castability, (2) properties, (3) machining, and (4) weldability.

- Radiant burner tubes: This application will utilize the higher strength and the high oxidation resistance and carburization resistance of nickel aluminide alloys as opposed to currently used HU alloys. Activities include (1) controlled testing of radiant burner tubes, (2) in-plant testing of radiant burner tubes, and (3) evaluation of materials.

Progress and Milestones

- Twenty-one rolls of nickel aluminide are under test at Bethlehem Steel, and development of rolls to expand test bed is continuing
- Physical and mechanical properties data of higher-temperature alloy IC-438 have been developed for experimental-size heats
- U.S. Steel and North Star Steel have been contacted for trials of larger-size rolls of nickel aluminide IC-221M and standard size rolls of IC-438
- Radiant tubes being developed and tested in commercial furnaces has begun



Project Partners

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North Star Steel, Toledo, OH

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February 1999