

## Secondary Refining

For purposes of this article, **Secondary Refining** or **Secondary Metallurgy** is defined as any post steelmaking process performed at a separate station prior to casting and hot metal desulfurization. It does not include normal alloying practice in the furnace or at the ladle during tapping. This definition is not universally applied and many include operations at the tundish, electromagnetic stirring in the mold, etc.

The purposes of secondary refining are many: temperature homogenization or adjustment; chemical adjustments for carbon, sulfur, phosphorus, oxygen and precise alloying; inclusion control; degassing, and others.

The equipment and processes are equally varied. Secondary Refining processes are performed at atmospheric pressure or under a vacuum, with or without heating, solids and/or gas injection, and stirring. Fully nine different vacuum processes are sold for carbon steels alone.

### Description and Operation of a Ladle Furnace

By James C. Simmons, Sr. Vice President Meltshop Division, Techint Technologies Inc.

A Ladle Furnace is used to relieve the primary melter of most secondary refining operations, and its primary functions are:

- Reheating of liquid steel through electric power conducted by graphite electrodes
- Homogenization of steel temperature and chemistry through inert gas stirring
- Formation of a slag layer that protects refractory from arc damage, concentrates and transfers heat to the liquid steel, trap inclusions and metal oxides, and provide the means for desulphurization.

Secondary functions that can be included with a ladle furnace are:

- Alloy additions to provide bulk or trim chemical control
- Cored wire addition for trimming or morphology control
- Provide a means for deep desulphurization
- Provide a means for dephosphorization
- Act as a buffer for down stream steelmaking equipment

The function of the porous plug is to provide gas stirring of the molten metal to promote homogenization. Normal stirring operations are performed by percolating argon gas through a purge plug arrangement in the bottom of the ladle. A top lance mechanism serves as a back up means for bath stirring in the event the plug circuit in the ladle is temporarily inoperable. The gas supply connection to the ladle is automatically made when the ladle is placed on the transfer car.

Fumes and particulates generated during heating and alloying operations at the LF will exit the water-cooled ladle roof through the various openings in the roof. These

emissions will be captured (i.e. entrained) in ambient air drawn into a lateral draft type fume collection hood mounted on supporting structures above the ladle roof.

The ladle roof is typically a water-cooled design with a refractory center or delta section and is configured to coordinate with existing ladles such that the roof will completely cover the top portion of the ladle when in the operating (i.e. fully lowered) position.



*Ladle Metallurgy Furnace*

### **Description and Operation of a Vacuum Tank Degasser (VTD)**

By James C. Simmons, Sr. Vice President Meltshop Division, Techint Technologies Inc.

A Vacuum Tank Degasser (“VTD”) is used to reduce the concentrations of dissolved gases ( $H_2$ ,  $N_2$ ,  $O_2$ ) in the liquid steel; Homogenize the liquid steel composition and bath temperature; remove oxide inclusion materials from the liquid steel; and, provide the means and technical conditions that are favorable for final desulfurization.

The fundamental requirements for the ladle degassing process include:

- Sufficient freeboard in the ladle to contain the vacuum-induced slag and steel boil;
- An inert gas percolating through the steel bath for stirring, inclusion separation, and enhancement of vacuum degassing performance;
- Sufficient superheat in the steel to avoid skull formation; and,
- Means to deliver additives while the ladle is inside the vacuum tank.



*Vacuum Degasser*

During operations at the VTD, the liquid steel is stirred to promote homogenization by percolating argon gas through a single refractory stir plug arrangement in the bottom of the ladle. The argon connection to the ladle is established when the ladle is set in place inside the vacuum tank.

The vacuum tank is evacuated to the required operating pressures by one of three ways: steam jet ejector, steam jet ejectors and a water ring pump, or, mechanical pumps. Emissions are evacuated through a vacuum pumping system and are collected prior to the pumps or they are discharged under water contained within a weir wall-equipped concrete hotwell. The process gases, including those entrained in the intercondenser discharge water, are exhausted from the hotwell via a motor driven fan to a vent stack equipped with a flare burner. Hotwell water is pumped to a cooling tower of the contact water system.