



Improving Quality and Productivity with AOD



Invented in 1954, Linde's proprietary argon oxygen decarburization (AOD) process was first used exclusively for stainless steel production; now it is used to produce military grade steels, tool steels, carbon and low-alloy steels, nickel grades, cobalt grades, and superalloys.

The Process

AOD is part of a duplex process in which scrap or virgin raw materials are melted in an electric arc furnace (EAF) or induction furnace and subsequently decarburized and refined in a special AOD vessel. Controlled injection of oxygen mixed with argon or nitrogen decarburizes the molten metal with a minimum of unwanted metallic oxidation.

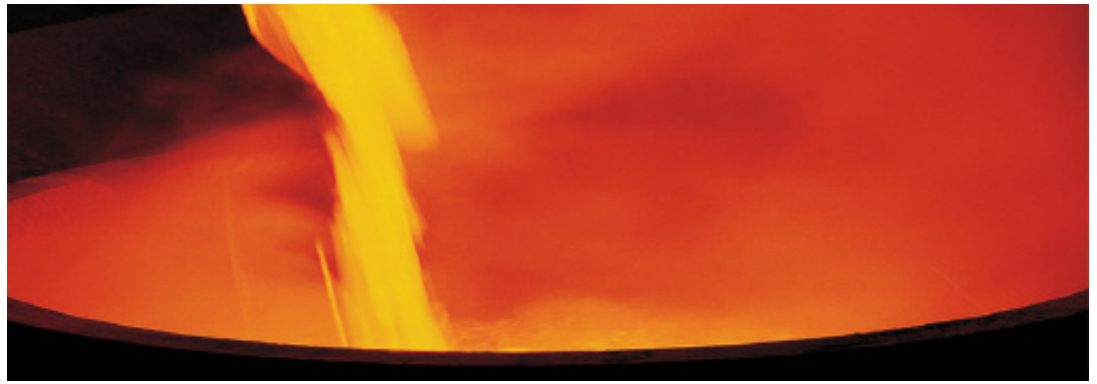
Deoxidation, desulfurization, dephosphorization (for low-alloy steels), and recovery of desirable metals from the slag are carried out in the AOD vessel. Degassing, homogenization and inclusion flotation proceed during various stages of the process to produce a clean and uniform product.

Linde's AOD process uses a trunnion-mounted, open-mouthed vessel lined with refractory brick. Oxygen and an inert gas (argon or nitrogen) are injected through underbath tuyeres located in the vessel's side wall and a top lance. Heat generation results from controlled oxidation of the bath components, so no external heat source is used or required.

The molten metal is initially blown with a high ratio of oxygen-to-inert gas. As the carbon content of the bath decreases, the oxygen-to-inert gas ratio is lowered. Dilution of the oxygen by the inert gas lowers the partial pressure of carbon monoxide in the bubbles within the bath, which favors carbon removal. As a result, carbon removal increases while metallic oxidation diminishes.

The Benefits Versus Baseline

- High-metallic yields
- Considerably lower material cost due to the ability to use less expensive high-carbon ferro alloys, sulfur-bearing scrap and alloys, low-quality scrap, and returns as raw materials
- Pinpoint process control accuracy in achieving desired aim chemistries, with precise control of carbon to 0.01 percent and lower
- Rapid desulfurization to less than 0.001 percent
- Lead removal to less than 0.001 percent
- Cleaner metal, with residual oxygen, nitrogen, and hydrogen comparable to those achieved in vacuum degassing
- Increased productivity capacity from a relatively small capital investment



The Process (con't)

All of the tuyere-injected oxygen reacts with the bath; none leaves the vessel unreacted. By monitoring and recording the oxygen consumption during the blow, very close control of endpoint carbon is achieved.

Because the bulk of oxygen and inert gases in the later stages of decarb and finishing are introduced below the bath surface and at high velocity, excellent bath mixing and intimate slag-metal contact occur.

As a result, the rates of all chemical processes that take place within the vessel are greatly improved. These include:

- Desulfurization to very low levels (under 0.001 percent), generally in less than five minutes
- Increased carbon removal efficiency, allowing lower carbon specifications without excessive metallic oxidation
- Efficient slag reduction, with stoichiometric amounts of silicon or aluminum to recover 98 to 100 percent of most metallics

A major benefit of the process is the degassing effect of the combination of the inert gas introduced through the tuyeres and the carbon monoxide generated during decarburization. Low amounts of residual oxygen, nitrogen and hydrogen are achieved without additional processing or expensive degassing equipment.

Linde's AOD system includes one or more unlined vessels, trunnion ring and drive system, top lance, sampling platform and a complete auto/manual gas control system. Systems can be sized to meet nearly every need.

The AOD vessels that are currently in operation worldwide have heat sizes ranging from one to 160 metric tons (one to 175 tons).

In addition to the equipment supplied as part of the AOD system, the foundry or mill needs a crane of proper capacity to lift an empty, fully-lined vessel, a fume control system and facilities for supplying gas and gas and power requirements.

Linde – For Better Metals Production

Our AOD technology is just one example of how Linde's dedicated team of engineers is working full time to provide our customers with the most advanced industrial gas supply and application technologies. This team is constantly working on new ways to discover how metals producers can use industrial gases to:

- Increase productivity
- Reduce costs
- Improve quality

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