



Industrial gases and
cost-effective technologies for
the iron and steel industry
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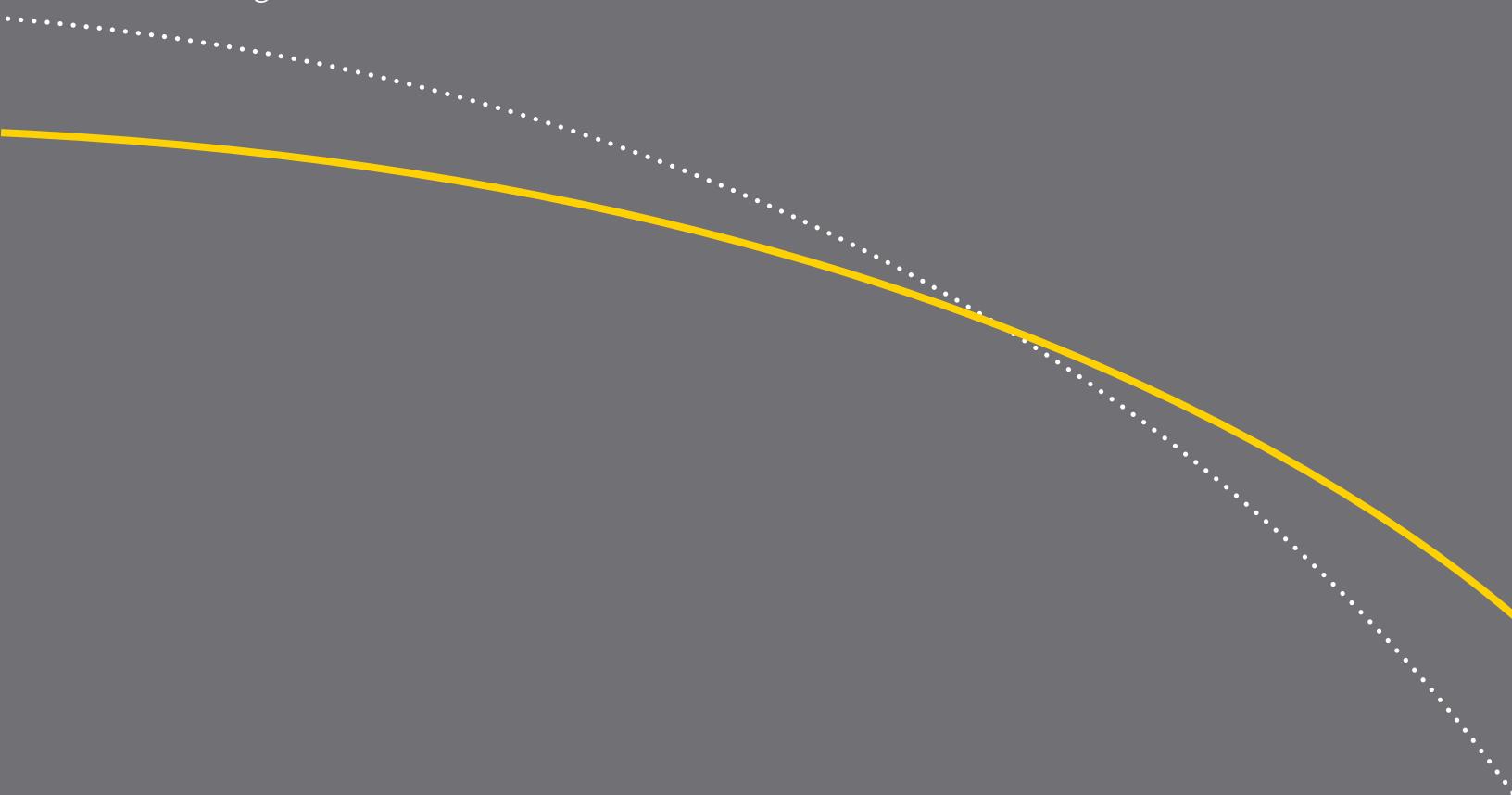


Industrial gases and cost-effective technologies for the iron and steel industry

Experience.

When it comes to delivering reliable gas supply and cost-effective technologies for your plant, Air Products has the experience to help you be more successful.

In 1951, we pioneered the on-site gas supply concept for the steel industry. Today, our comprehensive range of industrial gases and cost-effective technologies can help you save money throughout your operations. Working side-by-side with iron and steel manufacturers, we have developed in-depth knowledge and understanding of every step involved in iron- and steelmaking, from the melt shop to the rolling mill. This experience allows us to provide you with the optimal supply mode to meet your needs, as well as novel technologies in the areas of combustion, gas injection, shrouding/inerting, heat treating, and fabrication.



Working with you

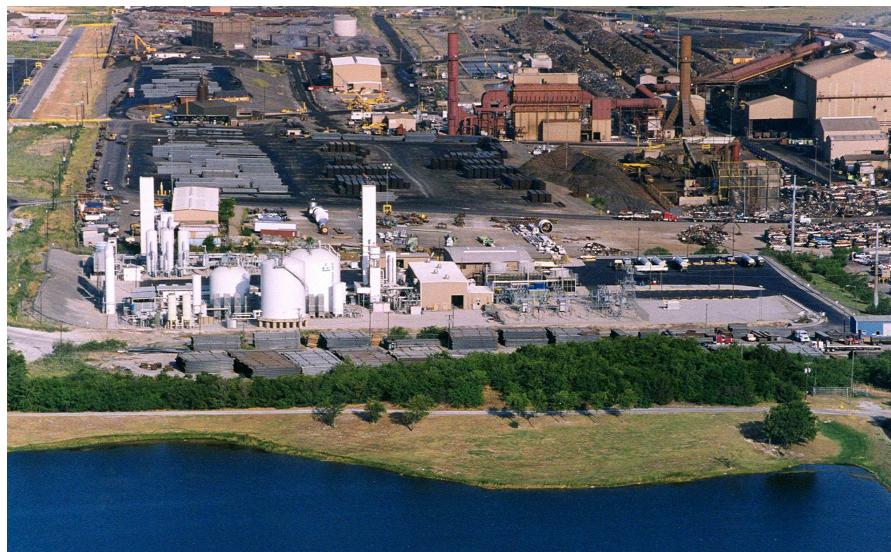
Air Products offers state-of-the art modes of supply for industrial gases including oxygen, nitrogen, argon and hydrogen. However, what sets us apart is our technical knowledge and experience. Working with you to understand your current and future needs, we can develop and implement the best technical solutions to your production challenges.

Reliable, cost-efficient gas supply

Air Products understands the critical nature of industrial gas supply in iron- and steelmaking. We pride ourselves on having a strong history of providing the most cost-effective supply option based on our customers' needs. Whether our gases are delivered by truck and stored on your site or supplied by an on-site plant, we are focused on providing you with the products you need, at the right time and right specification. And if requirements change, we are poised to respond quickly so that your needs are met.

Depending on your gas supply needs, we can deliver bulk quantities of nitrogen, oxygen, argon, and hydrogen from over 90 production facilities worldwide. Our teams work around the clock to maintain an outstanding global reliability record of over 99.9%—supplying product on time at the flow, purity and pressure our customers specify. Plus, our Customer Service Centers are available 24/7 to help with gas and equipment service needs.

When your gas requirements are fairly continuous and steady, on-site gas generation can be an economical mode of supply. Our on-site gas generation options include both non-cryogenic and cryogenic supply systems. Plants requiring small-to



mid-sized volumes can benefit from noncryogenic on-site pressure swing or vacuum swing adsorption systems for either nitrogen or oxygen supply. As the gas requirements move into the cryogenic plant range we can supply oxygen and nitrogen and in some cases argon from a single plant. We also offer a range of modular on-site gas generators to supply hydrogen for downstream metals applications such as annealing. Our experienced technology teams will work closely with you to provide the gas generation solution that meets your needs.

For many of our steel customers requiring larger gas volumes, an on-site air separation plant is the most practical mode of supply. Air Products has the technology, experience, and resources necessary to design, engineer, construct, and operate a cost-effective on-site cryogenic gas supply system to meet your specific requirements. We currently own and operate over 800 air separation plants in over 40 countries worldwide and we have sold, designed, and built more than 2200 air separation plants globally. Our cryogenic offerings span plant sizes producing 50 tons per day of oxygen up to single-train facilities with oxygen production capacities above 4,000 tons per day. Plus, with

our vast operating experience, we offer plant assessments to help our customers optimize their gas supply.

Gas technologies to improve performance

Air Products researchers and technologists continually strive for advancements in the application and efficient use of our gases. We conduct specialized research focused on the most efficient and economical use of our gases in your processes to help you to achieve your energy, quality, environmental, and operating cost goals.

Our gas-based technologies can help you achieve higher performance levels and lower your costs versus conventional technologies. Here are some examples of the benefits you could realize:

- Production increases up to 25%
- Fuel savings up to 75%
- Power cost reductions of 20–35%
- Off-gas volume reductions of 70–90%
- CO₂ and NO_x emission reductions
- Significant improvements in yield and product quality

Gases and support that can give you a competitive edge

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“Reliable supply is critical to us—a run out costs us a lot of money. Having Air Products in close proximity with 24/7 coverage is a real help.”

—Purchasing Supervisor

“The more we work with Air Products, the more it pushes us to collaborate further with them. Their knowledge and its application to problem solving appear to be unsurpassed.”

—Heat Treatment Engineer

“Anyone can supply molecules. Air Products’ after-sales technical support has been phenomenal. Their engineers have done a lot to help us optimize our oxygen gas.”

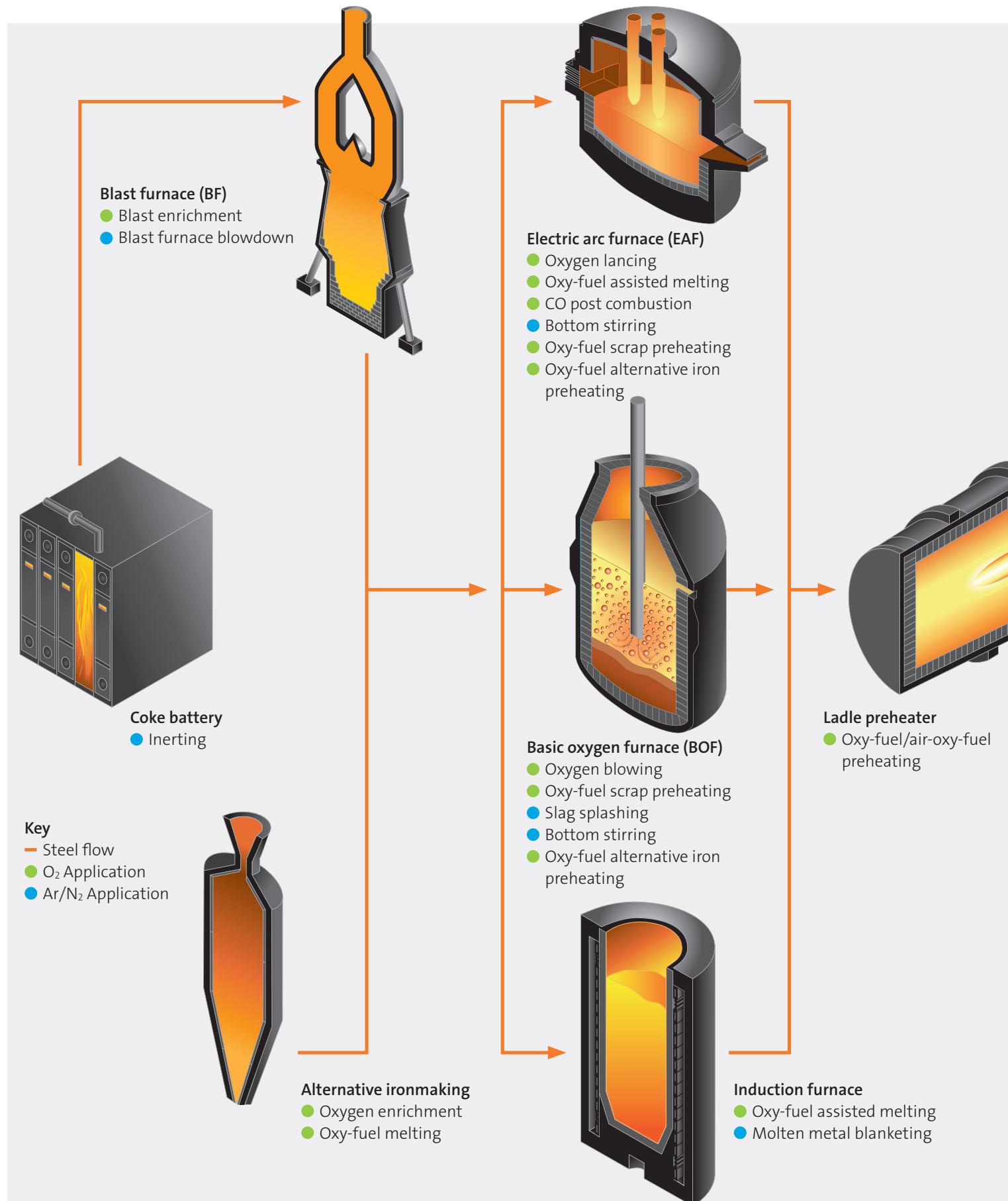
—Plant Engineer

“Air Products was very thorough in showing us how to safely use the equipment and maintain it. I’d have to give them an A+ in safety training.”

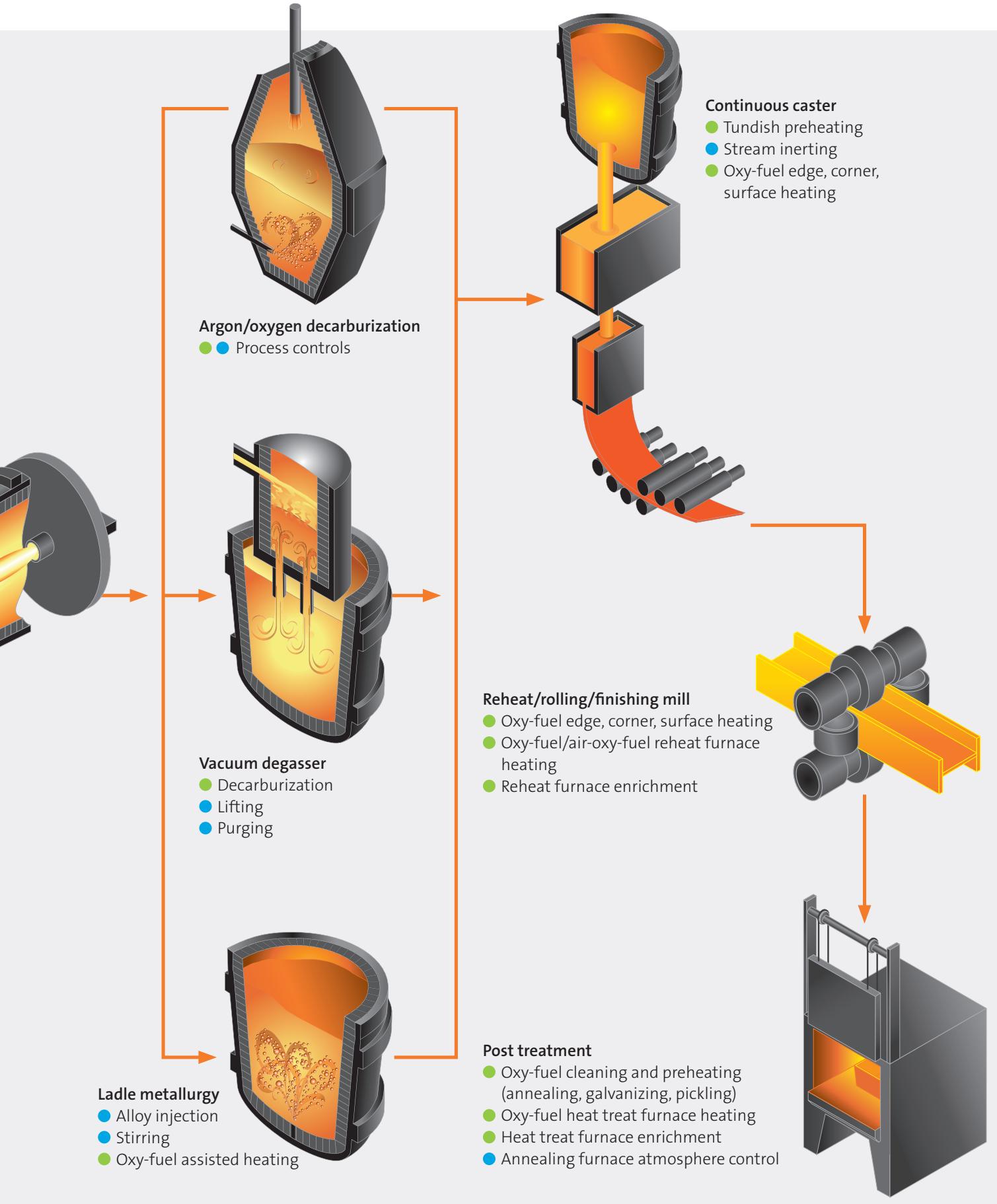
—Operations Manager

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Our experience benefits application of gas technology



Technologies from the hot end to the rolling mill





State-of-the-art instrumentation and process control capabilities enable you to test your application to its full potential in our combustion labs.

Combustion

Our approach to combustion is to understand the requirements of each of your heating and melting processes so that we can employ the proper technique or burner to best perform the job. We employ state-of-the-art computer modeling to test concepts and design technology best suited to meet your demands. As a result, we have a wide range of technologies specifically designed for each application. From blast furnace enrichment to ladle preheating to reheating steel to post combustion, we have the technology to fit your needs.

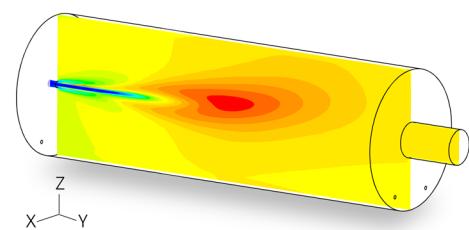
Also, you can quickly assess the performance of your combustion application in a controlled environment at our world-class laboratories located at our headquarters in Allentown, Pennsylvania. Our newest combustion laboratory even features a remote video imaging system that enables real-time participation in testing from remote locations. We invite you to visit us for a demonstration of our unique capabilities.

Gas injection

Many of our gases are critical to the refining and alloying processes in the mill. We work closely with customers so that gases are delivered accurately and at the right pressure to hit chemistry specifications each and every time. Our state-of-the-art flow controls and data acquisition systems can provide critical process data to monitor gas consumption, develop process history, and aid troubleshooting. Additionally, we have expertise in the area of tuyere design to help you minimize refractory erosion and tuyere degradation.

Shrouding/Inerting

In some operations, inert gases such as argon or nitrogen are needed to prevent reactions or oxidation from occurring. We have considerable experience in designing equipment to deliver these gases so they provide the necessary coverage to prevent air or oxygen from reacting with molten/hot metal surfaces and fuels. Gas pressure, flow, and velocity all play a critical role when a surface is being protected or blanketed by an inert gas. Our modeling capabilities help us design cost-effective and reliable shrouding/inerting systems.



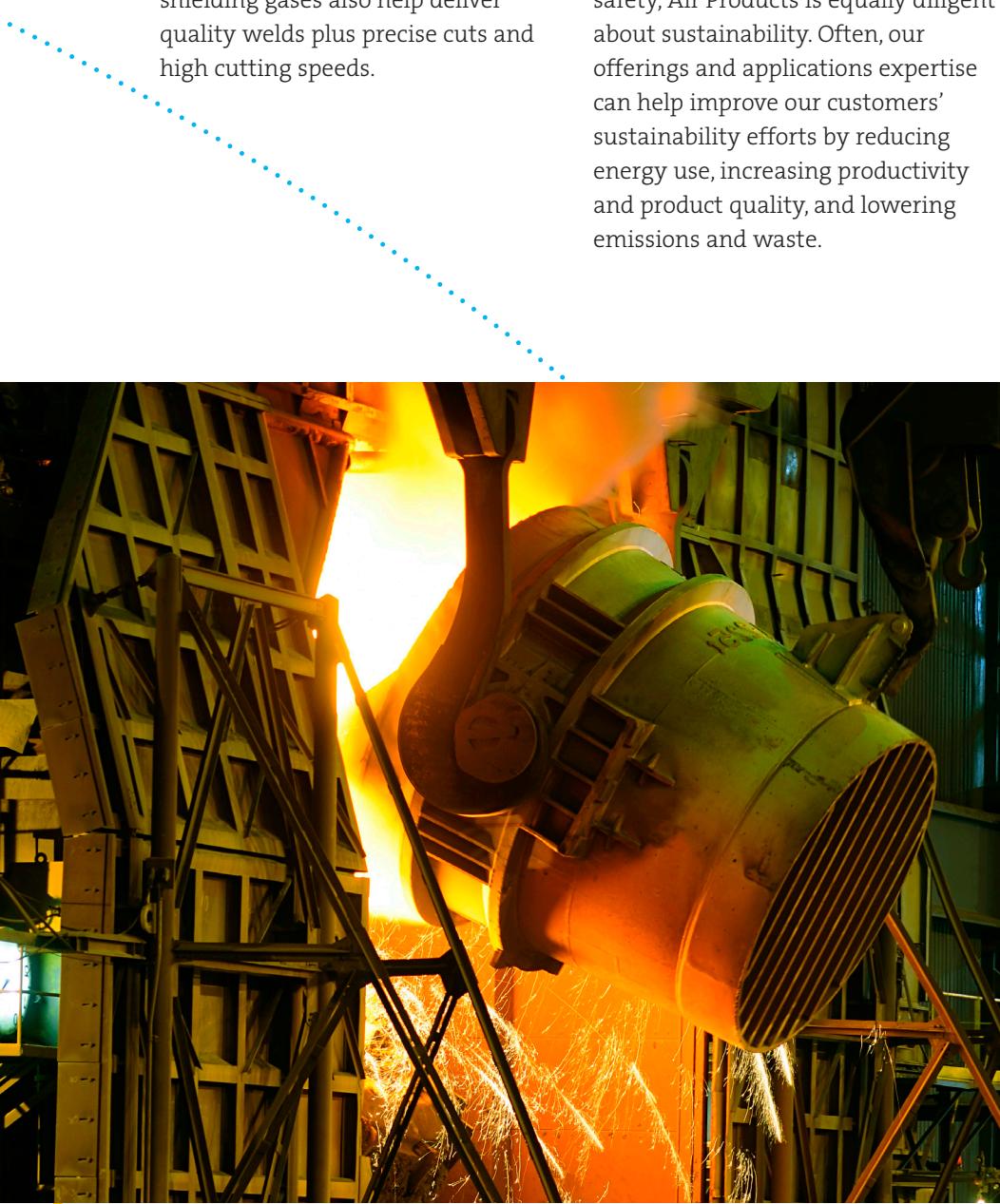
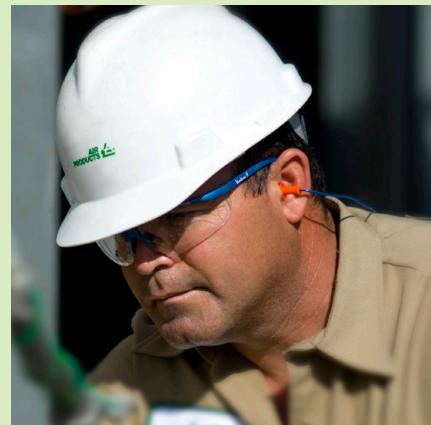
Our advanced computational models can let you see inside your combustion application.

Heat treating and fabrication

Metal processors around the world have come to rely on Air Products' industrial gases, gas atmospheres and technical support to help them improve product quality and increase production, while reducing operating costs. We offer high-purity gases, gas handling equipment and technology, and—most importantly—unmatched industry experience and technical know-how to help you meet stringent quality targets. Our fabrication technologies and related Maxx® shielding gases also help deliver quality welds plus precise cuts and high cutting speeds.

Dedicated to safety and sustainability

At Air Products, nothing is more important than safety—a commitment to total safety is the commitment to doing things right. Air Products has one of the best safety records in the industrial gas and chemical manufacturing industries, and we try to improve each and every year. We hold all of our people accountable for working safely and protecting the safety of our contractors and customers. Complementing our commitment to safety, Air Products is equally diligent about sustainability. Often, our offerings and applications expertise can help improve our customers' sustainability efforts by reducing energy use, increasing productivity and product quality, and lowering emissions and waste.



Benefits of Air Products' offerings:

- Reliable, economical gas supply
- Lower gas consumption and cost through optimization
- Improved safety
- Increased productivity
- Better product quality
- More efficient operations

And all this can lead to lower operating costs versus conventional technologies!

Cost-effective gas technologies to improve performance while lowering overall costs

Air Products provides gases and technologies for all aspects of the iron- and steelmaking process, from raw materials to post treatment.

Process	Application	Technology/offering
Coke battery	• Inerting	• Express nitrogen services (APEX)
Blast furnace	• Blast enrichment: coal injection • Blast enrichment: natural gas injection • Blast furnace blowdown	• Low soot coal injector • Oxygen-enhanced combustion technology • Express nitrogen services (APEX)
Alternative ironmaking	• Oxygen enrichment • Oxy-fuel melting	• Oxygen-enhanced combustion technology • DRI Melting
Electric arc furnace	• Oxygen lancing • Oxy-fuel assisted melting • CO post combustion • Bottom stirring • Oxy-fuel scrap preheating • Oxy-fuel alternative iron preheating	• Oxygen-enhanced combustion technology • High performance oxy-fuel burner • High efficiency post combustion system • Low erosion tuyere design and argon control • High performance oxy-fuel burner • DRI preheating
Basic oxygen furnace	• Oxygen blowing • Oxy-fuel scrap preheating • Slag splashing • Bottom stirring • Oxy-fuel alternative iron preheating	• CFD modeling • High performance oxy-fuel burner • Slag splashing system/nitrogen control • Low erosion tuyere design and argon control • DRI preheating
Induction furnace	• Oxy-fuel assisted melting • Molten metal blanketing	• High performance oxy-fuel burner • Molten metal blanketing system
Ladle preheating	• Oxy-fuel/air-oxy-fuel preheating	• High performance oxy-fuel and air-oxy-fuel burner
Argon/oxygen decarburization	• Process controls	• AOD control system/process monitoring
Vacuum degassing	• Decarburization • Lifting • Purging	• Oxygen injection controls • Argon injection and controls • Argon and nitrogen injection and controls
Ladle metallurgy	• Alloy injection • Stirring • Oxy-fuel assisted heating	• Argon and nitrogen carrier gas and controls • Argon and nitrogen injection and controls • High performance oxy-fuel burner
Continuous caster	• Tundish preheating • Stream inerting • Oxy-fuel edge, corner, surface heating	• High performance oxy-fuel and air-oxy-fuel burner • Argon control and monitoring • Rapid heating oxy-fuel burner
Reheat/rolling/finishing mill	• Oxy-fuel edge, corner, surface heating • Oxy-fuel/air-oxy-fuel reheat furnace heating • Reheat furnace enrichment • Modeling	• Rapid heating oxy-fuel burner • Uniform heating oxy-fuel burner • Oxygen-enhanced combustion technology • CFD modeling
Post treatment	• Oxy-fuel heat treat furnace heating • Heat treat furnace enrichment • Annealing furnace atmosphere control • Oxy-fuel cleaning and preheating (annealing, galvanizing, pickling)	• Uniform heating oxy-fuel and air-oxy-fuel burner • Oxygen-enhanced combustion technology • Annealing gases atmosphere control • Rapid heating oxy-fuel burner



Air Products' solutions and services

As an Air Products customer, you gain access to our team of industry and technology specialists in all fields. We routinely provide our customers a wide range of engineering services and consultation to assist with processes using industrial gases.

- Technical and design experience
- Data acquisition and process monitoring
- Flow control and process equipment
- Commissioning
- Optimization
- Maintenance contracts
- Safety training

For more information

Achieving a competitive edge is critical to your success. Air Products' knowledge and experience can help you achieve that edge through reliable, low-cost gas supply and proven, cost-effective technologies. Contact us today to see how we can help deliver success.

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