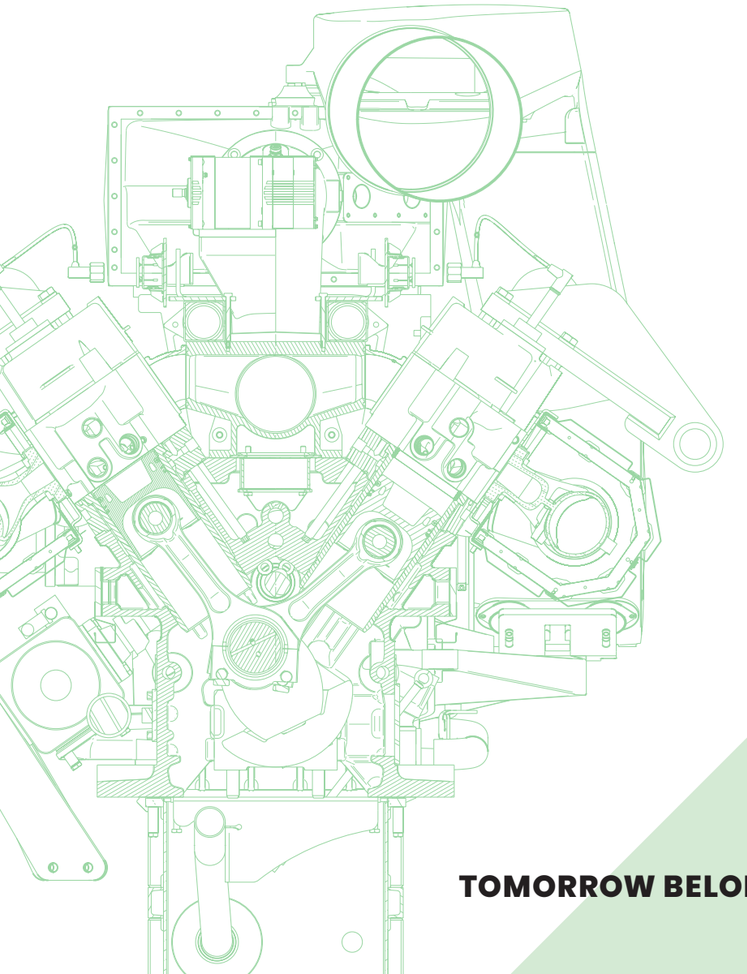
IJB-320007-EN

INNIO* is a leading solutions provider of gas engines, power equipment, a digital platform and related services for power generation and gas compression at or near the point of use. With our Jenbacher* and Waukesha* product brands, INNIO pushes beyond the possible and looks boldly toward tomorrow. Our diverse portfolio of reliable, economical and sustainable industrial gas engines generates 200 kW to 10 MW of power for numerous industries globally. We can provide life cycle support to the more than 50,000 delivered gas engines worldwide. And, backed by our service network in more than 100 countries, INNIO connects with you locally for rapid response to your service needs. Headquartered in Jenbach, Austria, the business also has primary operations in Welland, Ontario, Canada, and Waukesha, Wisconsin, US.

For more information, visit: innio.com

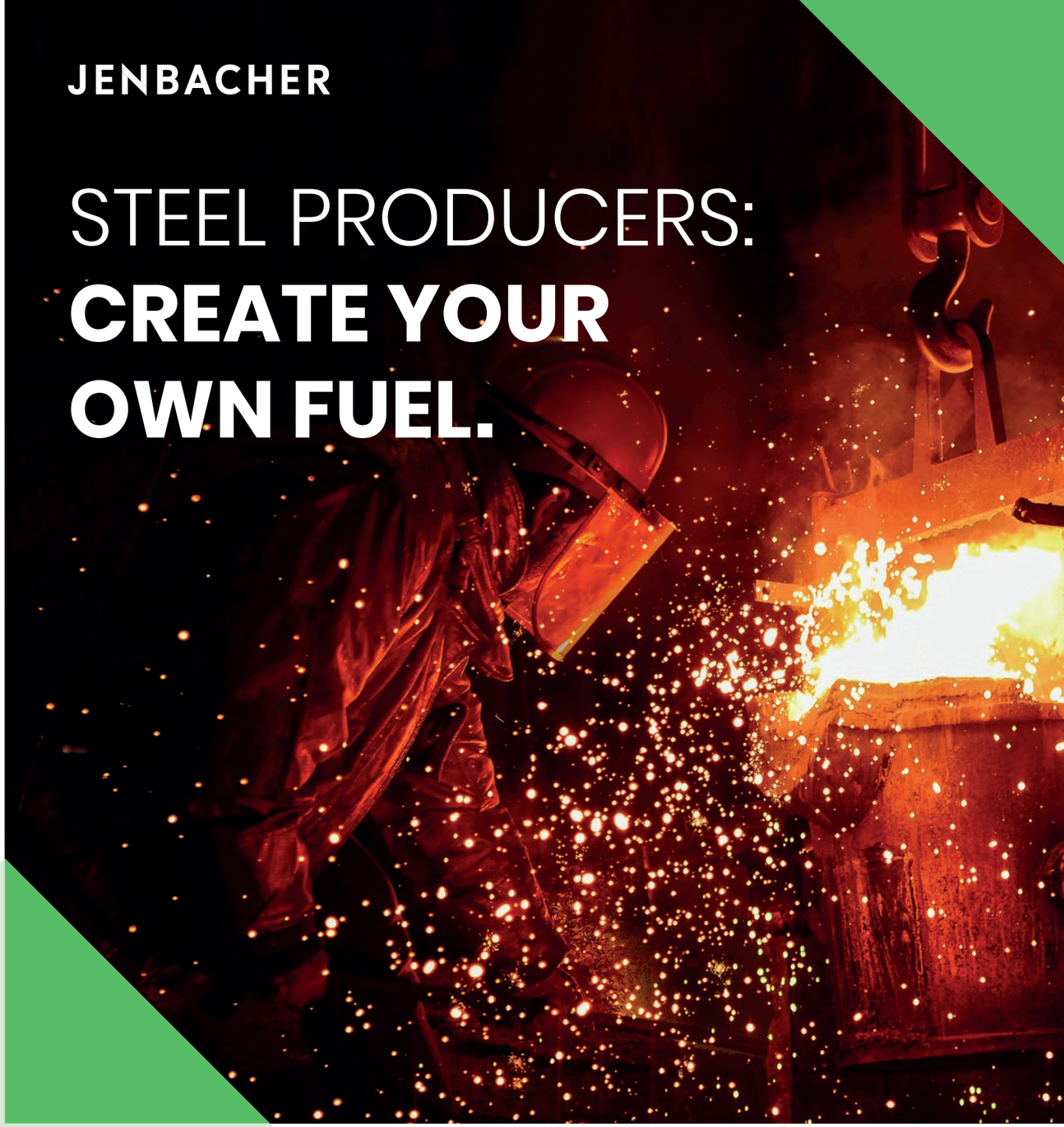
*Indicates a trademark



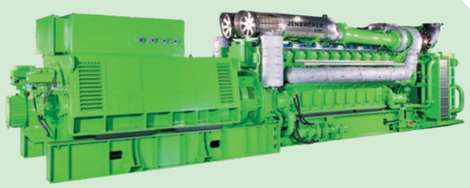
TOMORROW BELONGS TO THE BOLD.

JENBACHER

STEEL PRODUCERS: **CREATE YOUR OWN FUEL.**



Jenbacher J620



Jenbacher gas-to-power solutions from INNIO – your gas engine expert – using ‘free’ gases from steel production processes

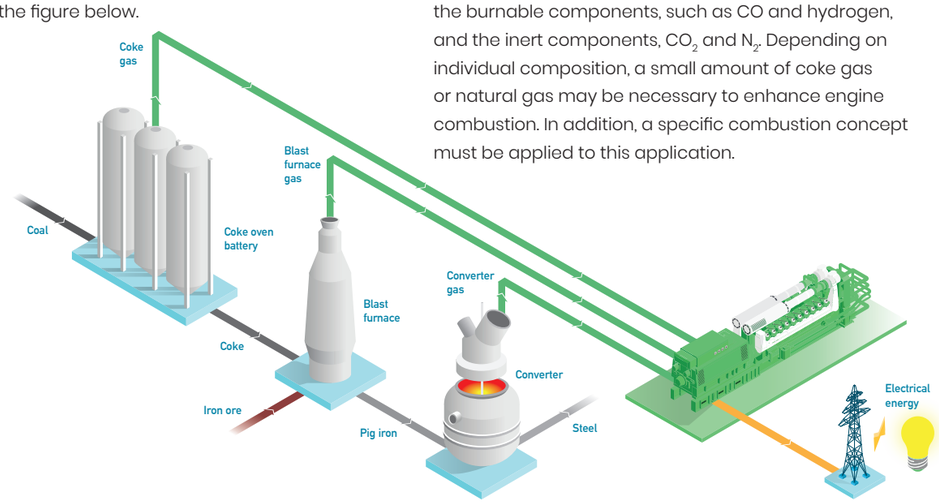
STEEL PRODUCTION BY-PRODUCT NOW AN ECONOMICAL ENERGY SOURCE

PS IT'S BETTER FOR THE ENVIRONMENT, TOO

In the steel industry, you need a lot of power—and energy costs are rising. Fortunately, there's an energy source that is closer than you think: Gases created as a „free" by-product during steel production processes can provide efficient power generation. In addition to the economic benefit, using these gases as engine fuel reduces industrial CO_2 emissions and saves natural energy sources.

DIFFERENT GASES FROM STEEL PRODUCTION PROCESSES

Steel production processes typically create large volumes of specialty gases such as coke gas, blast furnace gas and converter gas. These gases, with different compositions and lower heating values (LHV), are shown in the figure below.



COKE GAS

A by-product of industrial coke production from pit coal, coke gas is created by high-temperature dry distillation of coking coals in the absence of oxygen. The gas mainly consists of hydrogen (50% to 60%), methane (15% to 30%) and a small percentage (10% to 20%) of carbon monoxide, carbon dioxide and nitrogen. With a calorific value of 5 kWh/m^3, coke gas constitutes a high-value fuel for effective power generation with INNIO* Jenbacher* gas engines.

BLAST FURNACE GAS

Presenting a new challenge for gas engines, blast furnace gas (BFG) is a by-product of the iron ore melting process with an extremely low calorific value (LHV ~ 0.7 kWh/Nm^3). BFG offers a challenging ratio between the burnable components, such as CO and hydrogen, and the inert components, CO_2 and N_2. Depending on individual composition, a small amount of coke gas or natural gas may be necessary to enhance engine combustion. In addition, a specific combustion concept must be applied to this application.

CONVERTER GAS (LD-GAS)

Converter gas is created from pig iron during the steel production process. Steel-making technology can be categorized into two different processes: blow molding or open hearth. Within the blow molding process, the pig iron is refined with oxygen or air, lowering the carbon proportion and providing enough process heat to maintain the steel liquid. With 60% of the worldwide raw steel production, the Linz-Donawitz (LD) process, classified as a blow molding process, is the most common production method to generate raw steel. On the other hand, the open hearth process extracts the oxygen of the added scrap and ore, requiring additional heat supply for the steel-making process. One of the most common open hearth processes is the electrical melting process. Converter gas from the LD and electrical melting processes can be used in Jenbacher gas engines. The gas consists of about 65% carbon monoxide, 15% carbon dioxide, 15% nitrogen and small amounts of hydrogen and methane.

THE JENBACHER CONCEPT

Varying compositions, calorific values and the combustion behavior of gases from steel production processes put greater demands on engine design. INNIO Jenbacher gas engines have been specially modified to make efficient use of these gases for combined generation of heat and electricity.

In general, the stable composition of coke gas makes it advantageous as an engine fuel. The high hydrogen content of coke gas, however, means the combustion process is very fast, which increases the danger of engine knocking or backfiring. To avoid this risk, INNIO has created an engine control system that is able to fuel the Jenbacher engine with a very lean mixture and, at the same time, react very quickly to variations in engine load.

Converter gas, with its high carbon monoxide content, has low combustion speed and is very harmful. The Jenbacher engine combustion system allows the gas to be burned efficiently and reliably. Plus, INNIO offers a safety technology package that allows secure handling of harmful gases such as carbon monoxide.

Both gases can be used to create hot water, steam and electricity. The hot water and exhaust gases from the gas engines are fed into boilers. The resulting steam can be used within the steel production processes.

Electricity generated by the Jenbacher engines can either be used onsite or sold to the public grid. Converter gas electrical efficiencies of up to 37% can be achieved, and coke gas efficiencies are even higher.

ADVANTAGES

- Creates an independent power supply
- Reduces energy costs
- Increases predictability and stability
- Provides an efficient and economical combined heat and electricity supply
- Offers high electrical efficiency compared to other power generation technology such as steam or gas turbines
- Suits an electrical output range of a few hundred kW up to 20 to 30 MW
- Requires considerably low gas pressure
- Eliminates a problem gas and harnesses it as an energy source
- Replaces conventional fuels
- Reduces greenhouse gases for environmental benefits

KEY FIGURES

Per ton of produced coke, approximately 470 m^3 of coke gas is produced, 60% of which typically is needed for internal processes. The remaining amount can be used for power generation using Jenbacher gas engines—resulting in about 400 kWh of electrical energy.

A typical blast furnace ranges in size from 0.5 to 5 million tons of pig iron per year. Per 1 million tons of produced pig iron, approximately 20,000 m^3 of blast furnace gas is produced, 50% of which typically is needed for internal processes. The remaining amount can be used for power generation using Jenbacher gas engines—resulting in about 30 MW of electrical power.

Per ton of steel produced through the LD process, approximately 50 m^3 of converter gas is released, which can be burned in Jenbacher gas engines—resulting in about 50 kWh of electrical power.

OUR COMPETENCE

Substantial research has been completed on this application. INNIO installed its first commercial Jenbacher gas engine applications for coke gas in 1995, for LD converter gas in 2004, and for blast furnace gas in 2008.

About 40 Jenbacher gas engines that work on either coke gas, LD converter gas or blast furnace gas have been delivered. Underscoring INNIO's technological expertise, these units reached more than 2 million operating hours. In addition, by using these „free" waste gases instead of natural gas for power generation, the Jenbacher gas engines can save approximately 240 thousand tons of CO_2 per year[1].

[1] Based on natural gas emission factor 0.2 metric tons CO_2/MWh fuel input