

# Integrated Gasification Combined Cycle (IGCC)

Turnkey IGCC facilities operated and maintained by Air Products



Air Products Syngas Solutions™ formerly:

- Shell Coal Gasification Process (SCGP)
- GE Energy's gasification technology

## Air Products Gasification Process (GP) at a glance

### Customer driver

IGCC is an advanced power-generation technology dramatically reducing emissions of harmful criteria pollutants while also improving power-plant efficiency. IGCC combines three technologies:

- **Gasification:** Utilizes coal or refinery residue to create and purify clean-burning synthesis gas (syngas).
- **Syngas cleanup:** Removal of sulfur species is most efficient at this stage rather than after combustion.
- **Combined cycle power generation:** A highly efficient method of producing electricity from syngas. A gas turbine combusts syngas to produce power. Heat is recovered from the turbine exhaust to produce steam, which is sent to a steam turbine for additional power generation.

IGCC results in significantly reduced emissions of the EPA-designated criteria air pollutants  $SO_2$ ,  $NO_x$ , CO and particulates. Levels of these emissions from a state-of-the-art IGCC plant are well below the federal New Source Performance Standards (NSPS) for pulverized coal-fired power plants.

## Case Studies

### Clean power: Taean

South Korea's first IGCC plant, in Taean, was started up in late 2015. This facility uses Air Products high-efficiency gasification and Sulfinol\*-M gas-treating technologies to produce 300 MW (net) of electric power from 2,650 tons per day of sub-bituminous coal. Taean also demonstrates the very low emissions of IGCC for  $SO_x$  (<0.1 ppm),  $NO_x$  (<25 ppm) and dust (<3.5 mg/ $Nm^3$ ).

### Improved efficiency: Vattenfal

This IGCC plant in the Netherlands has been in operation since 1998. Beginning with a coal intake of 585 MWe, it generates a net output of 253 MWe (gas and steam turbine output minus plant consumption) for a net energy efficiency of 43% (LHV).

### Refinery IGCC: Jazan

The Jazan project in Saudi Arabia implements IGCC from refinery residuals converting an un-marketable by-product into power.

\*Sulfinol is a Shell trademark.

## How it works

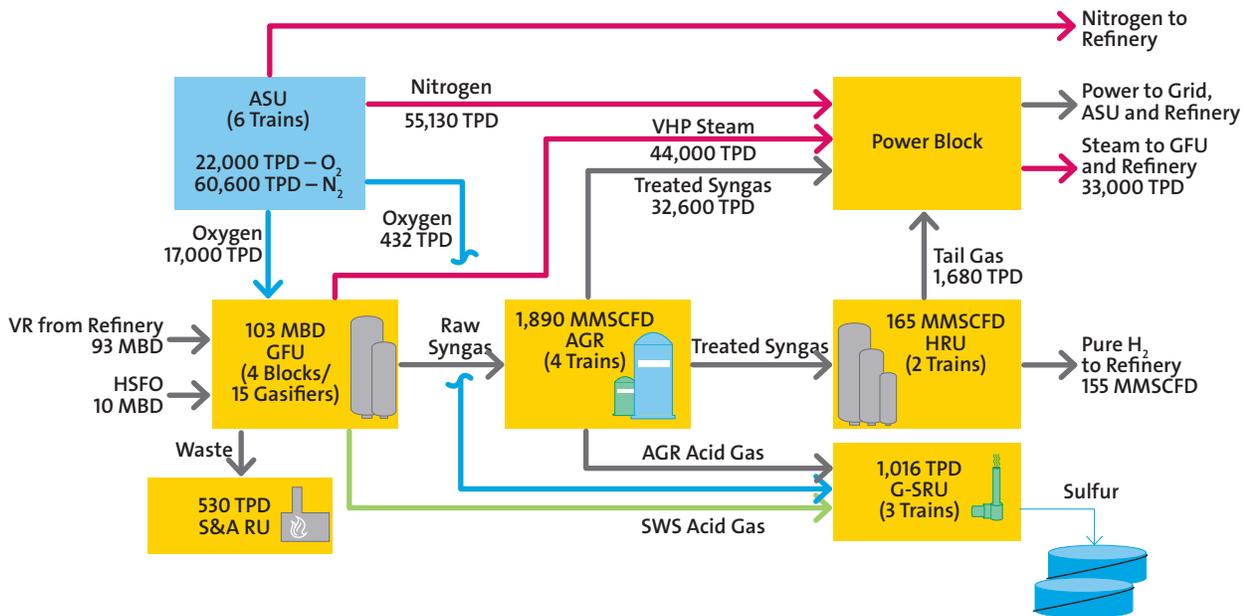
First, coal, petcoke or refinery residual hydrocarbons are gasified by oxygen in a pressurized reactor. The resulting chemical reactions with the feedstock generate syngas, a mixture of carbon and hydrogen ( $\text{CO} + \text{H}_2$ ). The syngas is burned directly in a gas turbine and then the waste heat is converted to steam that drives a second turbine to maximize thermal efficiency.

## The carbon capture option

IGCC plants can also be configured to capture carbon dioxide. After generating raw syngas in the gasifier, the carbon monoxide in the process gas is reacted with water

via the water-gas shift reaction to produce hydrogen and additional carbon dioxide. The carbon dioxide is subsequently removed in an acid gas removal unit to product  $\text{CO}_2$  specifications. The resulting  $\text{CO}_2$  stream is available for enhanced oil recovery and/or long-term sequestration. This means that an IGCC power plant combined with carbon storage technologies can be free of carbon emissions. An example of a zero-emission power and chemical plant combining gasification with  $\text{CO}_2$  capture and storage can be found in Kedzierzyn in Poland ([climatetechwiki.org/technology/igcc](http://climatetechwiki.org/technology/igcc)).

IGCC is an efficient way to make power and has lower emissions compared to pulverized coal boilers. Carbon dioxide capture is also possible from these units. Air Products can provide gasification technologies and purification into IGCC applications. We offer IGCC capabilities for coal, petcoke or refinery residuals as a stand-alone facility financed, operated and maintained by Air Products. Applying our skills in gasification, gas purification and combined-cycle power, turnkey plants can be more cost and capital efficient when operated and maintained by Air Products.



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