

Residue Gasification

Converting the bottom of the barrel into valuable products



Air Products Syngas Solutions™

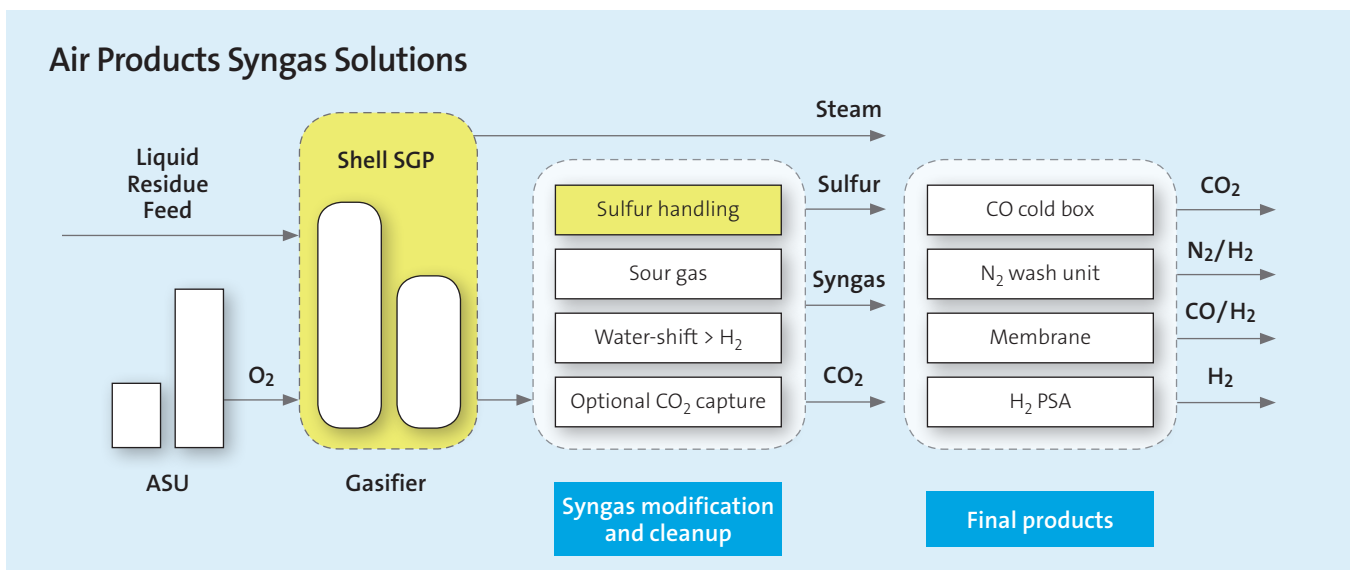
In cooperation with Shell Global Solutions International B.V.

Traditionally, refinery residues have been sold as marine bunker fuel or used on-site as furnace fuel. However, with changing legislation, refineries are under pressure to reduce their emissions and the sulfur content of their products, and the market for fuel oil is shrinking. The Shell Gasification Process (SGP) can be combined with other upgrading and treating technologies to convert a wide

range of low-value heavy residues and asphaltenes into synthesis gas (syngas) for:

- Integrated gasification combined-cycle (IGCC) power generation with optional carbon dioxide capture
- Hydrogen production
- Petrochemical production

Air Products Syngas Solutions provides complete residue gasification islands delivering syngas or hydrogen to clients with Air Products financing, operation and maintenance allowing customers to focus valuable capital, management and personnel on their own primary value-added products.



Air Products offers refinery liquids gasification islands in partnership with Shell's liquids gasification process technology. Shell licensed sub-systems shown in yellow.



Residue Gasification Process (GP) at a glance

Customer driver

- Access to resources, changing feedstock slates (heavy and/or sour crudes), changing demand patterns (fuel specifications), sustainable operations (emissions)

Solution

- A proven gasification technology, which can convert a wide range of low-value heavy residues and asphaltenes into syngas

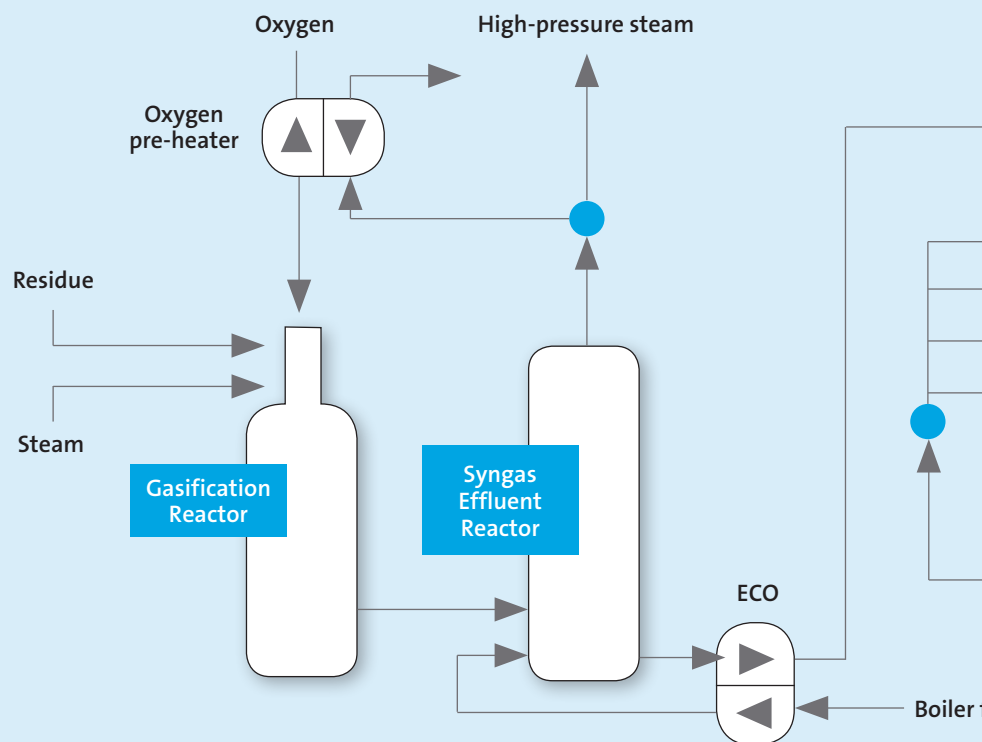
Value delivered

- Enhanced yield of high-value products, increased hydrogen production, ability to process a wide range of crude oils

Proof point

- Three plants (nine reactors) commissioned in the last 10 years

A typical gasification process scheme



Process description

The non-catalytic partial oxidation of hydrocarbons takes place in a refractory-lined reactor. The syngas is cooled in the syngas effluent cooler, which is directly connected to the reactor, and high-pressure saturated steam is produced. The low level of soot in the syngas is removed when it passes through a quench, a separator and a scrubber. An automated heat-up, start-up and shutdown system helps to provide reliable plant operation.

Performance

Special burner and reactor designs help SGP technology to:

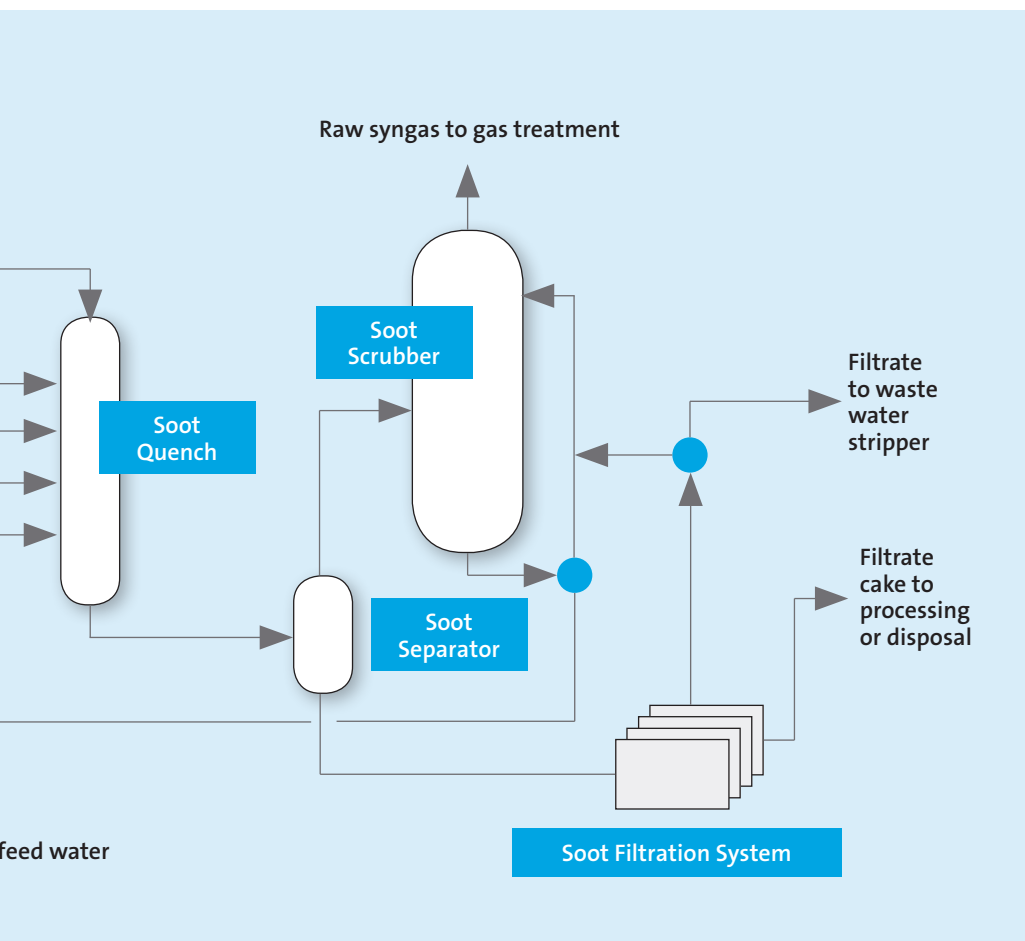
- Convert high ash, sulfur and viscosity feeds; give high syngas yield—typically >2,600 Nm³ syngas per ton of feedstock

- Operate with low soot formation (<1 mg/Nm³ of soot in raw syngas)
- Provide enhanced thermal efficiency through the syngas cooling process (with high-pressure steam generation)

Value

The gasification process provides an intermediate product and is integrated into an existing (refinery) complex. This makes our gasification technology highly flexible and configurable to meet different needs. It can help to:

- Improve product quality while reducing plant emissions
- Produce hydrogen for processing today's clean fuels
- Adapt processing facilities for reducing fuel oil demand



- Reduce demand for natural gas
- Convert low-value products into high-value products
- Use bottom-of-the-barrel oil for power
- Implement an enhanced oil recovery project using carbon dioxide

Meeting refinery environmental and product quality needs

A gasification unit was integrated at a Netherlands refinery with a new hydrocracking unit and a cogeneration plant to help meet stringent environmental and product-quality requirements.

A revamped deep thermal cracker produces 1,650 tons per day of high-sulfur, heavy residue as gasification feed. The syngas produced is used to

make 285 tons per day of hydrogen for the hydrocracker and as a clean fuel for power generation in a 117-MWe IGCC plant.

Producing synthetic crude from oil sands

Bitumen extracted from the Athabasca oil sands, Canada, was converted using OPTI Canada's OrCrude™ process to partially upgraded product and a heavy asphaltene by-product. The heavy asphaltene feeds a 3,800 tons per day SGP unit. The gasifiers generate hydrogen for a distillate-hydrocracking unit, which upgrades the product further into premium-quality synthetic crude. Excess syngas is used to generate steam and power for bitumen extraction.

What differentiates us?

- Air Products offers the complete residue gasification island from oxygen supply/feeding to clean syngas or hydrogen, including capital investment and operations.
- Gasification experience dating back to the 1950s; more than 170 gasification reactors have been built
- State-of-the-art master designs incorporate technology efficiencies from lessons learned with current systems.
- Residue gasification units can process a wide range of feedstocks, including highly viscous, high-sulfur residues.
- Our designs offer performance advantages by helping to minimize oxygen and fresh water consumption, reduce soot formation and enhance syngas yield.
- Air Products and Shell both are gasifier owners and operators. We have extensive experience in start-up, operation and maintenance.



Have you considered how you can . . .

- Improve product quality while simultaneously reducing plant emissions?
- Produce sufficient hydrogen to increase the yield of clean fuels that meet ever more stringent requirements?
- Adapt your processing facilities as demand for fuel oil diminishes?

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