IGCC Plant SNG: production analytics overview

SNG production and main uses

Syngas can be produced from a wide variety of carbon based feed stocks such as low grade or high sulfur coal and heavy petroleum residues. In subsequent processes, impurities such as CO_2 and H_2S can be removed and the Btu content of the gas increased. The purified syngas can then be converted to synthetic or substitute natural gas (SNG), which can supplement or replace natural gas in many industrial applications, as it can be injected in gas distribution grids. In an integrated gasification and combined cycle (IGCC) power plant, SNG is often used for energy storage when power demands are lower. In an natural gas combined cycle (NGCC) power plant, SNG can be used to fuel combustion turbines combined with steam turbines, and represents a new ‘clean coal’ energy initiative, with a smaller carbon footprint than the direct burning of coal. In the U.S., investment in IGCC plants are limited as a result of shale gas availability. However, a large number of IGCC plants are being developed in the Asia Pacific region, which has large amounts of natural coal resources but limited natural gas. In China alone, since 2013 the government has approved nine large-scale SNG plants with a total capacity of 37.1 billion m3 of natural gas per year[1]

The overall IGCC SNG production process

The first step in producing SNG is the production of syngas via gasification. The raw syngas is cleaned up to remove particulates and to convert any COS to H_2S, for later removal. In order to increase the availability factor to > 0.95, multiple trains of gasification are often used. The syngas of these trains is combined in a common header for subsequent processing. In some cases, the CO_2 generated can be captured and sequestered (CCS), or it can be used for enhanced oil recovery (EOR). In this case, the syngas is first processed by a shift converter to increase CO_2 capture efficiency and increase the Btu content of the synthesized SNG. In an IGCC power plant, the syngas is used as fuel gas for a combustion turbine. The waste heat from the gas turbine exhaust is recovered as steam using a heat recovery steam generator (HRSG), which is then used to drive a steam turbine, with both turbines generating electricity. When power demand is less, some of the syngas can be converted to SNG via methanation, and subsequently purified and compressed to meet pipeline quality and pressure.

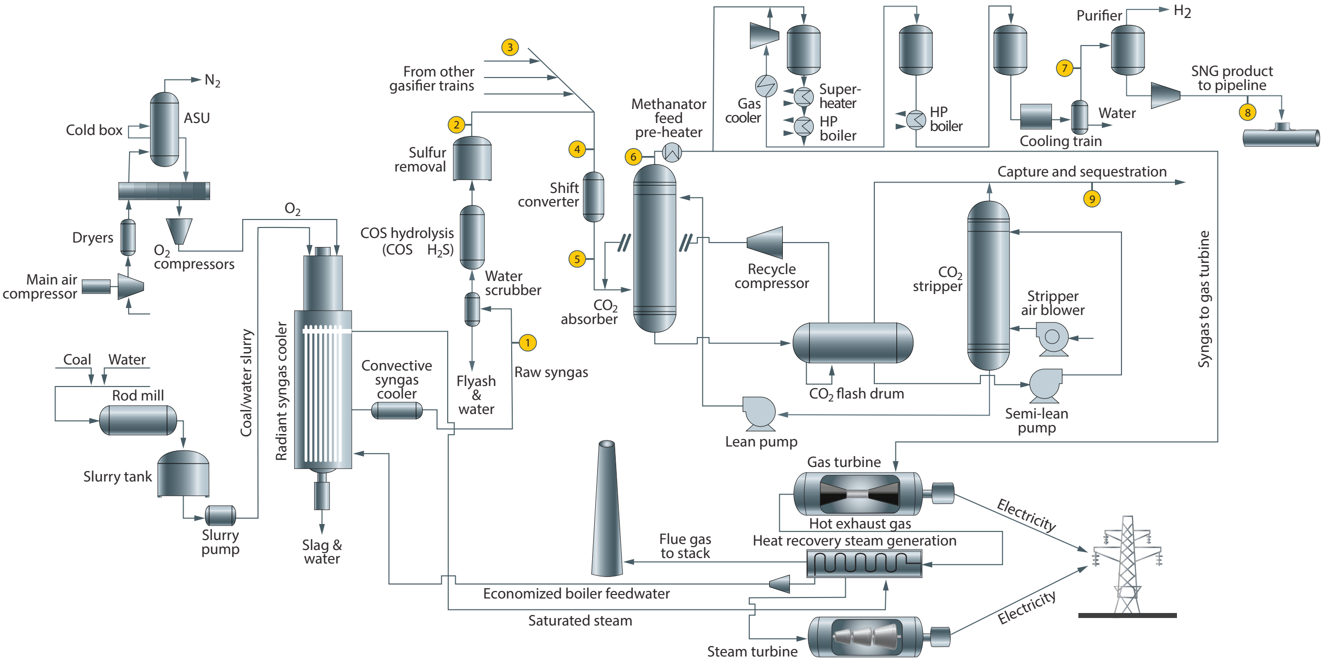

Figure 1: A simplified process diagram showing the main process units in an IGCC power plant generating SNG

1. Yang, C-J. and Jackson, R.B., “China’s synthetic natural gas revolution”, Natural Climate Change. Vol 3 (Oct 2013), 852-854.

Process analytical challenges

In the SNG production process, there are several streams that are typically analyzed in real time which form the basis for controlling and optimizing the main process units. However, although most of the streams are relatively easy to analyze using traditional on-line analyzer techniques (such as GC, MS, and photometry), in several cases the process conditions are severe enough to present significant challenges to the standard sampling and conditioning systems, thus impacting the possibility of obtaining a reliable analysis. For an IGCC, examples of these extreme stream conditions are gasifier raw syngas effluents and the syngas stream after the water scrubber.

Solution: Raman Rxn5 analyzer

The Raman Rxn5 analyzer is a unique spectroscopic instrument capable of analyzing the diatomics H_2 and N_2, as well as CO, CO_2, and CH_4, which allows measurement of all the streams shown in the typical "stream service" list below. Speciation is achieved without any columns, valves, stream switching or the need for carrier gas as in the case of GCs. The Rxn5 analyzer uses fiber optic cables of up to 150 meters in length to connect an Rxn-30 gas probe to the analyzer. The user of fiber optic cables allows the gas probe to be interfaced with a sample conditioning system near a sample tap point, such that no gas needs to be transported to the analyzer via expensive and high-maintenance heated gas transfer lines, and eliminating lag time typical for GC and MS systems. No potentially toxic or explosive gas mixtures are brought near or into the analyzer, enhancing operator safety during maintenance activities. With a properly designed sample conditioning system, gas composition measurements can be made at temperatures up to 150°C and pressures of up to 1000 psia. The ability of the Rxn-30 probe to measure under these conditions simplifies the sample conditioning required and often allows the sample to be returned to the process after non-destructive Raman measurement, eliminating costly flaring.

	Stream service	Key measurement parameter	Pressure* (barg)	Temp* (°C)
1	SNG: raw syngas from gasifier effluent	Composition/CH_4	49	337
2	SNG: syngas after scrubber	Composition/H_2/CO/CO_2	49	199
3	SNG: raw syngas from other trains	Composition/H_2/CO/CO_2	49	199
4	SNG: common syngas header after scrubbers	Composition/H_2/CO/CO_2	49	199
5	SNG: shift converter outlet	Composition/CO_2	41	250
6	SNG: CO_2 absorber outlet	Composition/CO/CO_2	41	42
7	SNG: methanator outlet	Composition/CH_4/H_2/CO_2	30	35
8	SNG: to pipeline	Composition/ CH_4/CO/CO_2/H_2	74	40
9	SNG: CO_2 recovery stream	Composition/ CH_4/CO_2/ N_2 /H_2	74	40

Table 1: Summary of the typical streams analyzed on-line in an IGCC SNG plant (see also Figure 1)

* Pressure and temperature values listed are for typical process unit outlet streams