Figure 1: Shell Gasifier System (Higman, Burgt 119)

The ground, pressurized coke is transported along with Nitrogen gas (Because Nitrogen is an inert gas). This petcoke is supplied with 95% Oxygen and steam through nozzle of the burner on the wall. The temperature inside the reactor is about 2700 ⁰F and pressure is around 360 – 650 psi which speeds up the reaction. As a result, the syngas leaves the reactor from the top through the lock hopper .The steam that is left behind, leaves the reactor through the annular space at medium pressure.

The slag comes down in the reactor where it is quenched in a water bath. The Boiler Feed Water (BFW) supplied to annular wall of the gasifier is used as water bath. The huge temperature drop due to water bath results into hardening of the slag. This slag is ground by slag crusher. The granulated slag leaves the reactor through the lock hopper and the Boiler Feed Water (BFW) supplied to cool the slag, moves to heat exchanger. The BFW water is supplied that liquefies the slag.

The Syn-gas goes into the heat exchanger where it’s cooled by supplied Boiler Feed Water (BFW). As a result, Syn gas moves down the heat exchanger and water leaves the heat exchanger as High Pressure Steam. Additional Boiler Feed Water (BFW) is supplied from the bottom nozzle of the heat exchanger that cools the syn gas even more. This water comes out of the heat exchanger as medium pressure and the syn gas leaves the heat exchanger at approximately 530 ⁰F and passes a candle filter unit where the solids from the gas are removed. About half the gas is then recycled via recycle gas compressor as quench gas and the other half is cooled in water scrubbing system.

|  |  |
| --- | --- |
| Syngas Quench (Maurstad 26) | |
| At the outlet of the gasifier reactor the temperature of the syngas is around 1500°C and the fly ash (or slag) is in liquid form. To protect downstream process equipment from fouling, a quench is needed to solidify the slag and make it non-sticky. | |
| Water Quench   * A water quench uses sensible heat from the syngas to vaporize water. * The quench may be total as in the simplest version of the GE gasifier where the syngas is saturated with water vapor, or it may be partial where the syngas is only cooled down to around 1650°F. * In the latter case, heat recovery by production of HP steam would be included. * In both cases, the addition of water drives the water gas shift reaction to increase the H2/CO ratio which is beneficial in the case of CO2 capture. |  |
| Radiant Syngas Cooler   * The radiant syngas cooler is available in one version of the GE gasifier. * The hot gas flows into a radiant boiler where saturated steam is generated. * At the Tampa IGCC demonstration plant, problems with the seals protecting the cooler shell from hot syngas caused five forced outages from 1997 to 2001, but the operators felt a solution was close |  |
| Quenching by Recycle   * Quenching by recycle of cooled syngas is applied in the Shell gasifier. * After particle removal in the candle filter, about half of the syngas flow which has a temperature around 600°F is recompressed and recycled to the gasifier outlet. * By mixing the 2700°F hot syngas with the recycle stream, a cooling down to around 1650°F is achieved. * Heat is then recovered in a convective syngas cooler. | N/A |
| Chemical Quench   * Chemical quench is a concept which has less experience, but offers some interesting advantages. * The principle is the addition of a second gasification step which uses the sensible heat in the hot syngas, and not oxygen, to gasify the coal feed with water. * This ensures that the second stage is non-slagging (slag is solid). Because the outlet gas temperature is decreased and has less sensible heat, the cold gas efficiency is increased. * A disadvantage is that some tars, which make gas cleanup more complex, may be formed. Conoco Philips’s slurry feed gasifier (E-gas) incorporates this principle. | N/A |

Reference:

Higman, Chris, and Maarten Van Der. Burgt. *Gasification*. Amsterdam: Gulf Professional Pub./Elsevier Science, 2008. Print.

Maurstad, Ola. *An Overview of Coal Based Integrated Gasification Combined Cycle (IGCC) Technology*. Rep. Cambridge: Massachusetts Institute of Technology, 2005. *For Energy and Environment*. Scribd. Web. 2 Feb. 2011. <http://www.scribd.com/doc/35269273/24/Syngas-quenching>.