High Efficiency Air Blown IGCC (Integrated Coal Gasification Combined Cycle) System


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1. Overview

Global energy consumption is expected to increase along with economic development in Asia and in other developing countries around the world. Coal, with its abundant and widespread deposits in various regions and countries, is expected to play an important role as a reliable and stable cost energy source to support energy security in the coming years.

Conventional coal fired power generation systems cannot match the high efficiencies enjoyed by state-of-the-art natural gas combined cycle power generation systems. Further, coal fired generating systems have higher rates of CO_2 emission compared to other fossil fuels including natural gas. The IGCC – Integrated coal Gasification Combined Cycle – system has been developed to overcome these big challenges and disadvantages.

"Air blown coal gasification system" has been tried and abandoned by others due to its higher technical hurdles. In Japan, initial development of this technology began in small scale test plants with subsequent step by step scale-up to eventually achieve successful operation at the 250MW demonstration plant. This plant has become the world's first commercial scale operation of a complete air blown IGCC system.

2. Technical Description

Figure 1 shows past and predicted future thermal power generation efficiency improvements. Recent new ultra-supercritical pressure coal fired power plants have efficiencies of approximately 42% (net, LHV), whereas a large commercial scale air blown IGCC system is expected to achieve an efficiency of 48 to 50%. When combined with fuel cells as an IGFC – Integrated coal Gasification Fuel Cell – system, the efficiency is expected to exceed 55%.

Figure 2 is an example of an IGCC system configuration. Coal is gasified in a high temperature, high pressure gasifier, then cleaned of impurities such as sulfur at the gas clean-up system. The clean gas is fired at the gas turbine to generate electricity. Steam generated from heat in the gas turbine flue gas and steam generated at the gasifier are used to produce electricity at the steam turbine. The IGCC system achieves higher efficiency compared to conventional systems by utilizing this combined cycle generating system with both the gas turbine and the steam turbine.

The gasifier uses air instead of pure oxygen as the oxidant for the gasification process. This dramatically reduces power requirements within the system, resulting in higher power generation efficiency of the air blown gasification system. This means less fuel usage and less CO_2 emission for the same electric power output. Impact on the environmental is minimized by cleaning the gas from the gasifier at the gas clean-up system prior to use at the gas turbine.

Air blown gasification was originally believed to be technically challenging. It was difficult to produce gas with sufficient heating value for stable combustion at the gas turbine, while reaching the high reaction temperature required at the gasifier to maintain stable melting and discharge of ash in the coal. If the reaction temperature at the gasifier was increased, heating value of the gas became too low for stable operation of the gas turbine. Development of the unique two-stage, two-compartment gasifier configuration resolved this challenge, enabling both stable ash discharge and stable gas turbine operation in a practical and industrial scale.

3. Summary

The 250MW demonstration plant, shown in Figure 3, has proven that the unique and original air blown gasification technology from Japan has been established and is applicable to actual commercial power generating facilities. The 250MW demonstration plant has begun commercial operation as Joban Joint Power Company, Nakoso Power Station, Unit #10 since April 2013. The next 500MW class IGCC production unit will contribute to improved energy security, efficient use of natural resources and to our path towards a low carbon green society by its high efficiency system and its reduced impact on the environment.

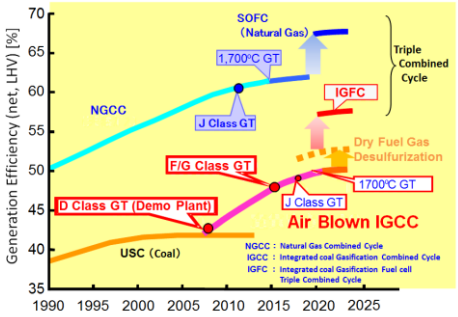

Figure 1: Thermal Power Generation Efficiency Improvements

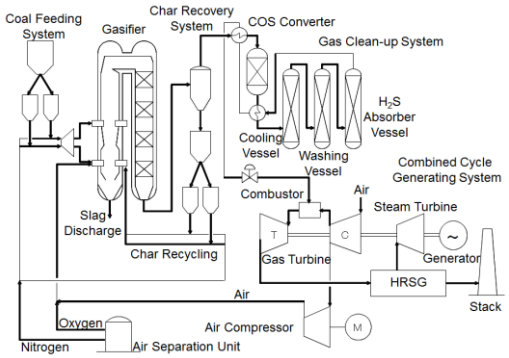

Figure 2: IGCC System Configuration

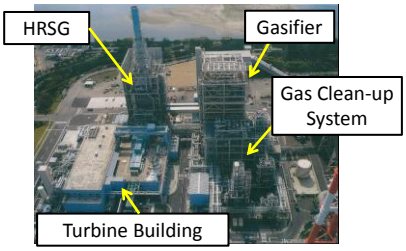

Figure 3: 250MW Nakoso IGCC Demonstration Plant (Nakoso Power Station, Unit #10)

[参考：所属先英語表記]

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