3톤/일 석탄가스화 시험설비 개발 현황

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DEVELOPMENT STATUS OF 3 T/D COAL GASIFICATION BSU SYSTEM

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INTRODUCTION

Technologies of efficient and clean utilization of coal are progressively developed so that coal is acknowledged as one of the major alternative energy resources in these days. In order to develop alternative power-generating technology, first phase program of IGCC technology development is started in 1992. The major objective of the first phase of IGCC project is to design/construct/operate 3 TPD IGCC gasifier unit and to organize design data for the IGCC system which will be used in the scale-up of 3 TPD IGCC system. First, design details for the construction of 3 TPD BSU plant and characteristics of manufactured/purchased equipments are incorporated into the engineering package. And then, this package will be upgraded and modified by incorporating the instruments characteristics, the information on design modification and upgrading, the process arrangements, etc. In this paper, design/construction methodology of 3 T/D coal gasfication BSU plant is explained. Engineering package which will be utilized in the Scale-up of IGCC system is also explained.

3 TON/DAY BENCH SCALE UNIT GASIFIER

A process & flow diagram of the 3 TPD IGCC BSU is shown in Figure 1. In the coal preparation system, 2-inch lump coal is fed to a pulverizer and reduced its size to 70-90% passing through 200 mesh (74 microns). The coal is also dried to less than 5% surface moisture for flowability through the feeding system. Oxygen and nitrogen are supplied from site-located storage gas tanks and fed to gasifier through pipeline. Water is pumped through high pressure water pump then boiled in the heater to provide steam to gasifier. In the actual gasifier operation, oxygen/steam feeding ratio is a major parameter to control gasifier temperature. Temperature data along the gasifier wall will be measured with thermocouple. Other measurement point, such as inside cooler, cyclone, slag removal system are also included in the temperature analysis.

Coal feeding system composed of 4-train lock-hopper which enables maintaining high pressure inside gasifier for entire experimental period. The coal feeding system uses nitrogen to pressurize the coal in lockhoppers from atmospheric pressure to the pressure of gasfier which is greater than 30 atm. The lockhoppers discharge the coal to pressurized injection hoppers, from which it is discharged by metering screws into the

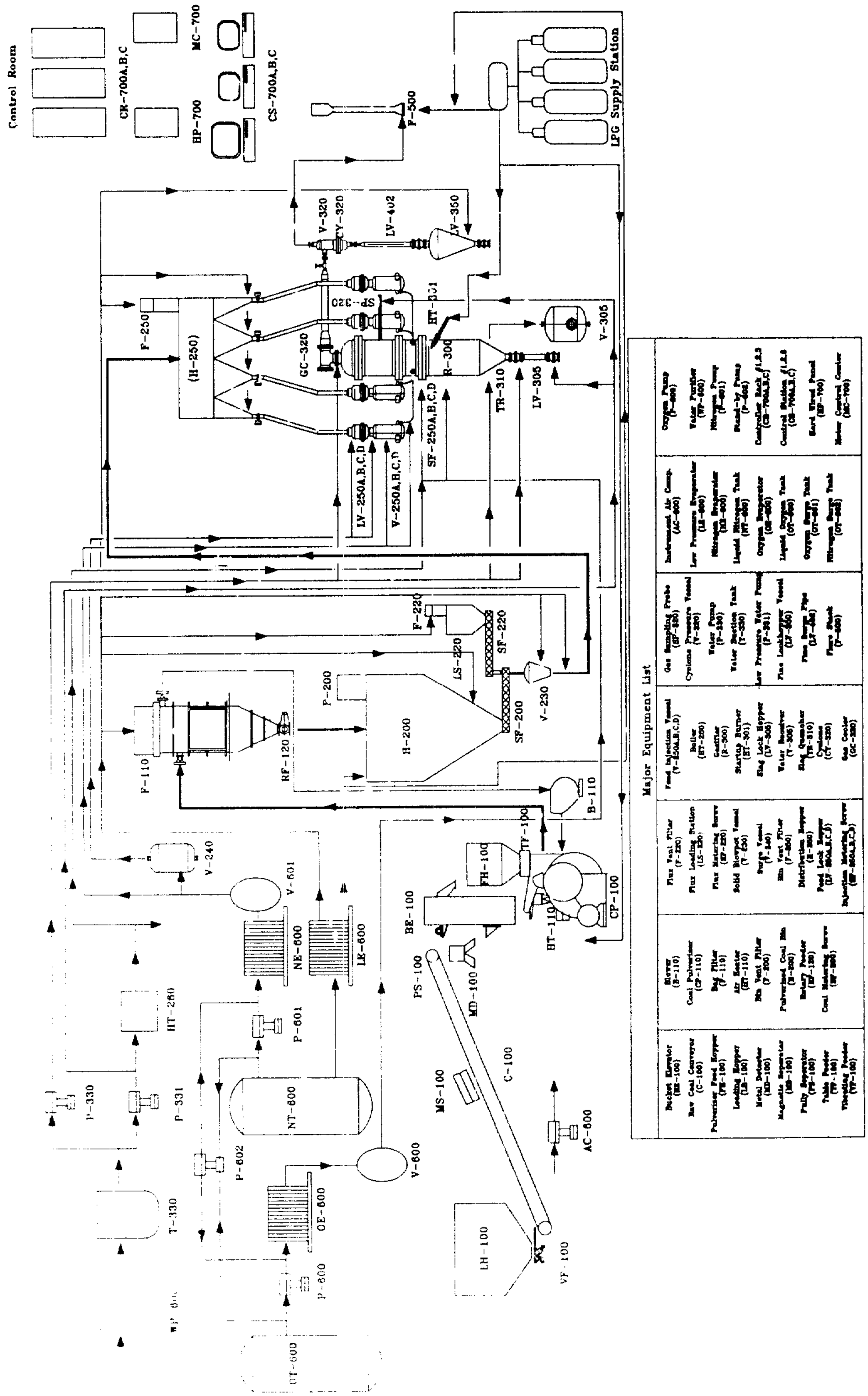

Fig. 1. Schematic Diagram of 3 T/D Coal Gasifition BSU Plant

coal injection lines. The coal is then pneumatically conveyed in dense phase with nitrogen to the gasifier burners. Coal, oxygen and steam enter the gasifier through tangentially injected nozzles located in middle sector of the gasfier. The gasifier operates at pressure up to 30 bars and temperature up to 1650°C.

The gasifier produces a product gas composed primarily of carbon monoxide, hydrogen, carbon dioxide and water vapor, along with trace amounts of methane, hydrogen sulfide, and hydrogen chloride. Product gases are sampled after the gasfier and analyzed their composition with Gas Chromatography. Product composition data are processed with data aquisition system and stored for further analysis. Product gas leaves the top of the gasifier, which contains a small amounts of entrained droplets of molten coal ash (flyslag) and a small amount of unreacted carbon. Most of the ash in the original coal is transformed into molten slag, which flows down the gasifier walls and leaves the gasification chamber through the slag tap.

The product gas is immediately cooled after gasfier in a direct contact quench tower using a nitrogen-atomized water spray. The cooled product gas and flyslag then enter a cyclone, which removes most of the solidified flyslag and unreacted coal char from the gas stream. Most of fly slag particles are collected by cyclone and accumulated in a lockhopper which is also periodically removed, and weighed for the material balance calculation. Gas leaving the cyclone will be reduced in pressure across the gasifier back pressure control valve, and then routed to the flarestack where the product gas is burnt with LPG. Provisions are made for the connection with hot gas cleanup system for the future development.

IGCC ENGINEERING PACKAGE

IGCC engineering package is developed mainly to provide the design basis of 10 MW PDU IGCC system. Design details for the construction of 3 TPD BSU plant and experimental results obtained from the operation of the BSU plant are incorporated into the engineering package. Two- and three-dimensional computer fluid dynamic analysis is done on the gasifier and the resulting profiles of temperature, velocity, gas compositions, etc. are evaluated according to the varied experimental parameters. Computational analysis is also conducted on the gas turbine combustor and expansion turbine which is also included in the engineering package. System simulation analysis is also incorporated in the IGCC engineering package.

Information of specialized equipments and instruments are grouped into a design specification data base and can be accessed whenever simliar equipments/instruments are involved in the future process design. Inter relation of design specification within component programs for the engineering design package is illustrated in Figure 2 and explanation follows as below. Many components involved in the IGCC system have to be bought from specialized equipment vendors after the design. Basically, the design specifications on the following components are incorporated into the data base: coal preparation system, solid feeding system, gas supply and distribution system, product gas cooling system, plant utilities, instruments characteristics, air separation unit, and gas/steam turbine characteristics. Furthermore, information gathered during the BSU operation on equipments such as pumps, compressors, sensors, valves is utilized here to the engineering package. Final purpose of this data base is to select the suitable equipments based on the experience and to estimate the performance characteristics of selected parts. Consequently, dynamic analysis of IGCC component, IGCC system analysis, and design specification of equipments and instruments all altogether organized into the IGCC engineering design package.

SUMMARY

Development status of Korean IGCC BSU are explained in this paper. Based on the technical evaluation, design coal for 3 TPD BSU selected. Best suitable IGCC system in Korea is also chosen as dry feeding, oxygen blown, entrained-bed slagging type gasifier with cold-gas desufurization process. With above chosen input, 3 TPD BSU gasifier and its peripheral are designed. It is consist of seperate components within BSU such as coal preparation system, coal feeding system, coal gasification system, gas cooling system, ash removal system, cyclone system, and flarestack. A engineering packages for the conceptual and basic design of 10MW-size PDU IGCC plant are described. Basic engineering design data in provided from experience of running 3 TPD BSU. Through the operation of BSU for the next three years, the engineering package will be improved and evaluated with actual data.

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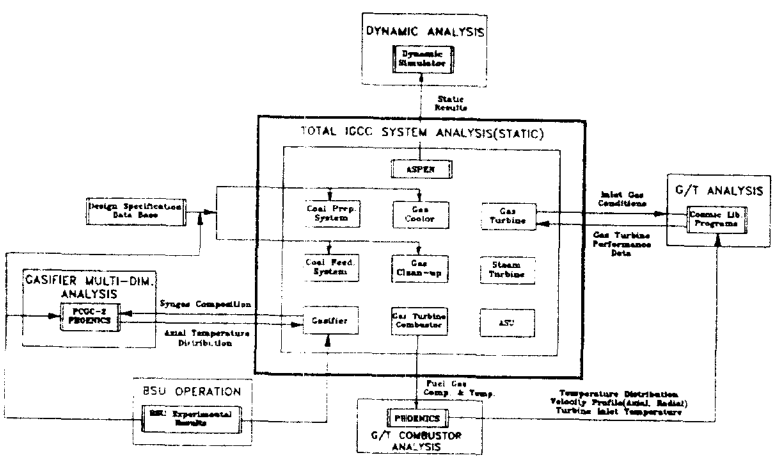

Fig. 2. Diagram of IGCC Engineering Package