2B5. Next-generation, High-efficiency Integrated Coal Gasification Electric Power Generating Process (A-IGCC/A-IGFC)

Technology Overview

1. Advanced IGCC/IGFC with exergy recovery technology

The integrated coal gasification combined cycle (IGCC) power generation system under development in Japan provides a generation efficiency of 48% for dry gas cleaning. Also, the integrated coal gasification fuel cell combined cycle (IGFC) provides 55%. These efficiency levels are 7% to 8% lower than that of natural gas-fired IGCC/IGFC. An important challenge for Japan is to develop technologies to more efficiently utilize coal, an energy source that can be stably supplied.

Unlike the existing IGCC/IGFC system that integrates partial oxidation gasifiers, fuel cells, and gas and steam turbines using a cascade method of energy utilization, the A-IGCC/A-IGFC (Advanced IGCC/IGFC) system directs recycled heat from gas turbines or fuel cells back into steam reforming gasifiers that employ endothermic reactions. This next-generation exergy recovery-type IGCC/IGFC being studied. With exergy recovery, the A-IGCC, using 1700°C gas turbines, is expected to provide a generation efficiency of 57% and the A-IGFC, employing fuel cells, is expected to provide a generation efficiency as high as 65%. Thus, this technology is expected to have the potential to bring about a dramatic increase in system efficiency, contributing, in the future, to the provision of energy resources and a reduction in CO_2 emissions.

Table 1 Comparison between existing IGCC and A-IGCC

	Existing IGCC/IGFC	A-IGCC/IGFC
System combination	Cascade method	Exergy recovery
Gasification	High-temperature partial oxidation (1100 to 1500°C)	Steam reforming (700 to 1000°C)
Gasifiers	Entrained flow	Multi-loop high density CFB
Generation efficiency	46 to 48% (55%)	53 to 57% (65%)

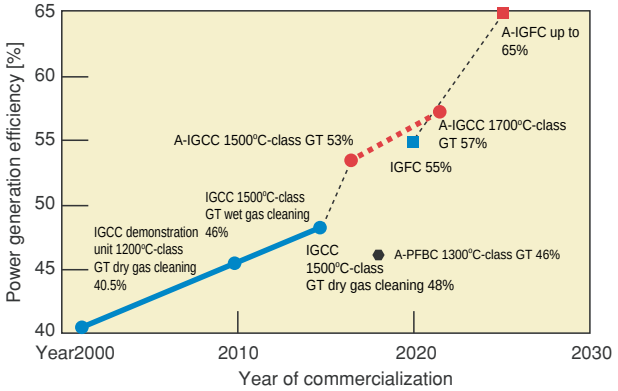

Fig. 1 Projection of A-IGCC/IGFC efficiency

2. Overview of A-IGFC

Figure 2 is a schematic drawing of the basic A-IGFC processes. The existing IGFC, which uses energy in a cascade method, integrates a gasifier, fuel cells, gas turbines and a steam turbine into a cascade-type system. Hydrogen-rich gas produced in the gasifier is purified and then sent to the fuel cell unit. Part of the fuel that has not been used in the fuel cell unit is transferred to the gas turbines for power generation. Since this process provides only a low fuel utilization rate, the inlet temperature of the gas turbines is around 1100°C and the power generation efficiency is not more than 55%. This is a result of the cold gas efficiency of coal, which is as low as approximately 80%. On the other hand, the exergy-recovering IGFC reuses the high-temperature heat generated by the fuel cells in the gasifier for steam reforming gasification by making use of an endothermic reaction. A-IGFC, using exergy recovery technology, can be expected to substantially improve the generation efficiency. Recovering waste heat from the fuel cells with low exergy loss and reusing the heat for steam reforming gasification that relies on an endothermic reaction will greatly enhance the cold gas efficiency and substantially reduce the exergy losses due to combustion.

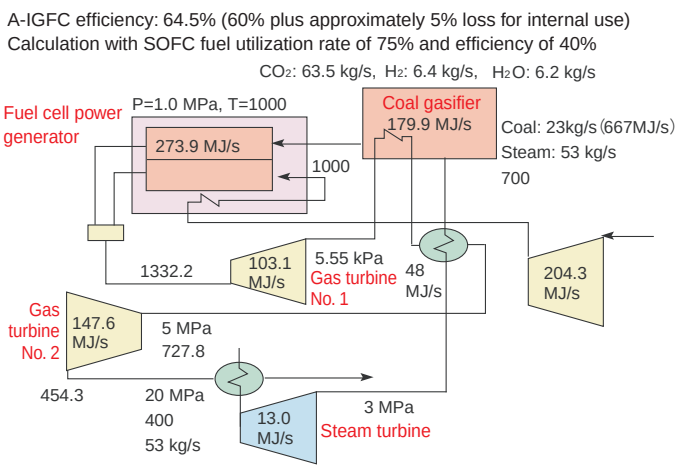

Fig. 2 Schematic drawing of basic A-IGFC processes

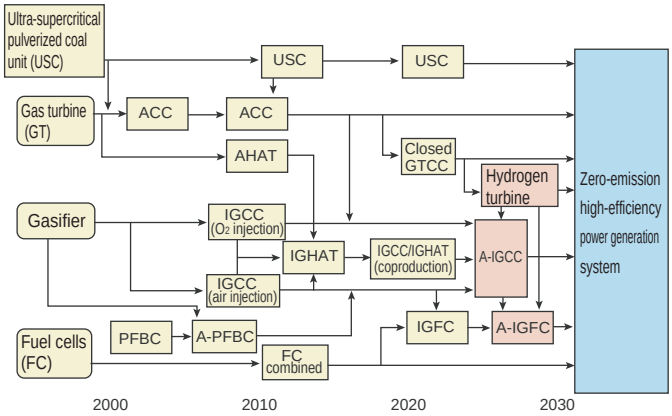

Fig. 3 High-efficiency power generation technology development