Expansion of fuel types and improvement of efficiency in IGCC

Background and Objective

Highly effective coal gasification combined cycle power generation (IGCC) is an important technology for electric power companies as next generation coal-based thermal power generation. Our laboratory has been researching from the process development of the initial stage of IGCC development. Based on the experience of our 2t/d gasifier and the numerical analysis technology, we have supported the examination of the design and operating condition of the demonstration plant. In this project, aiming at the development of commercial IGCC in the future, for flexible fuel operation, improvement of the efficiency and the reliability, we develop expansion technology of fuel types in gasification process, dry gas cleaning system for IGCC, and gasifier operating condition diagnosis and trouble prediction system.

Main results

1. Development of evaluation technology on gasifier characteristics for commercial scale gasifier

The performance of the demonstration plant gasifier was evaluated, and the design adequacy was clarified. Moreover, our three-dimensional numerical simulation technology for coal gasifier was verified by using demonstration plant data, and it was confirmed that the evaluation of characteristics of the commercial scale gasifier was possible. From these results, a tool that can be used to design a large-scale commercial plant gasifier was constructed.

2. Development of expansion technology of fuel types in gasification process

As a catalyst effect of the element contained in coal, the influence of Ca and K on the gasification reactivity was clarified. In addition, the existing reaction model is extended, and the reaction rate equation that was expressible of the change in reactivity by the effect of the catalyst was constructed (Fig. 1). These results can be reflected in the establishment of the technique to forecast adaptability of wide range of fuel type.

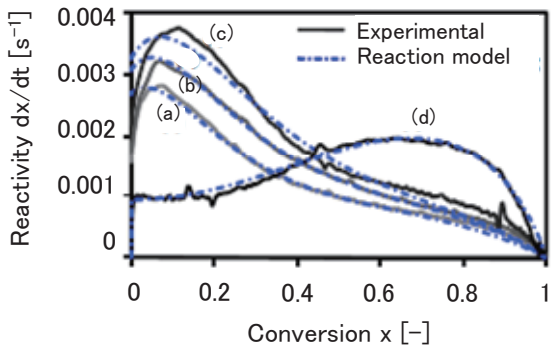
3. Development of gas cleaning system for highly-efficient IGCC

Dry gas cleaning technology is essential for realization of highly-efficient IGCC. But the development of optimum whole-dry gas cleaning system requires stepwise scale-up procedure, because dry impurity removal processes have differing degree of developmental levels. The hybrid-type gas cleaning system (Fig. 2), which was arranged conventional water scrubber and advanced dry desulfurization process in series, was suggested for advantaged in early realization of higher power generating efficiency than wet gas cleanup system [M09016].

4. Development of gasifier operating condition diagnosis and trouble prediction system

A real-time operating condition diagnosis and the trouble prediction are requested aiming at safe and steady operation of the gasifier. Next, a supporting system for gasifier optimum operation that composed a part of the diagnosis and the prospect system was developed (Fig. 3). This is integration of the gasifier operating condition optimization program by the statistical processing of online data and the molten slag flow monitoring program by the image analysis. It will become an important technology for an advanced operating control of the gasifier in the future.

Other reports [M09002]



(a)Ca2.5%(Coal A)、(b)Ca5%(Coal A)、(c)Ca10%(Coal A)、(d)K2.5%(Activated Carbon)

Fig. 1　relation between conversion and reactivity[1]

Ca has the effect of improving the reactivity in the first stage of the reaction. On the other hand, K improves the reactivity with the progress of the reaction. The reaction rate equation that was able to express the change in this reactivity was constructed.

[1] Y. Zhang et al., Fuel 89,152－157 (2010)

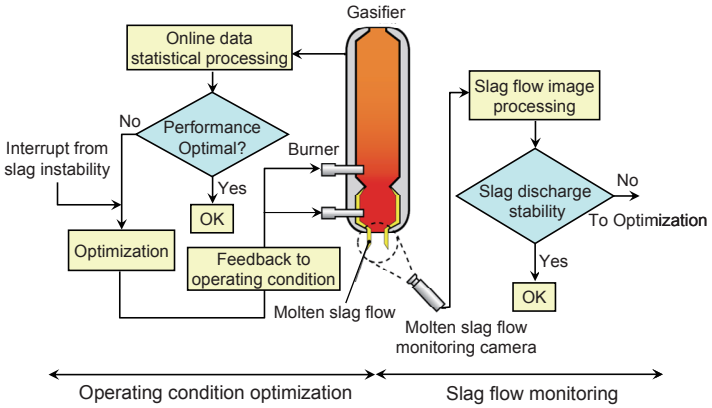


Fig. 3　supporting system of gasifier optimum operation

The gasification performance and the flow situation of molten slag can be evaluated online, and it becomes the basic system of the gasifier operating condition diagnosis and trouble prediction system.

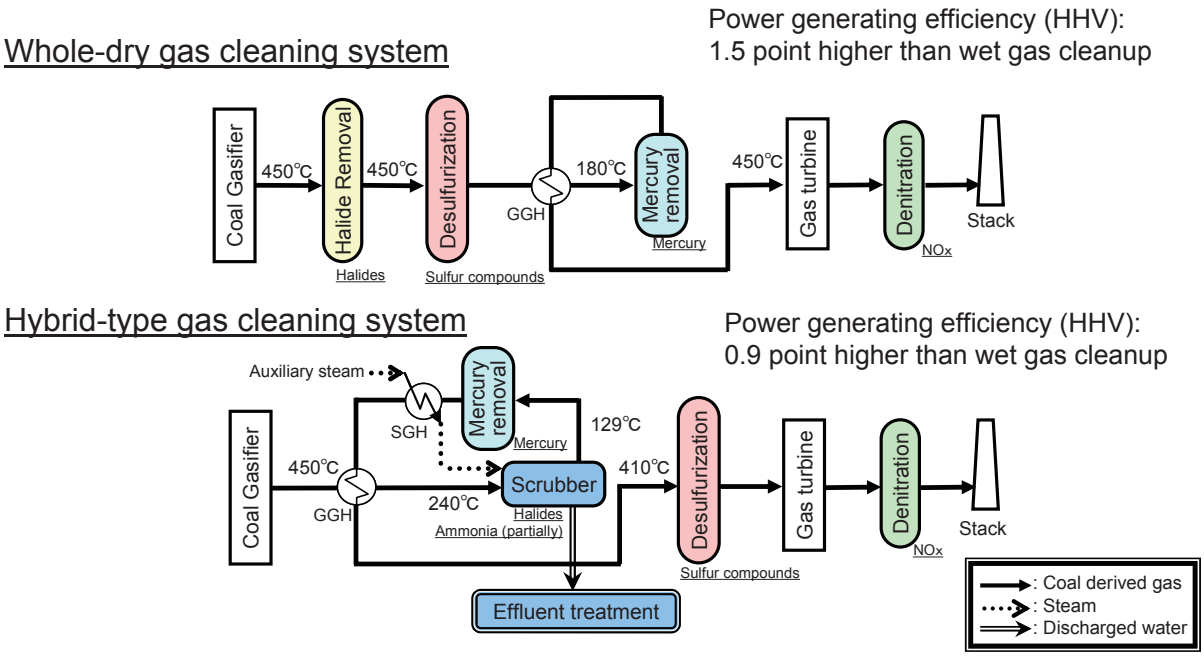


Fig. 2　system constitution of gas cleaning systems for IGCC

Dry gas cleaning technology will be established with development of the hybrid-type gas cleaning system, which was arranged water scrubber and dry desulfurization process in series. The ultimate purpose is to revitalize the whole-dry gas cleaning system which is most effective for improvement of power generating efficiency on IGCC.