High Temperature Gas Reactors in Japan: Present Status and Perspective

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Abstract

The first commercial scale nuclear power plant in Japan entered into operation in 1966. Since then, nuclear power plants have been constructed continuously, and 51 units of 45 GWe are in operation at present with occupying about 35 % of electric power supply in Japan. Among various technological options, nuclear energy will be able to play an essential role to reduce CO_2 emissions from energy production, preventing global warming. However, the nuclear energy supply is now facing unfavorable wind. A criticality accident occurred in 1999 makes it difficult to gain public consensus on the construction of new power plants. The trend toward deregulation of the electricity market might prevent utilities from investing in large power plants.

Under the circumstances, small and medium nuclear reactors are of increasing interest, in parallel with life-extension of exiting nuclear power plants, because of enhanced safety and small capital investment. From the viewpoint of safety and economic competitiveness, the high temperature gas reactor (HTGR) is considered to be the most promising candidate among the various types of small and medium nuclear reactors.

From 1960's, Japan Atomic Energy Research Institute (JAERI) keeps on developing HTGR technologies. JAERI constructed High Temperature Engineering Test Reactor (HTTR), which achieved the first criticality in 1998. HTTR is graphite moderated and helium gas cooled reactor with a thermal output of 30 MWt. High temperature operation at 850 ℃ is supposed to start soon. In the HTTR projects, extensive research and development is planned to establish and upgrade HTGR technology including its heat application. JAERI, in cooperation with Japanese utilities and industries, is also proceeding with a feasibility study for gas turbine HTGR system.

Efforts to deploy HTGR plants in Japan have been made continuously by non-governmental organizations such as Japan Atomic Industrial Forum (JAIF) and Research Association of HTGR Plant (RAHP), which consist of utilities, vendors and research experts. They have summarized Japanese industrial interests and requirements of future HTGR plants.

As for the fuel fabrication, Japanese nuclear fuel manufacture has an ability of

providing HTGR coated particle fuel with high reliability. Release rates of fission products from the coated particle fuel were found to be extremely low. RAHP and JAIF carried out the survey study on the fuel cycle in Japan, which indicated that both “reprocessing option” and “once-through option” can be possible corresponding to the future needs after interim storage of spent fuel for several ten years, though HTGR fuels are fundamentally suited for “once-through option” due to their high burn-up ability, chemical stability of coating layers.

Among various heat applications of HTGR, hydrogen production is expected to be a promising future technology, considering the rapid progress of fuel-cell electric generators. JAERI and other research organizations are plugging away at development of hydrogen production not only by the steam reforming method of natural gas, but by thermochemical processes which produce hydrogen from water without CO_2 emission.

The significance of HTGR is clear from the viewpoint of enhanced safety, economic competitiveness, and high efficiency of energy use including electricity and heat. Research and development on HTGR in Japan are expected to be more activated by the joint efforts of industries and research institutes.