**Department of Applied Nuclear Technology**

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Part-time laboratory assistant at Fukui University of Technology
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### Consultations, Lectures, and Collaborative Research Themes

Industrial application use of reactor heat, Demand for small modular reactors in Japan, Radiation dose simulation by Monte Carlo method

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## Main research themes and their characteristics

### 「Applicability of SMR Technology for JAPAN」

The development of small modular reactors (SMRs) is attracting attention around the world, and many regions have begun to consider the installation and construction of SMRs, which are expected to offer high safety, short manufacturing and construction times, and low cost.

Japan has successfully restarted 10 of its large reactors since the Fukushima Daiichi accident all of which are large scale reactors. In Japan, which depends on imports for energy resources, nuclear power generation is an important source of base-load power. On the other front, the place where Japanese nuclear power plants can be installed are limited. Therefore, a large-scale reactor is required for a nuclear reactor operated to obtain maximum from the site area. Therefore, it was considered necessary to examine non-power generation utilization of SMR. This paper summarizes the current status of SMR design and discusses the possibility of applying SMR in Japan. This study also considered thermal applications such as chemical processes and hydrogen production, and tried to adapt the type of SMR applicable to each demand for applied applications.

There are many different designs for SMRs currently being proposed. The IAEA (International Atomic Energy Agency) has documented several versions of small reactors and there are many more with over 100 concepts currently being discussed in the open literature. Figure 1 shows the reactor power and coolant core outlet temperature for the SMRs currently under development. As expected, as the core outlet temperatures increase the reactor type moves from light water reactors to liquid metal, molten salt, and gas-cooled type of reactors. This means that SMR applications for certain temperature ranges will give preference to certain types of reactors.

Heat utilization processes exist in many industrial plants such as oil refineries and chemical plants. Since fossil fuels are also used for these heat sources, carbon dioxide emissions from industrial plants can be reduced. In Japan, refineries, ammonia plants, steel mills, and soda plants are located close to each other or share a site. In most cases, petrochemical plants such as ethylene plants are integrated with oil refineries, indicating that each industrial plant is densely located in each region. Therefore, it is possible that SMRs can be installed in the vicinity of industrial areas to provide both electricity and heat to each industrial plant. Figure 2 shows the system schematic of a petrochemical and iron industry plant using heat from SMRs. The industrial site where the heat is supplied has multiple plants in close proximity and multiple heat processes as described above. As an example of industrial heat supply, first, heat at 350°C is supplied to the atmospheric distillation unit of a petroleum refinery plant to obtain petroleum products. Next, heat of 800°C or higher is supplied to a pyrolysis furnace to obtain chemical products such as ethylene from naphtha, a petroleum product. The above suggests the possibility of using the thermal energy obtained from SMR for Japanese industry.

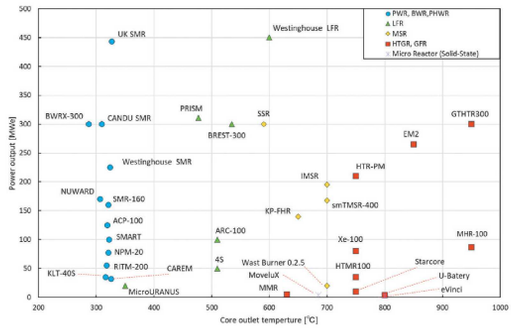


Fig1. Current Power-Core Temperature relationships of different proposed SMR Design Concepts.

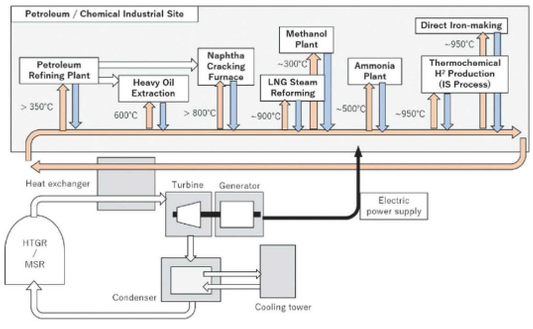


Fig.2 System overview of SMR heat application for industry

## Major academic publications

Y. Aoki, G. Harvel,
"Applicability of SMR Technology for Japan",
CNS, Proc. of the 41th Annual CNS Conference, (2022)