

§2. Archival Studies on Devices and Technologies of Plasma Heating

Kuroda, T., Iguchi, H., Namba, C., Matsuoka, K., Obayashi, H., Fujita, J., Ohkubo, K., Watari, T., Fukumasa, O. (Ube National College Technol., President)

Plasma heating is an important key issue for the production of high temperature plasma for fusion. In the early days of fusion research, plasma confinement and heating were tackled simultaneously and with equal efforts. Heating methods based on various principles were proposed. The basic physical research of heating processes has been done in order to establish more effective plasma heating method which does not disturb the plasma confinement and also the development of heating devices have been carried out by adopting the new available advanced technologies of the time. As the technology and engineering for plasma heating are related to many applications in other fields, the energy source technology for plasma heating such as ion source and Gyrotron has been actively discussed with the researchers of the other field and developed by the collaborations with them. Therefore, to analyze and investigate the processes of the progress on the heating devices gives useful knowledge and suggestions for a course of research and development on new devices as well as on future big scientific projects.

Objective of research

The main objective of the research is to collect and arrange the documents/materials on the heating devices for fusion research, which were built and used from the early stage in fusion research to the recent fruitful stage. Another objective is to provide the collections as materials available to researchers who are interested in the history of science as well as the fusion research..

Activities in this fiscal year

During this fiscal year, in order to collect materials systematically, we have historically reviewed the researches of plasma heating from the dawn stage of fusion research to the middle stage in Japan through the conference proceedings of academic societies, the journals of ‘The physical society of Japan’ and ‘The Institute of electric engineer of Japan’, the journal of ‘Kakuyugokenkyu’ and the reports published with the committees related to Fusion Science.

By 1959 in Japan, experimental devices had been

constructed on the basis of three different concepts of plasma confinement - Pinch concept, Stellarator concept and Mirror concept - ,with which many machines had been constructed and tested in the world during early days of fusion research. These early-days devices aimed to produce the high temperature plasma required for fusion mainly by using the promising heating methods : joule heating, radio frequency heating and injection of high energy particles. As they experienced a number of technical problems and difficulties in the early experiments, the experiments had have to spend a lot of times on solving the problems and the difficulties. However, there were a few presentations and reports for plasma heating research in the devices. The research of ion cyclotron heating of plasma was carried out on Heliotron device in Kyoto University. In researches in apparatus except for these fusion devices, we could find few experiments at the meeting of physical society of Japan which focused on the production of high temperature plasma by heating. The most of experiments related to plasma heating were on the propagation and the absorption of waves in the plasma and the radiation from plasma which were the important physical problems for heating plasma.

During 1964 to 1970, with more deeply understandings of plasma physics and advancing of plasma diagnostics and plasma production technologies, the experimental studies by various heating methods increased. Fundamental experimental studies for the plasma heating by beams, turbulent heating, and adiabatic compression heating were actively carried out as the alternative and additional heating methods for main proceeded heating methods on the small devices in many universities because of rather small budget and less technical and engineering problems. Since 1964, the ion cyclotron heating experiment with high power began on QP machine at the Institute of Plasma Physics in Nagoya University, which was established in 1960, under the collaboration with universities. Thereafter, the research and development on the technology of powerful R.F heating and new other heating methods have been aggressively continued.

Present status and future plan

In this fiscal year, some documents of the apparatus for ion cyclotron resonance heating and of the development of the antenna and the high frequency transmitting system in QP machine at The Institute of Plasma Physics have been collected

We are going further historically to review the research of plasma heating and will collect the materials of the additional heating devices since 1973, when the first successful experiment by neutral beam heating was carried out on ATC Device at Princeton University and the development of high power additional heating devices were begun at the facilities in the world .

This work was conducted under NIFS Collaborative Research Program (NIFS10KVXP003).