

§4. Archival Studies on Devices of Fusion Science

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Objective and Method of Research

The main objective of this research is to collect and arrange the documents/materials on the devices of fusion research, which were built and used from the early stage in fusion research to the recent stage. Another objective is to provide the collection as materials available to historians as well as scientific researchers.

In order to see when the experimental study including thoughts on fusion began in Japan and how the devices have evolved, we have historically reviewed the experimental devices in the dawn of fusion research in Japan (1945 to 1965) through the proceedings of the meeting of some academic societies, some scientific journals and the related reports for two years. According to the review, we have collected the documents/materials of the devices in the early stage of fusion research.

Results and Conclusion of Review

Before 1948, except for the paper by J. Watase in Osaka City Univ. which discussed the radiation mechanism on a magnetron by considering plasma oscillation, papers and articles related to plasma were not found in the gaseous discharge session at the meeting of the Physical Society of Japan (PSJ) and also in the published journals. During 1949–1955, studies concerned with plasma increased gradually among the gaseous discharge session but gas discharge physics still had been an active field of study both in universities and industrial laboratories, and there had been no presentations related to nuclear fusion. Small glass discharge tubes were used in those experiments and the experiments were carried out with a small discharge current.

The study of pinch effect presented at the meeting of the PSJ in 1957 by M. Okada et al. in Osaka Univ. attracted attention because the pinch might be useful to provide the high temperature plasma for nuclear fusion. They initiated a preliminary experimental study to produce high temperature by heavy current discharge from capacitor bank in 1955. On the basis of the

preliminary experimental results, they constructed the linear pinch device for fusion research and began the fundamental experiments to produce a high temperature plasma. The toroidal devices and Scylla type experiments at Electro Technical Laboratory and the toroidal pinch experiment in Nagoya Univ. followed almost at the same time. These appear to have been the first experiment for fusion research in Japan. At this time, the presentation of the study of plasma attained to 1/3 of all papers submitted in the gaseous discharge session.

By 1960, the experimental devices on the three confinement approaches, - pinch, mirror and stellarator concepts-, which had been pursued in the countries of the world, had been constructed and the experiments had been started in universities, institutes and industrial laboratories.

These devices were similar in the geometrical dimensions and the principal parameters to those constructed at laboratories and universities in the world. They aimed to confirm and extend the published work of the experiment in foreign countries.

The early stage experiments for fusion in the world aimed at the demonstration of thermonuclear reaction by observing neutrons, but the researches for fusion in the early stage in Japan gave priority to understanding of plasma behavior, especially the production of stable quiescent plasma. Each experiment encountered technical difficulties and was also experiencing various problems such as arcing, electric breakdown and lack of reproducibility. The researches had been progressed through an iterative process including the better understanding of plasma, the improvement of experimental apparatus and the development of devices such as low impedance capacitor bank and switches and reliable diagnostics of high temperature plasma. Although there were no remarkable results concerned with serious issues of magnetic fusion such as the confinement and the heating of plasma during the decade 1956–1968, the foundation of new technologies and high temperature plasma physics were laid for the next stage which progressed to tokamak research.

In the 1960s, the experimental plasma studies were enhanced towards the fundamental physics of fusion. Most of the experiments moved to the study of plasmas in a magnetic field and the size of the apparatus became also larger.

Present Status on Collecting the Documents

In this fiscal year, some documents of the mirror machine, GAMMA, have been collected in the collaboration with University of Tsukuba, and some photographs of the devices in the early stage of fusion research in Japan have been collected.

This work was conducted under NIFS Collaborative Research Program (NIFS05KVXJ007)