Foreword

In 2010, the Southwestern Institute of Physics (SWIP) made progress in many aspects of magnetic confinement fusion research. An increasing number of research programs of SWIP have been approved and started up during 2010. A total of 279 research papers and reports were submitted, including 18 papers (1 plenary presentation and 3 oral presentations) accepted at the 23rd IAEA Fusion Energy Conference.

First, I would like to extend my sincere thanks to the colleagues and friends from other institutes and organizations, home and abroad, who have provided help or contributed insights to SWIP.

Second, I'd briefly introduce the 2010 Annual Report. This report summarizes the achievements at SWIP in the scientific research, development of applied technologies, personnel training, and other fields during the period from 2009 to 2010. The first paper of this report “Fusion Research at SWIP in 2010” is an overview of the latest progresses in the fusion research in 2010 and the first paper of each section introduces the overall progresses in the corresponding field.

Finally, I'd like to make a brief summary of the work of SWIP in 2010 in following areas:

Physics and engineering on HL-2A

In 2010 experimental campaign, the operational parameters on HL-2A were achieved as; 2.7 T (toroidal magnetic field), 450 kA (plasma current), 4.2 s (duration), 5 keV (electron temperature), 2 keV (ion temperature), and $0.8 \times 10^{20} \text{ m}^{-3}$ (plasma density). Steady and repetitive H-mode discharges were realized in HL-2A tokamak, with the total auxiliary heating power of 5 MW and the supersonic molecular beam injection (SMBI) and pellet injection techniques. Seven special research topics were devoted to improving the HL-2A plasmas confinement. The ECRH-assisted start-up experiment was carried out on HL-2A and expected results were obtained. A number of new results were achieved with the SMBI technique when the plasmas are highly confined with high operational parameters. Innovative results were obtained in the studies of plasma zonal flow and sheared Alfvén eigenmodes.

HL-2A modification (HL-2M) project has been carried on as scheduled. We continued making calculations for the HL-2M components, and began testing the manufactured components.

Key techniques of nuclear fusion

We continued developing key techniques of nuclear fusion, such as fueling techniques, diagnostic techniques and heating techniques for plasmas, and high-voltage power supply techniques. Key techniques as 25-tube extruded pellet injection and SMBI were developed. Much progress has been made in the advanced diagnostics development, such as the multi-channel bremsstrahlung measurement, the visible light imagery temporal and spatial profile measurement and impurity injection by the laser blow-off. These diagnostics have been applied to HL-2A experiments.

Achievements have been obtained in the researches on fusion reactor design, low activation fusion structural materials, high heat load components, and the fusion reactor technology.

Fusion plasma theory and numerical simulation

PIC code for the numerical simulation of the neoclassical tearing mode was developed. The physical effects of double tearing modes and geodesic acoustic mode (GAM) were numerically investigated. We will continue the numerical simulation research on pellet injection, ECRH and H-mode.
ITER participation

SWIP signed with ITER China the purchase contract of the first-phase technological qualification for ITER gravity support. The design of the CN HCSB TBM (Chinese helium-cooled solid breeder test blanket module) has been modified, mainly on the structure and configuration of breeding zone of the sub-module. Calculation and analysis results have showed that the modified HCSB TBM design is feasible and can be developed with the existing domestic technologies. The Chinese low-activation ferritic/martensitic steels CLF-1, which is the structural material of HCSB TBM, is being manufactured by industry. The neutron multiplier Be and tritium breeder Li2SiO4 pebbles are being prepared in the laboratory.

International cooperation

SWIP has been actively participating in ITER related activities and training scientists and engineers for ITER. It developed special cooperation and exchanges of experts on engineering and physics with other countries. During 2010, SWIP sent 157 persons abroad for international academic exchanges and cooperative tasks and received 87 foreign experts and scholars.

Application of the plasma technology

In 2010, we continued developing fusion related technologies and applying them into industry. The production line of the heat-insulation film has been built, which has an annual output of 900,000 square meters. SWIP has become the first supplier specialized in manufacturing magnetron sputtering window films in China. Its market sale has risen steadily.

Publications


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