10. Fusion Engineering Research Center

Basic and R&D studies have been carried out aiming liquid-breeder based blanket systems. One of critical issues is compatibility of the structure materials with the breeding/cooling materials, namely, corrosion behavior in static and flowing conditions of the liquid breeder. In Fusion Engineering Research Center (FERC), corrosion of ferritic steels, vanadium alloys in Flibe and Li are mainly studied collaborating with laboratories in universities.

A purification system for Flibe has been developed using TNF (The University of Tokyo-NIFS Flibe Grove box) facility. The high purity Flibe has been utilized for corrosion studies under static and flowing conditions. It has been found in experiments with static conditions that compatibility of JLF-1 with high purity Flibe is inherently good. According to SEM-EDX line analyses at the surface of JLF-1, chromium dilution is observed. On the other hand, tungsten is segregated and stably remained, which suggests possible W coating against corrosion.

A few thermal convection loops were constructed and dedicated to corrosion experiments under flowing conditions. Temperature difference was arranged along the flowing directions. Specimens of ferritic, austenitic steel and some insulating materials were exposed to Li or Flibe for hundreds hours. It has been observed that weight losses of specimens in the heating region are larger than the other part, and that the specimens placed in the low temperature region gained slightly the weights. These are due to the phenomenon of mass transfer, and this caused the dissolution corrosion in the high temperature region and deposition of dissolved material in the low temperature of the loop.

For the purpose of more systematic corrosion studies in future, construction of a Flibe non-isothermal forced convection loop is planned and design study has been carried out. A mechanical pump is utilized to provide the maximum flow velocity of 40L/min. A heater and a cooler is used for control temperature difference of 30 degree C. The test section in the loop is carefully designed for realize easy replacement of the test pieces with safety. Based on the geometry of the test section, pressure drop is estimated to be 0.479 MPa when the flow rate is 40L/min.

A 3-d neutronics calculations system has been further developed and applied to design studies on Force-Free Helical Reactor, FFHR2m. Tritium Breeding Ratio (TBR) , neutron wall loading, neutron shielding performance have been evaluated for the multi-layered Spectral-shifter and Tritium breeding Blanket (STB) concept. Discussion of further optimization of the design has been started to improve the shielding performance significantly.

A uniaxial creep testing machine for small specimens of low activation materials is developed. A creep test was conducted on 0.25 mm-thick sheet of NIFS-HEAT-2 (NH2) at 1073 K under load of 63 N, which is equivalent to the stress of 210 MPa. Vacuum during the creep test was 1×10^{-5} Pa, which is one order better than $1\sim5 \times 10^{-4}$ Pa for conventional creep test machine. Results close to biaxial data have been obtained due to a good vacuum condition.

Neutron irradiation test for superconducting magnet materials is continued with a cryogenic target system installed at Fusion Neutron Sources (FNS) in Japan Atomic Energy Agency (JAEA). In parallel with the experiments, reviewing was performed to clarify the mechanism of change in superconducting property. regarding the superconducting properties, the critical current, the critical temperature and the critical magnetic field are concerned and the experimental facts and the mechanism on the critical current are discussed.

An innovated novel method has been developed to measure critical current and stability of superconducting cables utilizing a closed electric circuit. Cu multi-strand Nb_3Sn cable was tested using 18 T superconducting magnet at

Tohoku University. A compressive load was applied up to 2770 kgf. Critical current measurement for ice-molded sample showed no degradation due to compressive load. In contrast, in un-frozen case, the degradation observed as usual cable samples.

Basic researches have been undertaken in these years using commercial GFRP, G-10CR, and the effect of the gamma ray irradiation on a evaluation process of interlaminar shear strength (ILSS) has been investigated empirically based on the precedent studies. The gamma ray dose is increased up to 10 MGy this year, and the results indicate that the ILSS decreases and becomes almost zero at 10 MGy. The clear degradation started at around 0.5 MGy.

A wire fabrication process has been developed and tested for the V_3Ga wires. High Ga content Cu-Ga compound is used and precursor mono-cored wires are fabricated through the Powder-In-Tube (PIT) process. The maximum Layer J_c (J_c value estimated by the cross-sectional area of the diffusion layer) achieved is 400 A/mm^2 (4.2K, 20T), and critical magnetic field (H_{C2}) property was about 22.5 T. Present results that V_3Ga compound superconducting wire had high potential property for an advanced fusion reactor application.

Offices of the center were moved to the 5th and 6th floors of the research staff building II in the fall of 2006. The building of former "Plasma Heating Laboratories" was rearranged and all the experimental facilities for fusion engineering studies were moved to this building. The building is renamed as "Fusion Engineering Research Laboratory" and dedicated to collaborations on blanket and material studies for fusion reactor from the fiscal year of 2007.

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