§26. Integration of Tritium, Irradiation and Thermofluid Researches and their New Directions

Okuno, K. (Shizuoka Univ.), Terai, T. (Univ. Tokyo), Kunugi, T. (Kyoto Univ.), Hatano, Y. (Toyama Univ.), Kimura, A. (Kyoto Univ.), Hasegawa, A. (Tohoku Univ.), Sagara, A., Muroga, T.

Blankets are component systems whose principal functions are extraction of heat and tritium. Thus it is crucial to clarify the potentiality for controlling heat and tritium flow throughout the first wall, blanket and out-of-vessel recovery systems. The joint project in Japan-US fusion cooperation program named TITAN (FY2007-2012) has a title of “Tritium and thermofluid control for magnetic and inertial confinement systems”. The objective of the project is to clarify the mechanisms of tritium and heat transfer throughout the first-wall, the blanket and the heat/tritium recovery systems under specific conditions to fusion such as irradiation, high heat flux, circulation and high magnetic fields. Based on integrated models, the breeding, transfer, inventory of tritium and heat extraction properties will be evaluated for some representative liquid breeder blankets and the necessary database will be obtained for focused research in the future.

In the NIFS collaboration program, discussion and coordination on Japanese side were carried out for planning the TITAN collaboration. Because the project is approaching the final period, modeling efforts to integrate the results obtained in each task plays increasingly important role. Table 1 is part of a summary table established in the TITAN common task activity showing parameters, models, underlying physics etc. for system integration modeling. Results of tritium transport, thermofluid and materials performance obtained in TITAN project are being modeled and analyzed in this framework.

Toward the landing of the project the emphases are summarizes as follows.

(1) Irradiation-tritium synergism studies are being enhanced especially for the impact of neutron irradiation on tritium diffusion and inventory in plasma-facing materials.
(2) In the task on thermofluid, the construction of LLE loop for testing in a magnetic field was successfully completed. Researches focused on MHD flow and mitigation of MHD pressure drop will be carried out in the remaining period.
(3) Tritium permeation in structural materials and permeation barriers in low tritium partial pressure are the major interest of the blanket tritium control.
(4) Neutron irradiation and post-irradiation examination will be accelerated including timely shipping of the irradiated specimens to Japan.
(5) Interaction between each task and the Common Task will be reinforced for enhanced contribution to the integration modeling and the reactor design.

In the framework of the collaboration, activities after the TITAN collaboration were also discussed including assessment of the previous research.

Table 1. An example of the summary sheet showing parameters, models, underlying physics etc. for system integration modeling efforts summarized in TITAN Common Task activity.

item	task	parameters	model	physics	assessment	coupling / remakrs	Coupling
PFCS							
erosion	1.1	N,Te,Ti,lSOL,G (edge), impurity	REDEP HEIGHTS	•sheath •sputtering	Input: plasma edge, angular-		
BLANKET							
nuclear response functions from		material, plasma source, geometry,	MCNP, TRIM ANISN			coupling for activation	all material property
LM thermfluid		Geometry, material properties,	HiMAG	3D potential	good for complex geometries and 3D	also applicable to	
TRIT RECOVERY							
extraction			ASPEN, Wilms/Merrill				
MATERIALS		dose, dose rate, material, particle	codes: molecular	binary collisions,			thermomechanics, tritium