§72. Concept Design of Li-enclosed Capsule in Pile

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1. Introduction

A vanadium alloy is expected as a candidate material of blanket system with liquid Li coolant for fusion reactor application. Since there is not yet enough knowledge about radiation effect and compatibility between liquid Li coolant and structural materials, its engineering design cannot be determined. In order to resolve this problem, it is necessary to exam the compatibility experiment in liquid Li with Li-enclosed capsule in pile, so that it is required to develop the Li-enclosed capsule as an irradiation vehicle in pile.

In this study, we discuss the compatibility experiment in liquid Li with Li-enclosed capsule in the domestic reactor such as JMTR and Joyo, and aim at acquiring the data in order to design the capsule.

Task items in this plan are shown in the following;

- Analyses of the tritium production and leakage amount from Li-capsule in irradiation
- Evaluation of thermal expansion difference (TED) in Li-fulfilled capsule
- Analysis of corrosion resistance of material against Li coolant
- Design of Li-enclosed capsule

2. Results

Capsules by the SUS316 steel were manufactured as a full-scale mock-up of Li-enclosed capsule in order to ensure the manufacture process of vanadium capsule for Li-fulfilled capsule. Fig.1 shows a dummy capsule made of SUS316 steels and a TED monitor used in Joyo made of SUS316 steel.

In the liquid Li environment, nickel component in SUS316 steel elutes it to a liquid Li side and it does not allow us to use the SUS316 steels as TED standard monitor in Li-enclosed capsule. In place of SUS316 steel, a vanadium alloy was adopted as the material of TED monitor for liquid-Li capsule. At the points of mechanical strength and radiation-resistant irradiation behavior during neutron irradiation in pile, a V-5Ti alloy was chosen as the TED material. From the Joyo laboratory in JAEA-Oarai, the blue print and the basic data of TED monitor were provided and the TED design drawing of a V-5Ti alloy was made as shown in Fig.2. It was designed and manufactured at pipe thickness of 0.1mm in the SUS316 steel, but its design was changed at pipe thickness of 0.2mm due to a problem of the accuracy of finishing in the vanadium alloy fabrication. An ingot of the vanadium alloy was manufactured by Daido analysis research Co., Ltd., and the fabrication of TED cap component was performed by S.F.C Co., Ltd. In 2011, EB weld of a TED component and sodium enclosure in TED capsule by laser weld will be done in JAEA-Oarai. An out-pile thermal aging test will be promoted as evaluation of TED performance at high temperatures.

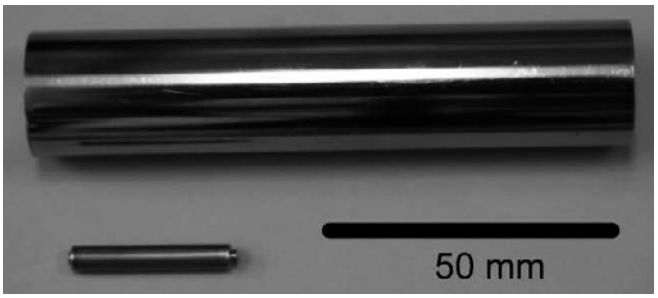

Fig.1 A dummy capsule made of SUS316 steels and a TED monitor used in Joyo made of SUS316 steel.

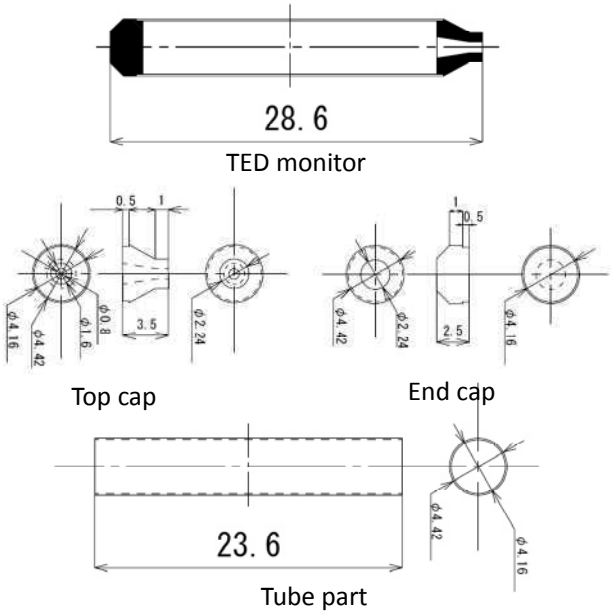

Fig.2 Blue prints of TED monitor for Li-enclosed capsule.