Transactions of the Korean Nuclear Society Spring Meeting
Gyeongju, Korea, May 29-30, 2008

Study on Integrated Fuel Handling and Inspection Concept in SFR

S. H. Kim [a*], J. H. Lee [a]
[a]*Korea Atomic Energy Research Institute, Daejeon 305-600, Korea*
[*]Corresponding author: *shkim5@kaeri.re.kr*

1. Introduction

The reactor core and the mechanical components in the sodium fast reactor are totally immersed in sodium, with the core being up to several meters below the sodium surface. Thus, the examination of the reactor internal structure is a difficult task and the visual techniques are impossible because of the opacity of liquid metal. The in-vessel fuel handling machine is used to handle fuel assembly ducts, control rods, reactor components in the sodium-filled core of the reactor. The machine is designed in two parts. The upper part is basically an electrically driven gear box for operating the in-vessel section lower part. The lower part is positioned vertically from the rotating plug and extends into the reactor. The machine can be rotated and pick the core assembly ducts up after positioning the grapple over the required fuel assembly duct. The function of the rotating plug which is located in the center of the reactor head control the rotation to move the fuel handling machine into all positions of the reactor core during the refueling time.

The movement for a special position in the reactor internal is possible by using these fuel handling machines and rotating plug, and the reactor internal structures under sodium can be inspected. The deformation of the reactor core occurred during the reactor operation make a significant effect for the exchange of the fuel assemblies. Thus, the identification of the reactor configuration and deformation is necessary and the inspection for the main position of the reactor internal structures is required[1].

2. Inspection for Reactor Internal Structures

The sodium surface and the in-vessel components above the sodium level will be examined using periscope or camera, inserted through the multiple access ports in the closure head deck. For components below the sodium level, normal in-service inspection approach is based on continuous monitoring, dimensional gauging and under sodium viewing as shown in Fig. 1. Continuous monitoring of sodium levels, outlet temperature of a limited number of core assemblies, vibration and the pressure in the pump discharge manifold will provide the indication of the integrity of the pressurized components in hard to access areas of the reactor pool. The structural components of the core support and restraints can be

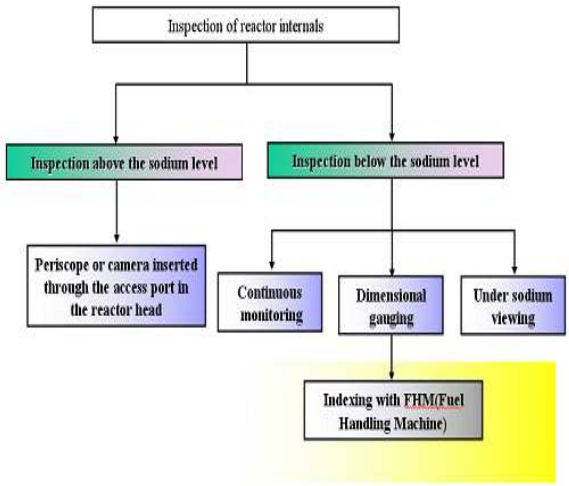

Fig. 1 Inspection procedure of a reactor internal structure

inspected with dimensional gauging. Dimensional gauging can be performed by indexing with the fuel handling machine or other dedicated indexing mechanism on several specified locations. The verification of the proper location of a component can also imply a proper location for the core support structure[2].

Under sodium viewing can also be used to map the core top, and used to investigate the condition of many difficult to reach areas. For an accurate measurement, gauge blocks and gauge marks are set at key locations to serve as reference marks for under sodium viewer. The rotating plug can move the fuel handling machine and the under sodium viewer to various locations inside the reactor vessel.

3. Integrated Concept of the Fuel Handling Machine

The integrated fuel handling and inspection concept has been suggested to enhance the effectiveness and application of an in–vessel fuel handling machine. This concept can reduce the period of the reactor internal inspection during the refueling time owing to performing dimensional gauging and under sodium viewing integratedly using the in-vessel fuel handling machine. The reactor internal inspection required during the refueling time can be simplified by using the fuel handling machine. Fig. 2 shows a schematic of a preliminary

concept of an integrated fuel handling and inspection machine.

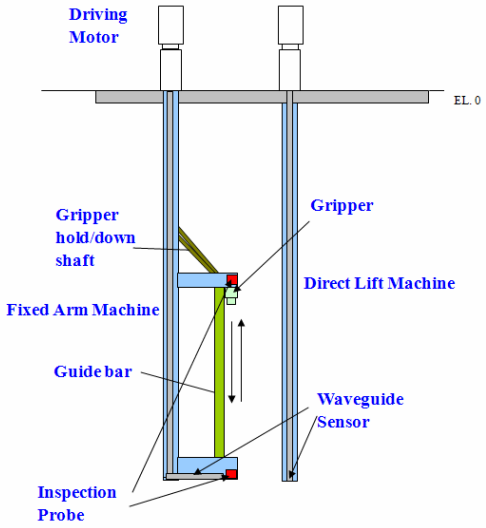

Fig. 2 A schematic for the preliminary concept of integrated fuel handling and inspection machine.

The inspection probes and sensors for the dimensional gauging and the under sodium viewing inspection are installed on the fixed arm of the in-vessel fuel handling machine. Fig. 3 shows the conceptual design of the in-vessel exchange concept for fuel assemblies[3]. The mechanism of two rotating plug and fuel handling machine can move to the top of the reactor core or the other specified location[4].

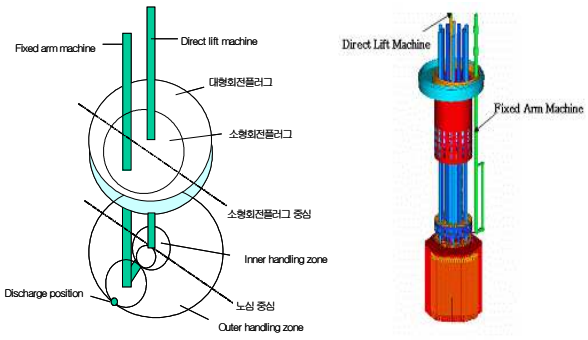

Fig. 3 Conceptual design of two rotating plug type in-vessel fuel handling machine in SFR

Fig. 4 shows the main inspection position of the reactor internal structures which can be inspected by applying the integrated fuel handling and inspection concept. The deformation of the core support structure can be verified by inspecting the elevation of the core barrel and other structural components in the hot pool. The core top mapping, sweeping and the inspection for areas difficult to access can be investigated using under sodium viewing.

4. Conclusions

The integrated fuel handling and inspection concept has been suggested to enhance the effectiveness and application of an in–vessel fuel handling machine. The reactor internal inspection required during the refueling time can be simplified by using the fuel handling machine.

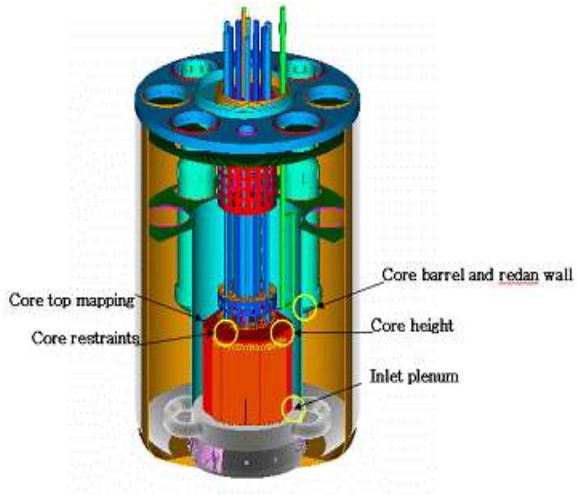

Fig. 4 Main inspection positions of the integrated fuel handling and inspection concept in SFR

Acknowledgements

This study was supported by the Korean Ministry of Education, Science and Technology through its National Nuclear Technology Program.

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