Conceptual Design of A-Frame Type Fuel Transfer System with Horizontal Movement in SFR

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Abstract

The A-frame fuel transfer system is designed in type of removing the spent fuel from the reactor and bringing the new fuel into the reactor inside from a specific location outside the reactor using an A-frame type fuel transfer port. In large scale reactors, double rotating plugs are primarily applied, and most of these reactors use A-frame fuel transfer ports to minimize the process and distance of withdrawing spent fuel assemblies from inside to outside of the reactor. The A-frame fuel transfer system moves fuel assemblies mainly by rotary movement from the top of the reactor. French PHENIX, European EFR, and Indian PFBR use rotatable movement type A-frame devices. In this study, A-frame devices that move horizontally from the top of the reactor were conceptually designed .

Introduction

■ Design Characteristics

- General design type of A-frame fuel transfer system
  . Rotary movement from the reactor top
  . PHENIX (French), EFR (Europe), PFBR (India)
- In this study, A-frame devices that move horizontally from the top of the reactor were conceptually designed as shown in Fig. 1.
- Main devices
  . A-frame fuel transfer port
  . Fuel transfer basket
  . Gate valve
  . Linear actuator and tilting system
  . Actuator support structure
  . Chain winch drum

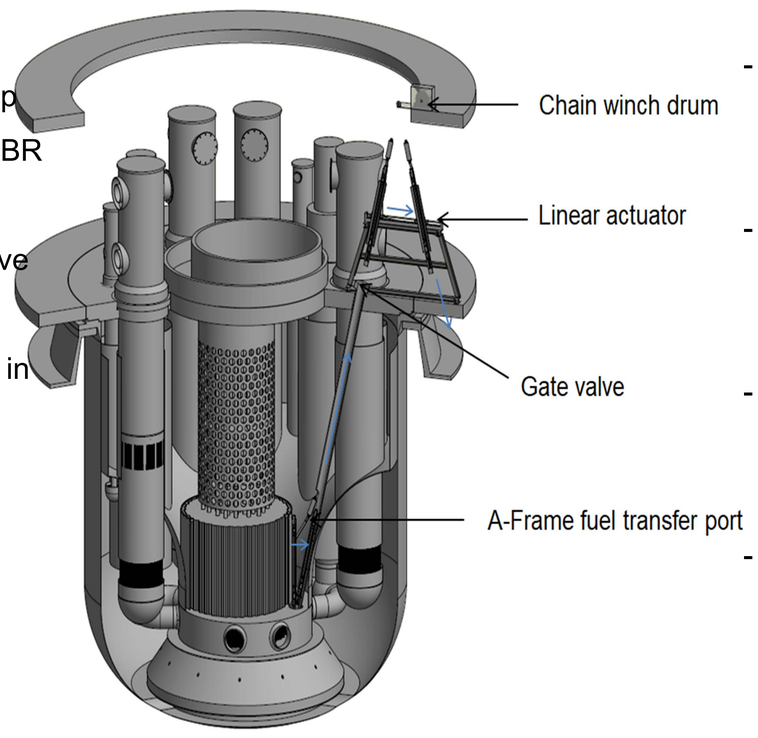

Fig. 1. Conceptual design of A-frame type fuel transfer system with horizontal movement

Conceptual Design of A-Frame Fuel Transfer System with Horizontal Movement

■ Fuel Handling Concept

- The spent fuel assembly inside the reactor moves to the fuel transfer port by the in-vessel transfer machine, which is loaded into the fuel transfer basket prepared in the fuel transfer port.
- Initially, vertically positioned fuel transfer basket tilts 14° relative to the vertical line due to the tensile force of the connected chain, which is withdrawn out of the reactor through an inclined A-frame transfer port as shown in Fig. 2.
- In addition, the reactor is shielded by the opening and closing of the gate valve installed on the reactor head.
- The fuel transfer basket withdrawn out of the reactor moves horizontally by the linear actuator and the tilting system, which is transported to the opposite end as shown in Fig. 3.
- At this time, the chain connected to the fuel transfer basket moves around the guide roller of the chain winch drum installed at the top of the reactor.

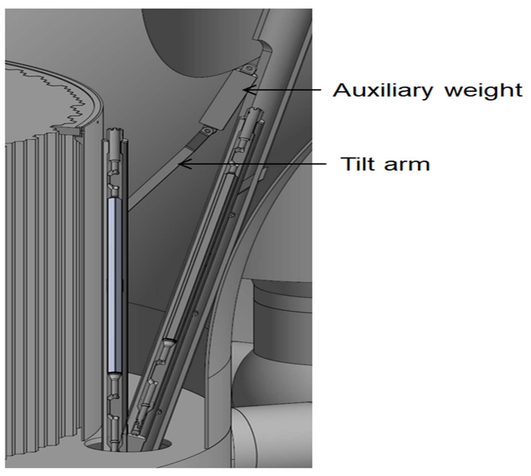

Fig. 2. Lower part of A-frame type fuel transfer system with horizontal movement

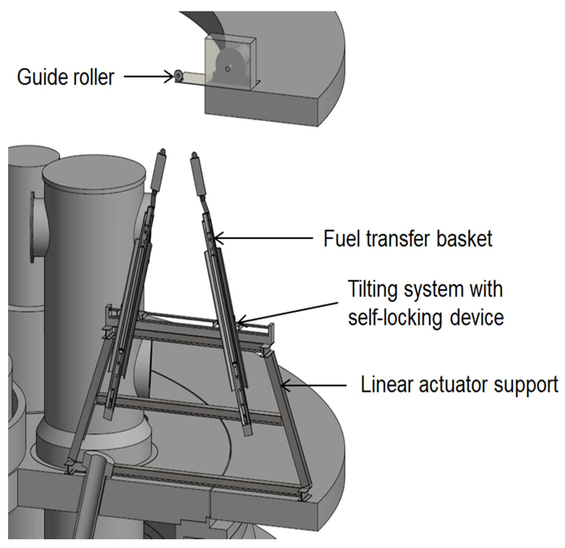

Fig. 3. Upper part of A-frame type fuel transfer system with horizontal movement

- At the end of the linear actuator, the fuel transfer basket is tilted to –14° using its own locking device and moved down to the temporary fuel storage.

Conceptual Design of Fuel Transfer Basket

■ Fuel Transfer Basket

- The movement of the fuel assembly in the A-frame refueling system takes place using a fuel transfer basket connected to the chain as shown in Fig. 4.
- The fuel transfer basket uses a circular tube to prevent the separation of the fuel assembly inside the reactor.

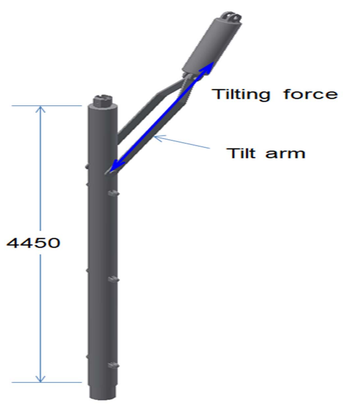

Fig. 4. Conceptual design of fuel transfer basket

- Six roller bearings were installed to minimize the frictional force in the circular tube.
- The configuration for the conceptual design of the fuel transfer basket is shown in Fig. 4.
- The fuel transfer basket in Fig. 5. is connected to the chain winch drum installed outside the reactor by a chain.
- The fuel transfer basket moves on the A-frame inclined surface through motor driving of the chain winch drum.
- Fig. 6 presents the configuration of roller bearing and rotating joint of the fuel transfer basket.

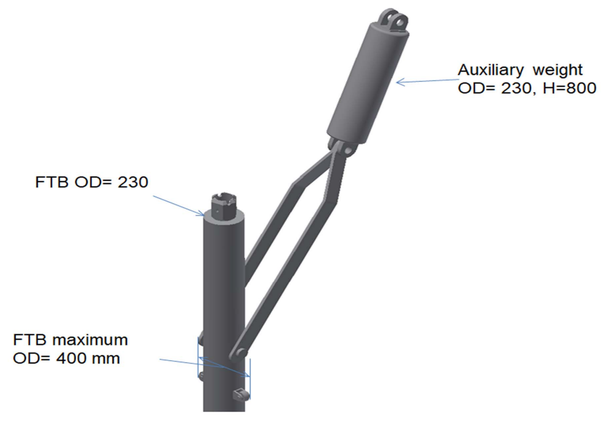

Fig. 5. Dimension for the upper part of fuel transfer basket

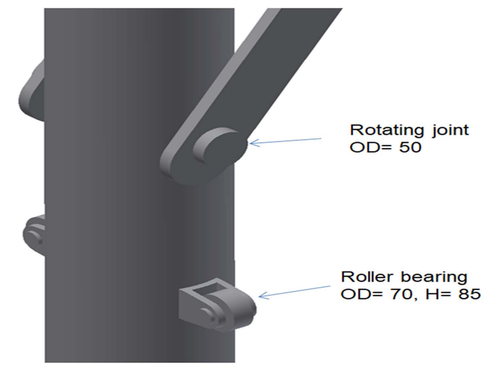

Fig. 6 Roller bearing and rotating joint of fuel transfer basket

Conceptual Design of Linear Actuator and Tilting System

■ Linear Actuator and Tilting System

- Fig. 7 shows the configuration for the conceptual design of the linear actuator and tilting system.
- The connected tilting tube rotates when the linear moving part installed on the ball screw-type linear actuator moves horizontally from side to side (Fig. 8).
- Inside the tilting tube, the fuel transfer basket connected to the chain is located.
- As shown in Fig. 8, the tilting tube is fixed with a self-locking device installed at the trunnion joint at an angle of 14°.
- The chain winch drum in Fig. 9 is connected to the fuel transfer basket located inside the reactor by a chain and is installed at the top of the fuel handling system outside the reactor.

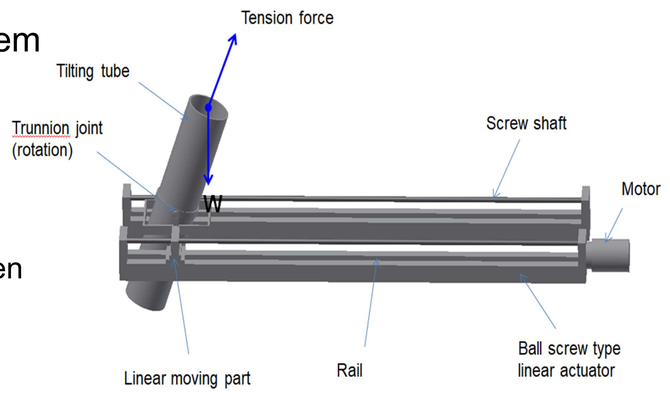

Fig. 7 Linear actuator and tilting system

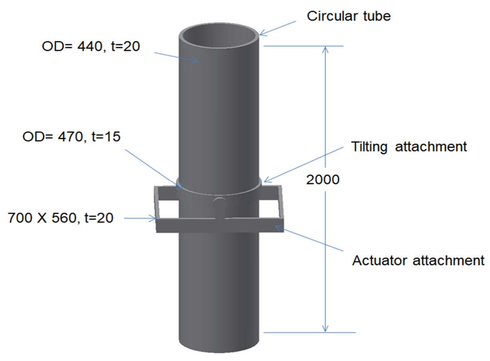

Fig. 8 Tilting tube connected to the linear actuator

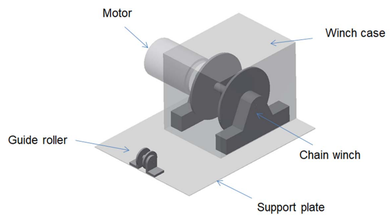

Fig. 9 chain winch drum

Conclusion

The conceptual design of A-frame type fuel transfer system with horizontal movement in SFR was performed, and the driving mechanisms for the movement and the support structure were reviewed.

Acknowledgements

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References

[1] J. H. Lee, Structural Design Report for Main Component, SFR-060-P4-462-003, KAERI, 2020.