

An Overview of the Mechanical Design Features of the Recently Developed Low Power Research Reactor

Yeonseok Choo ^{a*}, Jihoon Lee ^a, Sanghaun Kim ^a, Gyeongho Kim ^a

^aKorea Atomic Energy Research Institute

*Corresponding author: chooyeonseok@kaeri.re.kr

1. Introduction

For the purpose of education and training, a new concept of low power research reactor has been studied in KAERI(Korea Atomic Energy Research Institute) and its mechanical design of reactor assembly has been proposed as a basis for the further realization. The design features of reactor assembly for the newly developed low power research reactor are described in this paper.

2. Mechanical Design Features

Efforts have been made to develop a reactor with a simple and stable structure for the efficiency and safety. Also, direct accessibility and ease of maintenance are considered importantly in the reactor mechanical design. In this section, design features for each component are presented.

2.1 Reactor Assembly

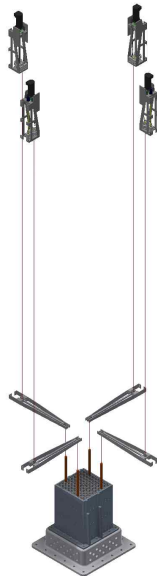


Figure 1 Configuration of Reactor Assembly

The reactor assembly is composed of a reactor structure assembly and four CRDM(Control Rod Drive Mechanism)s. The reactor structure assembly is fixed on the pool bottom with anchor bolts. The anchor bolt specification and its pretension are calculated from structural analysis so that the reactor can be firmly fixed against external events including earthquake. The

CRDMs are fixed on the pool wall with bolts and can be directly approached from the pool top by hands for the maintenance.

2.2 Reactor Structure Assembly

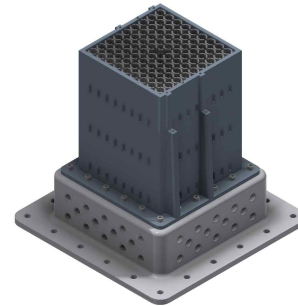


Figure 2 Reactor Structure Assembly

The reactor structure assembly consists of a core support structure and a core box. The reactor structure assembly shall provide the structural support and cooling geometry for the core, which shall be maintained under any condition defined in the design bases. The reactor structure assembly shall ensure the insertion of control rod for reactivity control or safe shutdown of the core, when necessary.

The core box contains and protects the core from the seismic events. The core and core box are supported by the core support structure. Since the core is cooled by natural convection, both the core box and core support structure should provide enough coolant passage. The core box and core support structure are made of zirconium alloy and low carbon stainless steel, respectively.

2.2 CRDM

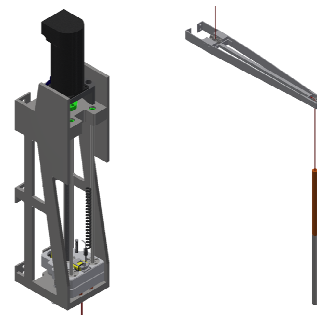


Figure 3 CRDM

The CRDM is composed of ball screw drive assembly, stepping motor, frame, mover-follower assembly, linear transducer, upper and lower limit switches, cable and the control rod with balance weight. The CRDM shall provide functions of the insertion and withdrawal of the control rod. The combination of mover with electromagnet and follower which made of permanent magnetic material is quite secure and reliable fail-safe system against accidents. The control rod shall be dropped fully into the core by gravity when the interruption of the electric power supply occurs. The connecting system with the cable is efficient for operation and instantly detectable in case of malfunction. The control rod is moved upward by the stepping motor turning a ball screw and its position is checked by the linear transducer. The upper and lower limit switches indicate the ends of the travel.

2.4 Core Support Structure

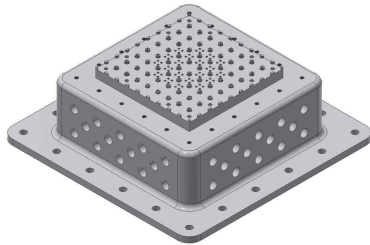


Figure 4 Core Support Structure

Since it supports the core, the core support structure should be assigned as a safety class component according to the law and code^[1]. As strictly applying rules stipulated in the code, the core support structure should maintain the coolable geometry for the core when all kinds of accidents in the design bases occur. The grid on the top of core support structure provides universal position for the fuel assembly and reflector assembly. The coolant pass through the cavity under the grid, and flow holes on the grid and side walls into the core.

2.5 Core Configuration

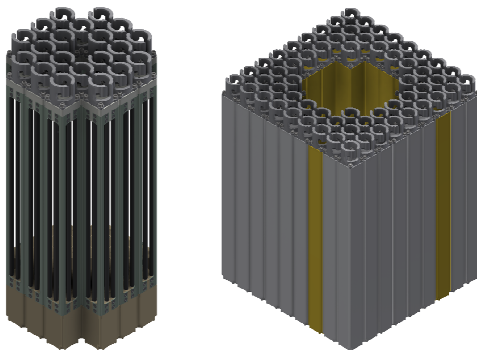


Figure 5 Core Configuration

The 20 fuel assemblies, 32 beryllium reflector assemblies, and 28 graphite reflector assemblies make up the core. The fuel assemblies are surrounded by the beryllium and graphite reflector assemblies. The beryllium reflectors and graphite reflectors provide positions for the control rods and irradiation rigs, respectively.

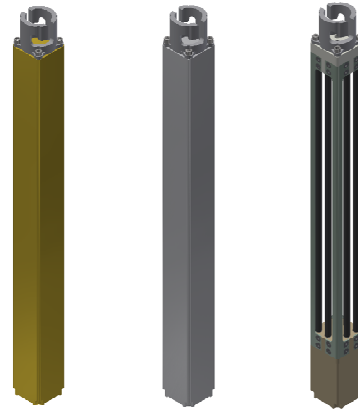


Figure 6 Components of Core

The fuel assembly and reflector assembly have same designs feature on the bottom and the head holder. They can be identically placed in any location of the grid and handled through a head holder using one type of special tool.

3. Conclusions

The design features of reactor assembly for the newly studied low power research reactor are presented. As described above, the conceptual design of the reactor with safe operation and easy maintenance has been completed. It is necessary to validate its structural integrity by performing numerical analysis.

REFERENCES

- [1] ASME Boiler and Pressure Vessel Code, Section III, Division 1 - Subsection ND, "Class 3 Components", Rules for Construction of Nuclear Facility Components, 2013 Edition, American Society of Mechanical Engineers.