Development of an Innovative Reflector Drive Mechanism using Magnetic Repulsion Force for 4S Reactor

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ABSTRACT

A small sized fast reactor 4S: (Super Safe Small and Simple) which has a core of 10 - 30 years life time is controlled by reflectors. The reflector is required to be risen at very low speed to make up for the reactivity swing during operation. This report shows the development of an innovative reflector drive mechanism using magnetic repulsion force that can move at a several micrometer per one step. This drive mechanism has a passive shut down capability, and can eliminate reflector driveline.

The reflector drive scheme of 4S using this mechanism at each operating condition is as follows:

.start up : reflectors are risen to the start position by the hydraulic upward force of coolant.

.normal operation: reflectors are risen at low speed by the reflector drive

mechanism. The typical speed of it is less than 1mm /day.

.at the shut down: reflectors are moved down by erasure of magnetic force between the mechanism and the reflector, or loss of the hydraulic upward force of coolant.

The scheme of the micro step movement is as follows:

.The drive mechanism connects with the core barrel, and has the magnet to support a reflector. And, it has the coil to give magnetic repulsion force between itself and the reflector.

.When the magnetic repulsion force is given to the drive mechanism, the mechanism rises at the micro step along the guide on the core barrel, and then the magnetic attraction force in the mechanism pulls up the reflector.

.Consequently both the reflector and the mechanism rise at the micro step, and return to the early condition.

Miniature models of reflector drive mechanism were manufactured. Reflector drive experiments were carried out under the air and the liquid conditions. The movement distance of 1 step under the liquid is smaller than it under the air, but it is verified that the mechanism and the reflector rose at micro step under both conditions.

The experimental apparatus simulated one sector model of reflector movement region and models of the reflector were manufactured. As experimental results, these critical flows of reflectors moving up were evaluated, they were verified that reflectors smoothly rose by the hydraulic force and smoothly fell down at the loss of the hydraulic force.

Fundamental characteristics of the reflector drive system using magnetic repulsion force were verified by these experiments.