HEAT REMOVAL TESTS ON DRY STORAGE FACILITIES FOR NUCLEAR SPENT FUELS

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1. INTRODUCTION

In Japan, spent fuels generated in a nuclear power plant are controlled and stored in a storage facility until they are reprocessed. It is foreseen that the amount of the spent fuel increases every year and a storage facility with large capacity constructed away from reactor is needed. If the large amount of spent fuels are stored in a dry storage facility away from reactor, natural convection system of the storage is advantageous from the safety and economical point of view. To realize this type of storage facility, it is necessary to develop an evaluation method for natural convection characteristics precisely and to make a rational design taking account of safety and economy.

2. HEAT REMOVAL TESTS ON STORAGE FACILITIES

To evaluate the heat removal characteristics on storage facilities such as cask, vault, and silo system, tests were performed with 1/2 or 1/5 scale model of the facility[1]. Main results are summarized below.

(1) Cask storage system

Figure 1 shows test equipment for Cask type storage system. In the test, flow patterns of cooling air were observed(Fig.2). It was observed that near the floor between the heater row, air coming from the inlet flowed to the center with relatively high velocity. Heat transfer of the heater surface dominates the vertical flow of the natural convection mainly but it is necessary to take account of the effect of the cross flow.

(2) Vault storage system (cross flow type)

It is desirable that the cooling air flows across the heater to promote the heat transfer of the heater surface in this system. Test equipment is shown in Figure 3 and heat removal tests were performed. As a result, distinction method of the flow pattern in the test module was discussed. Ri number is an indicator of the flow pattern. If Ri <3, cross flow is dominate in the heater zone. Average heat transfer rate of the heater surface after row No.4 is almost same and agrees with existing empirical equation(Fig.4).

(3) Silo storage system

Figure 5 shows the test equipment. The relation between the heat transfer and flow rate can arrange by Ri number. If the flow rate is small (Ri number is large), heat transfer rate can calculate by the equation of the natural convection on a horizontal cylinder. If it is large, heat transfer rate can calculate by the equation of the forced convection on a horizontal cylinder(Fig.6).

3. CONCLUSION

By the heat removal tests with the reduced scale models of the storage facilities (cask, vault, silo system), the flow pattern in the test module are made clear. Temperature and velocity distributions were obtained and heat transfer characteristics are evaluated.

REFERENCE


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Heater: height 1 m
Diameter 0.5 m
Heater Power 0~1.2 kW/unit

Heater: height 1.3 m
Diameter 0.1 m
Heater Power 0~0.3 kW/unit

Fig. 1 Test Equipment (Cask Storage System)
Fig. 2 Flow Pattern (Cask Storage System)

Fig. 3 Test Equipment (Vault Storage System)
Fig. 4 Relation between Re and Nu (Vault Storage System)

Fig. 5 Test Equipment (Silo Storage System)
Fig. 6 Relation between Ri and Nu (Silo Storage System)