HEAT REMOVAL TESTS ON DRY STORAGE FACILITIES FOR NUCLEAR SPENT FUELS[1]

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1. INTRODUCTION

In Japan, spent fuel generated in a nuclear power plant is controlled and stored in a storage facility until it is 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 a large amount of spent fuel is stored in a dry storage facility away-from-reactor, the natural convection system of the storage facility is advantageous from the safety and economic point of view. To realize this type of storage facility, it is necessary to develop an evaluation method for natural convection characteristics and to make a rational design taking into account safety and economy.

2. HEAT REMOVAL TESTS OF STORAGE FACILITIES

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

(1) Cask storage system

Figure 1 shows test equipment for a 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. The test equipment is shown in Figure 3 and heat removal tests were performed. As a result, a distinction method of the flow pattern in the test module was discussed. Ri number is an indicator of the flow pattern. If $Ri < 3$, the cross flow dominates in the heater zone. The average heat transfer rate of the heater surface after row No.4 is almost the 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 be arranged by Ri number. If the flow rate is small (Ri number is large), the heat transfer rate can be calculated by the equation of the natural convection on a horizontal cylinder. If the flow rate is large, the heat transfer rate can be calculated by the equation of the forced convection on a horizontal cylinder (Fig. 6).

3. CONCLUSION

Through the heat removal tests with the reduced scale models of the storage facilities (cask, vault, silo), the flow pattern in the test modules have been identified. The temperature and velocity distributions were obtained and the heat transfer characteristics are evaluated.

REFERENCE

[1] SAKAMOTO, K., et al., "Heat removal characteristics of dry storage facilities for spent fuel tests with reduced scale models", IMechE Conference Transaction 1996-7, Int. Conf. on Storage in Nuclear Fuel Cycle, Manchester, (1996) 217,226.

[1] This programme is sponsored by the Science and Technology Agency of Japan.

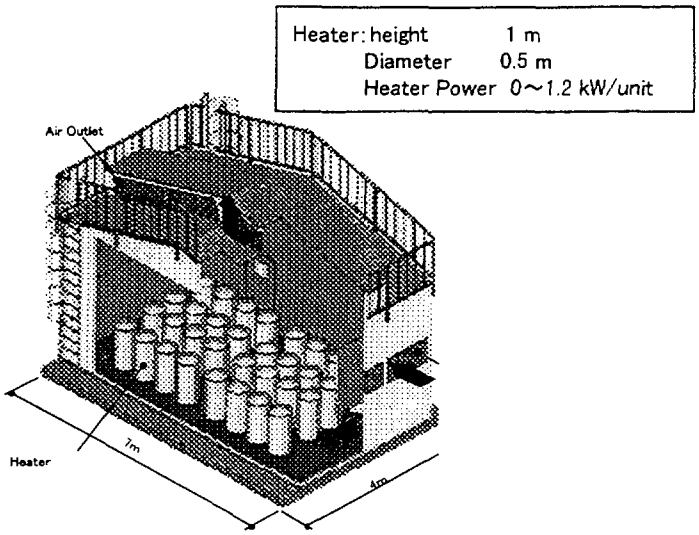

FIG. 1. Test equipment (Cask Storage System)

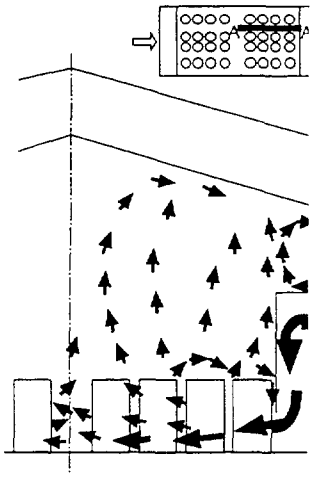

FIG. 2. Flow pattern (Cask Storage System)

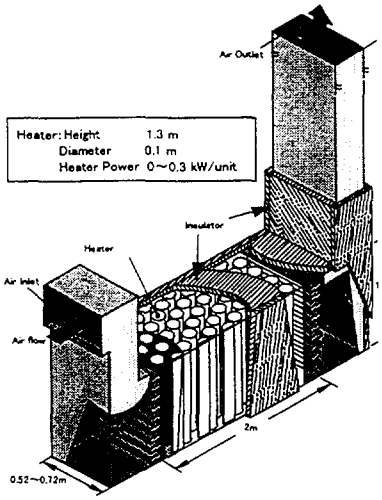

FIG. 3. Test equipment (Vault Storage System)

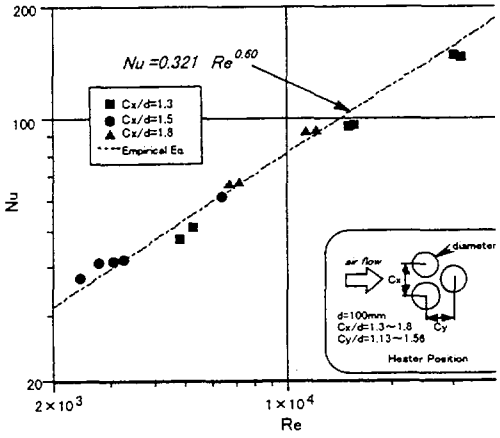

FIG. 4. Relation between Re and Nu (Vault Storage System)

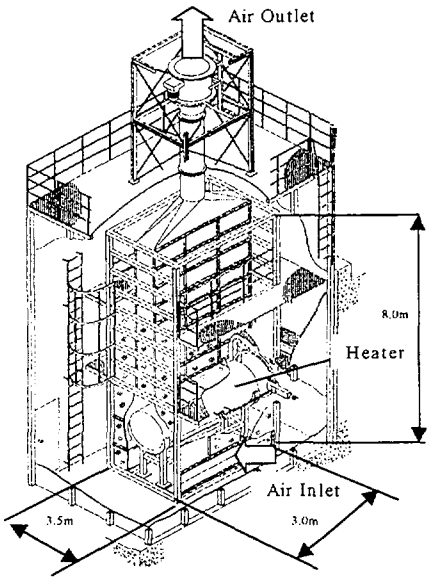

FIG. 5. Test equipment (Silo Storage System)

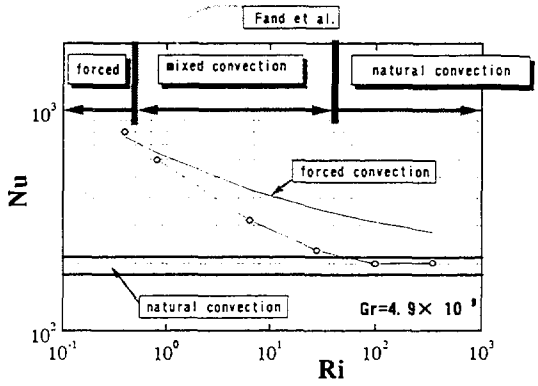

FIG. 6. Relation between Ri and Nu (Silo Storage System)