§5. Design Research on the Advanced Thermal Structure System in the Nuclear Fusion Reactor

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1. OBJECTIVE

Molten salt Flibe has been considered as one of suitable blankets in the nuclear fusion reactor, and the accumulation of heat transfer data and handling technique of the high temperature molten salt for offering the design is being desired. However, the melting point of Flibe is so high at 459 C and it contains highly toxicant material Be, so that, in Tohoku Univ., experimental research which makes HTS to be working fluid as the simulant of the high Pr fluid Flibe has been performing [1](See Fig. 1 and Fig. 2). In the present design research, the knowledge of the heat transfer data and the handling technique that have been obtained so far, and the guidelines for carrying out the design evaluation are summarized.

2. HEAT TRANSFER DATA

The heat transfer characteristics in a straight pipe flow had been almost confirmed in the last year. The experimental data seems to almost agree with conventional empirical formula qualitatively though the value is a little lower than the empirical formula due to wall temperature drop at the outlet of a heating section which is caused by a high heat capacity of mixing chamber to measure a outlet bulk temperature and not enough fluid mixing in the chamber. At present, the experiment using the improved mixing chamber is implementing. It will be possible to show the exact heat transfer data under the high-temperature condition and the limit of similarity law. On the other hand, heat transfer performance of the high Prandtl fluid is quite low, so that the heat transfer experiment using the pebble pipes is being started in order to enhance the heat transfer and applicable data to the design is expected.

3. HANDLING TECHNIQUE OF HIGH-TEMPERATURE MOLTEN SALT

It was clarified that the slippage of about 14mm had been generated at the connection of the stainless test section for 1 year by the repetition of the high-temperature operation though the piping system around the test section was constructed in consideration of a thermal expansion. In the actual nuclear fusion reactor design, it is considered that severer attention will be required for the system design on the assumption of the higher temperature condition. In addition, composition change of the molten salt, which originates from thermal decomposition with high-temperature operation, and moisture absorption and oxidation by the air that flows into the piping system at the maintenances were confirmed. These phenomena have the high possibility that the physical property of molten salt, namely heat transfer performance itself, changes, and it is necessary to estimate the composition by sampling once in a while and to attempt thoroughgoing prevention at the operation, management and maintenance in the design stage.

4. CONCLUSION

Furthermore, many important experience for offering to the design such as prevention from entering of the molten salt into the gas piping system, optimum control of high-temperature free liquid level, seals of the high-temperature molten salt, airtight maintenance technique, etc. are being accumulated as well as the heat transfer data. The system design must sufficiently be made to reflect these knowledge.

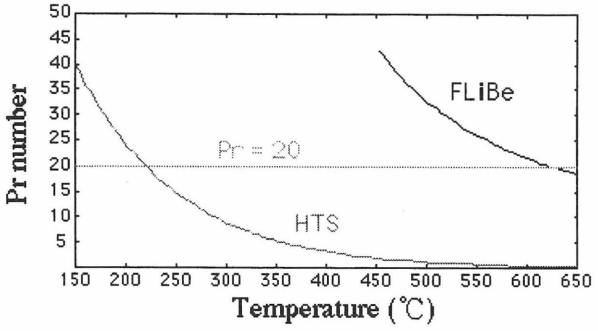

Fig. 1 Thermal property of Flibe and KOH

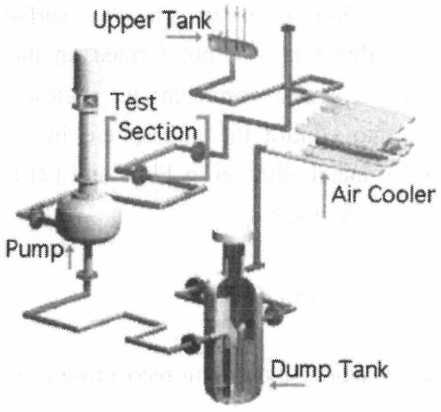

Fig. 2 High temperature molten salt loop@Tohoku univ.