§15. Heat Transfer Experiment by Molten Salt (HTS) High Temperature Loop - Straight Close Channel Test

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In this study, we have chosen **HTS**(Heat Transfer Salt) as a working fluid for the Molten Salt High Temperature Loop in place of **Flibe**. The main purpose of this experiment is to investigate heat transfer enhancement in molten salt flows, however, we have not yet obtained so such accurate Nu number in circular smooth pipe that is on going as the preliminary experiment. It arose from the following two reasons. In measuring Nu number, working fluid has not be stired enough so that bulk temperature can be measured accurately. However, molten salt have to be stired by different ways from a way applied for usual fluids like water due to its high viscosity. Another reason is a heat capacity of the pipe in a mixing area. The mixing area to stir a fluid is located just after a heating area. The large heat capacity of the mixing zone brought a part of temperature profile of the working fluid shifted to high temperature. For improving the former problem, it is qualitatively examined that a packed-bed tube is effective to stir molten salt(Fig. 1), and in addition, the packed-bed tube can be expected to enhance heat transfer characteristics of molten salt. For the latter problem, we have applied another way to use a newly manufactured mixing zone.

Through this experimental study, we can obtain how to handle the high temperature molten salt flowing in this loop. It is clarified for the loop that a maximum flow rate is about 3.1×10^{-5} (m^3/s) (18 ℓ/min.) at 200 ^oC(Fig. 2). The maximum flow rate is changed depending upon temperature and pressure drop of the working fluid. The maximum flow rate is 3.3×10^{-5} (m^3/s)) (19 ℓ/min.) at 300 ^oC.

When the whole working fluid is returned into a dump tank after shutdown, some of molten salt stays behind at welding points of the loop due to less flluidity with its high viscosity. We have to solve this problem if Flibe is used instead of HTS in future. Before operating the molten salt loop, gas leak tests should be made for preventing from the case of molten salt leaks from connections of flanges. In the present loop, airtightness of the loop was found to be broken not from the connections but from some of solenoid valves. However, the leak was so small that the leak check is needed over several days for its inspection. We have to take into consideration of enough check of airtightness if we use Flibe instead of HTS because Flibe vapor involves Be.

It takes much time needed for melting HTS (5 or 6 hours) because a melting point of HTS is 142^oC but its heat capacity is equivalent to water. From this reason, the loop must be entirely preheated over the melting point up to about 200^oC. Although the pre-heater is installed to the present loop, temperature rising at the parts of flanges is very slow compared with another parts of the loop since these heaters of flanges have to controlled together with the neighboring parts of the pipes. Temperature rising at the parts of normal pipes is very quick. Heaters of flanges have to be controlled separately in order to keep away from solidification.

We have to consider the molten salt might invade into pipes and be freezed there, which are not covered with thermal insulation during the case of abnormal conditions like false operating. For the case, it is necessary to install some hazard equipments which help us to find such a hazard situation and preventing from closing channels. From the present experiments, we are summarizing procedures how to handle safely this loop so that we can perform experiments without trouble.

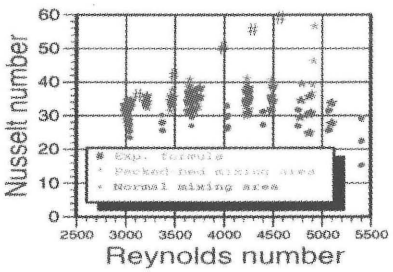

Figure 1: Re *vs* Nu

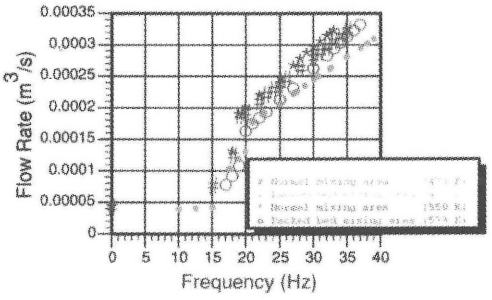

Figure 2: Frequency *vs* Flow rate