Three-dimensional finite element model of ADS zero-power facility is constructed to perform dynamic evaluation using ABAQUS/standard code. Weight, hydrostatic pressure and seismic loads are applied. The Square Root of Square Sum (SRSS) calculation method is chosen to combine modals in response spectrum analysis. The structure strength of the integrated model qualifies for nuclear services as ASME code Section III. Both water zero-power reactor core and lead reactor core vessels meet ASME-III-ND specification. The support leg stress assessment meets the requirements of ASME-III-NF. Therefore, ADS zero-power facilities maintain structural integrity during the earthquake.

5 - 21 Effects of Turbulent Intermittency on Fluctuation of Thermal Parameters in a Heated Channel

Feng Li

I. Experimental apparatus

A schematic diagram of the experimental test loop is shown in Fig. 1. The flow circulation starts from the pump, sub-cooled water is pumped through filter and turbine flowmeter into the test section. The heat is provided to the flow using an electrical DC power supply by applying a voltage over the test section. The fluid absorbs heat when passing through the test section, causing an increase in the temperature measured at the exit of the test section. The water then flows to the condenser where it is further sub-cooled in order to complete the circulation, the flow then back to the pump again. A control valve at the inlet of the test section enables the accommodation of flow rate. Flow rate was also adjusted by controlling the motor speed. The experiment was conducted by slowly increasing the flow rate while maintaining the heat flux as constant parameter which was 19.66 kW/m^2. The outlet temperature, pressure drop and wall temperature under the same heat flux and different flow rate conditions were measured.

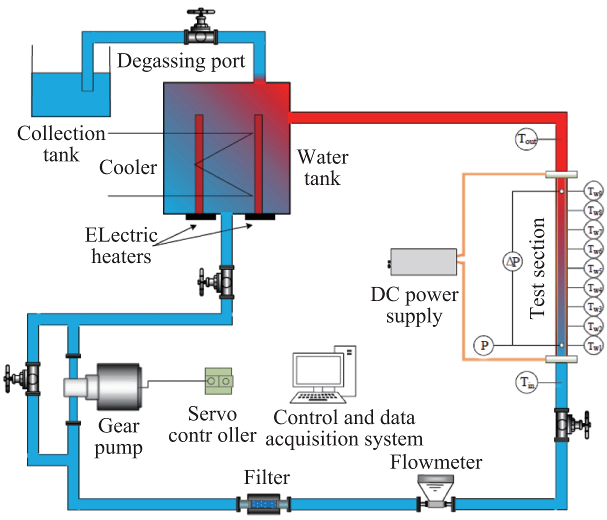

Fig. 1 Schematic diagram of the experimental test loops.

II. Result and discussion

The fluctuation of outlet temperature with Reynolds number is presented in Fig.2. The fluctuation of outlet temperature of heat pipe is mainly observed in the intermediate range of Reynolds number (about 2 244-3 029). In the present experiment, the outlet temperature oscillation reaches its maximum fluctuation rate, which is more than 5 ℃ of average value. But at the condition of lower or larger Reynolds number, the outlet temperature remains relatively steady. Similar phenomenon can also be found in pressure drop (Fig.3) along the testing pipe.

The variation of outer wall temperature of heating pipe with the increase of Reynolds number is shown in Fig. 4. $T_{\rm w2} \sim T_{\rm w8}$ represent the wall temperature along the flow direction. We can see that the wall temperature of vertical heating pipe decrease with the increase of Reynolds number and the decrease is the most remarkable in the transition regime. When the flow rate is increased, the wall temperature near the outlet ($T_{\rm w8}$) fluctuates firstly and the fluctuation is more intense under the same flow rate. When the flow rate is increased further, the wall temperature fluctuation gradually extended to the inlet section ($T_{\rm w2}$). Continue increase of the flow rate, the wall temperature fluctuation gradually disappear.

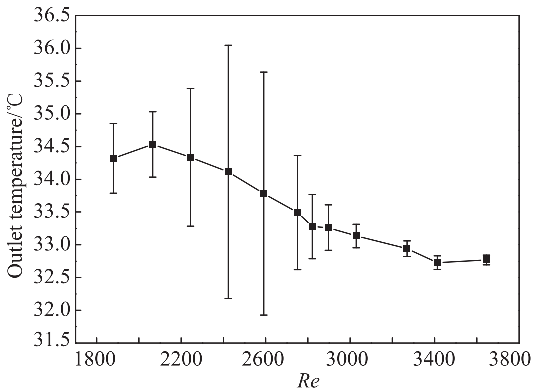

Fig. 2 The fluctuation of outlet temperature with Reynolds number.

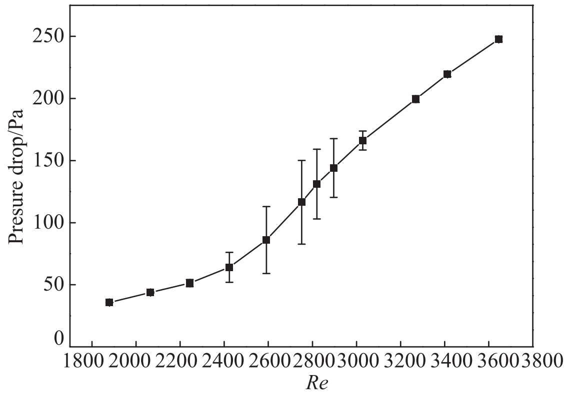

Fig. 3 The fluctuation of pressure drop with Reynolds number.

Fig. 5 shows the variation of friction factor with Reynolds number. In low Reynolds number, the friction factor decreases with increase of Reynolds number, which means laminar flow. The Reynolds number (about Re=2 244) correspond to the first abrupt change in the friction factor, which means the start of transition region. Then the friction factor increases with increase of Reynolds number in transition region. At last, the friction factor become flat with increase of Reynolds number in the turbulent flow. Fluctuation of outlet temperature, pressure drop, and wall temperature grow under Reynolds number of 2 244 to 3 029, which are in the laminar to turbulent transiton region. Fluid breaks down to a condition marked by intermittent appearances of turbulent bursts, and the corresponding flow regime will be designated as transitionally intermittent. Laminar flow and turbulent flow is intermittent in transition regime *i.e.* laminar break down now and then. The intermittency characteristic decide by the time scale for turbulence. The producing of turbulence is decided by the time scale for turbulence to spread and the time scale for turbulence to decay. At low Re, the mean time of decaying turbulence increase with increase of Re, which means turbulence decrease quickly at low Re, and the fluid keep laminar flow. At large Re, the mean time of spreading turbulence decreases with increase of Re, which means turbulence produce quickly. The key to determine the onset and sustainment of turbulence has been to separate the analysis of decay and proliferation mechanisms. The onset of turbulence radically changes transport efficiency and mixing properties. As a result, the flow and heat transfer characteristics viariation.

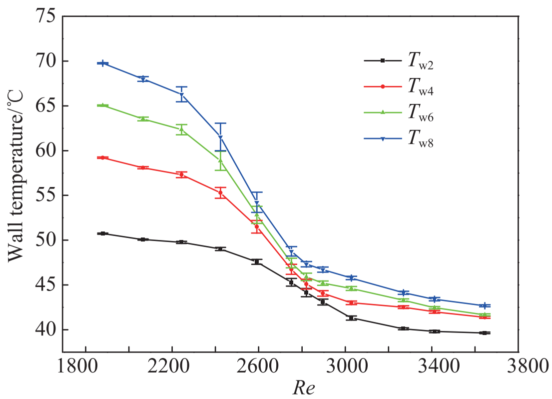

Fig. 4 (color online) Wall temperatures and their fluctuation under different Reynolds number.

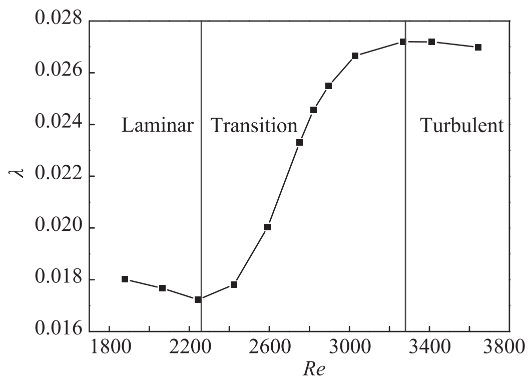

Fig. 5 Variation of friction factor with average Reynolds number.

The process of laminar to turbulent transition region in a heated pipe is investigated experimentally. The heat flux and the inlet temperature are kept constant in the experiment. The result indicate that transient outlet temperature, pressure drop, wall temperature keep steady in laminar and turbulence flow. In the laminar-turbulent transition regime, the fluctuation of the transient outlet temperature, pressure drop, wall temperature change with flow rate increase. At lower Re, fluctuation amplitudes of the transient outlet temperature, pressure drop, wall temperature increase with flow rate increases. At larger Re, fluctuation of the transient outlet temperature, pressure drop, wall temperature decrease with flow rate increase. The flow and heat transfer characteristics variation result from the fact that laminar flow and turbulent flow is intermittent in transition regime. The intermittency characteristic decide by the time scale for turbulence.