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IFMIF/EVEDA事業におけるターゲット評価のための水流動装置を用いた高速流体特性評価

Evaluation of high-speed flow property by water flowing device for target study in IFMIF/EVEDA project

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1. Introduction and Background

In the IFMIF/EVEDA project, the various validation experiments using the 1/2.6 scale down-sized duct of the Li target in EVEDA Li Test Loop (ELTL) have been performed until 2014 [1]. In this study, parallel to the ELTL experiments, the experimental water flowing device was fabricated in order to compare the flow properties obtained from two kinds of the ducts which simulate the quench tank through the downstream of Target assembly (TA). One duct simulates the duct which is installed in ELTL, while other duct simulates the duct which has been installed in Fusion Materials Irradiation Test Facility (FMIT). The visualized high-speed liquid flows under various flow rates and vacuum conditions were obtained from the two kinds of the ducts in order to compare their performances.

2. The experimental water flowing device

2.1 Fabrications

The specification of fabricated water flowing device is shown in Table 1 and the over view of this device is shown in Fig. 1. Fig. 2 (a) shows the simulated piping of ELTL, while Fig. 2 (b) shows the simulated piping of FMIT.

2.2 Valuation Tests

The visualized high-speed liquid flows at the flow rates of 4 m/s ~ 15 m/s under 10 kPa ~ 100 kPa will be obtained with using the two kinds of the ducts in order to compare their performances.

3. Experiments and Results

The valuation tests using this device for simulated cavitation phenomena in the simulated piping of ELTL were performed under a collaboration studies with Kyoto Univ. In this device, it tested in the principal objective that reproduced vibration supposed cavitation phenomena which occurred in ELTL. The detection of cavitation in ELTL used AE sensor, but it used an accelerometer as this device does not have the equipment. Although because this device could not visualize jet impingement point expected that cavitation would occur, identify the outbreak of cavitation could not only with an accelerometer, but by the technique [2] that was developed by the nuclear reactor plumbing by the plumbing outside to detect cavitation using an accelerometer, cavitation outbreak evaluated it using ratio of acceleration rms in the expected point and in the upper reaches. Fig.3 shows Position of acceleration measured. Positions are the jet impingement point and its upstream 150 mm point. Fig.4 shows an example of the acceleration result of a measurement. Table 2 and Fig.5 show in results of experiments. By 8 m/s, 30 kPa and 15 m/s, the atmospheric pressure that the number of cavitation is approximately equal in, the ratio of rms becomes the about the same value, and an inertial force is supposed when the state of the high speed jet that a low speed jet and the jet width that became small enlarged becomes similar.

4. Summary

The ratio of acceleration rms values which are measured at the jet impingement point and its upstream 150 mm point was agreed with tendencies from cavitation bearing the incipient stage to the transition area in comparison with a study of the past. Thus, a visualized water flow test would be necessary since it is difficult to identify the area where the cavitation occurs merely by the experiment using the accelerometer.

References

[1] E.Wakai et al., “Development of Lithium Target System in Engineering Validation and Engineering Design Activity of the International Fusion Materials Irradiation Facility (IFMIF/EVEDA)”, J. Plasma Fusion Res. **88** (2012) pp. **691-705**.

[2] S.Mizuyama, M.Murase, “Detection of Cavitation Behavior using Accelerometer and Microphone outside of Piping at Orifice”, INSS Journal,**13**,(2006) pp.**115-127**.

Table 1 Spec. of the experimental water flowing device

Testing fluid	Water
Temp.	0 ~ 25 °C
Flow rate	650 L/min (maximum)
Material	TA: Acrylic / Pipes: Stainless steel
Flow speed at outlet of nozzle	4 ~ 15 m/s
Operating pressure	10 kPa ~ 100 kPa (Atmosphere)

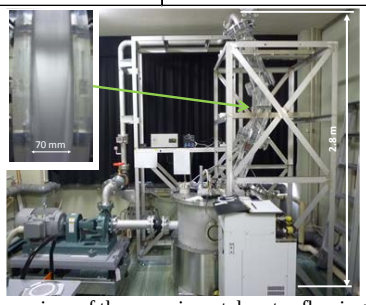

Fig.1 Over view of the experimental water flowing device.

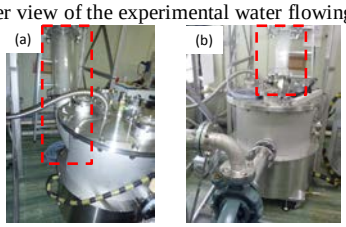

Fig.2 Detail of the simulated piping.

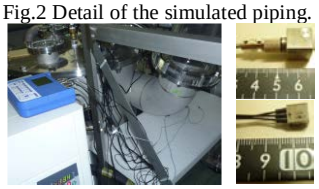

Fig.3 Position of acceleration measured and sensors.

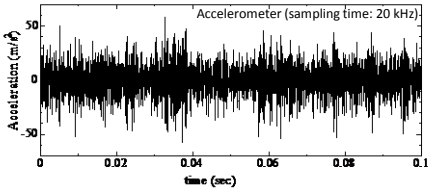

Fig.4 Data of accelerometer at 30kPa, 15 m/s.

Table 2 Experimental parameter

Pressure	Velocity(m/s)	Cavitation No.
3.00E+04	8	0.91
3.00E+04	10	0.58
3.00E+04	12	0.40
3.00E+04	15	0.26
1.00E+05	8	3.10
1.00E+05	10	2.00
1.00E+05	12	1.38
1.00E+05	15	0.88

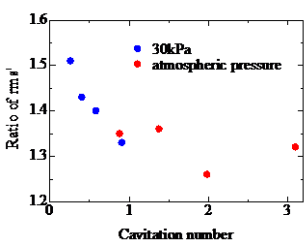

Fig.5 Ratio of acceleration rms