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VISUALIZATION EXPERIMENTS ON THE TRANSITIONAL DECAY PROCESS OF SECONDARY FLOW GENERATED IN 90-DEGREE BENDS

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ABSTRACT

A large number of bends and elbows exist in various types of piping system etc., and these effects on system itself are not negligible. Especially, in nuclear power plants, thermal fatigue of structural material originated from a thermal striping phenomenon, which occurs in such the case that two fluids with different temperatures mix together in a T-junction area, becomes a problem, and the possibility that the transitional decay process of secondary flow generated in a 90-degree bend, which is installed in the upstream, affects the fluid mixing and the temperature fluctuation of the structural wall has been pointed out. Furthermore, a considerable pressure drop in multi bends is also the phenomenon in which the decay process of the secondary flow becomes primary factor.

In this study, the decay processes of the secondary flow generated in the 90-degree bends are visualized experimentally by using a PIV measurement system in order to clarify the relation between the decay process and the wall-temperature fluctuation in the T-junction area. The main experimental parameters are a Re number and a curvature ratio of the bend, and three kinds of the 90-degree bend are prepared. The working fluid used in this experiment is distilled water and a horizontal test section to visualize the secondary flow is set as shown in Figure A-1. It is confirmed that axisymmetric and apparent secondary flow, which is a twin-vortex, is formed in a cross section of the pipe shortly after the bend outlet for each curvature ratio where the flow field is analyzed in the time average. However, it is proven that this secondary flow unsteadily and intensely fluctuates in the cross section regardless of the curvature ratio and that generation, movement, and disappearance of multiple vortices repeatedly occur as shown in Figure A-2. Especially, where the curvature ratio is the lowest (=1.0), it is confirmed that an entrance distance from the bend outlet rapidly shortens by the interaction between the secondary flow formed by a centrifugal force and newly generated separation vortex. In addition, it is shown that a frequency band of the unsteady behavior of secondary flow almost corresponds with that of the wall-temperature fluctuation in the T-junction area under a certain fluid mixing condition.

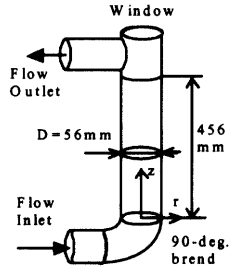

Figure A-1 Test section

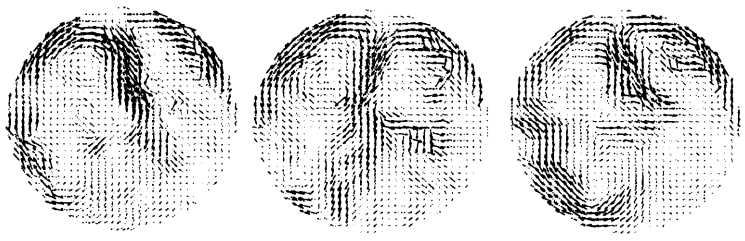

Figure A-2 Unsteady behavior of secondary flow (Re=49,000, γ=1.5)