Investigation of Multi-dimentional Flow Behavior in a Steam Generator Distribution Ring

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An experimental study has been conducted in the Fauske & Associates, LLC (FAI) FLUME #1 Test Facility to understand the multi-dimensional flow behavior in a steam generator distribution ring. Experiments have been conducted on a 1/5 scaled model which is a three dimensional representative of the prototypic distribution header. Reynolds number scaling, geometrical scaling and scaling of dynamic head were the major scaling considerations to represent the phenomena in the laboratory environment.

The scaled distribution header is built by machining flow paths into two acrylic blocks and gluing these acrylic blocks together. It consists of thirty- four flow nozzles. The flow rates through these nozzles are measured via twelve ultrasonic flow meters and multiplexer valve arrangements. Also, seventeen pressure measurements are considered. A photograph of the top view of the scaled model and the measurement locations are provided in Figure 1.

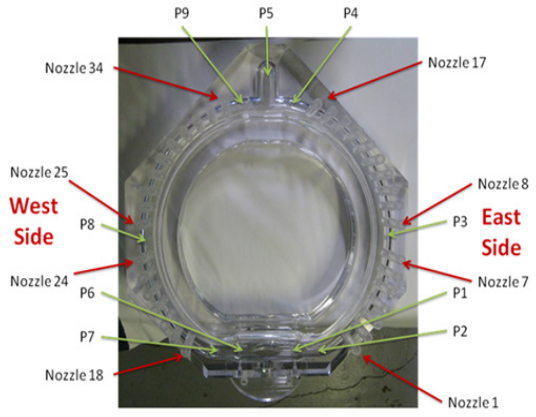

Figure 1. Top view of the scaled model

Experiments have been performed with an inlet configuration, which is scaled from a prototypic plant design. Figure 2 represents the flow rate and pressure measurements from a typical data set.

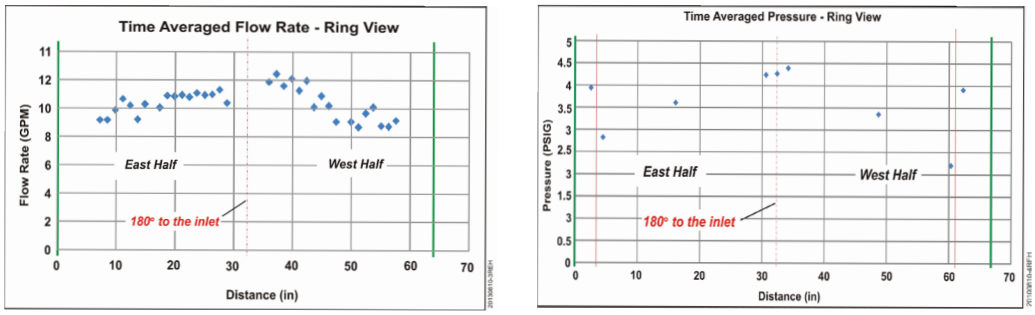

Figure 2. Typical data set

It is clearly seen from the data that the flow has a directional preference, i.e. more flow goes toward one side of the distribution header.

This is also proven through flow visualization via dye injection in Figure 3.

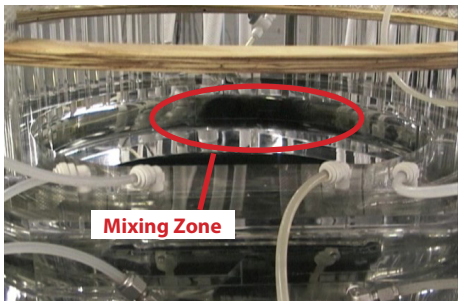

Figure 3. Flow visualization for scaled inlet configuration from a prototypic design

The mixing zone, where the flow streams coming from both sides meet, is shifted toward east of the distribution header indicating that a slightly higher amount of the flow is going through the west side. Of particular interest, additional tests with a different inlet configuration showed that the mixing zone can be moved toward the west side as shown in Figure 4.

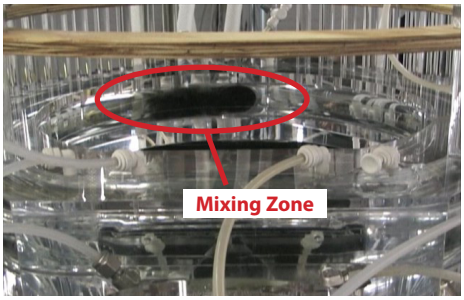

Figure 4. Flow visualization for inlet configuration for a fictive design

This leads to the conclusion that the flow distribution inside a circular header is strongly dependent on the structure of the flow induced by the inlet piping configuration.

If the flow structure at the inlet of such a header is not fully developed and bistable (i.e. have internal swirls flip flopping directions), this can cause the mixing zone to shift from one side to the other and may generate unstable operating conditions on the steam generator feed water system.

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