AFT Arrow Project Report

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Team Sonyc used AFT Arrow as a design aid for their Utah State University senior design project. The project goal was to design a solution that would reduce the noise output from a natural gas regulator used in residential areas. Through research, Sonyc discovered that noise in regulators is widely considered to be caused primarily by sonic flow conditions. Further research determined that noise solutions for other companies' regulators typically employ a device made up of several orifices. Sonic flow is caused by pressure drops that are too large for the system to handle, so multiple orifices in series allow the pressure to drop in increments in order to prevent the flow velocity from exceeding the speed of sound.

Several sets of multi-stage orifices were designed to drop the system pressure by 70% in varying increments. Before manufacturing anything, Sonyc wanted to verify that they would function appropriately. AFT Arrow was desired as a design tool because of its ability to model compressible flow through a piping system. Sonyc created a model of the test fixture with set boundary pressures and short lengths of pipe running between each orifice in series. As each multi-stage orifice device was designed, the area of each orifice in the model was adjusted, and the output pressures, velocities, and mass flow rates were analyzed. An ideal design was one that behaved in the Arrow model as it was designed. The most useful feature in Arrow was the sonic flow warning. A couple of the design methods examined produced multi-stage orifice designs that were, according to theory, not supposed to choke under the test conditions. After modeling the designs in Arrow, however, it was quickly determined that the designs were in fact likely to choke. By using Arrow, Sonyc was able to determine which design method would produce the most desirable results in the actual test system.

Two designs were ultimately manufactured and tested using air. Arrow allows for an easy change between model fluids, so examining the behavior of the designs in air versus natural gas was not a problem. The goal of the project was to reduce the noise produced by the natural gas regulator, but due to facility constraints, the regulator needed to be modeled as a single orifice. The two multi-stage orifice designs were placed after the model regulator, and air was run through the system as modeled in Arrow. Both designs were able to reduce the noise produced by a statistically significant number of decibels.

The multi-stage orifice designs were developed to reduce pressure incrementally in order to reduce the noise produced. AFT Arrow was used to confirm the validity of the designs. Testing the designs in a physical test fixture confirmed that both the design method and the Arrow model were correct. Thanks to Arrow, Sonyc was able to produce significant research and results, and the natural gas customer received valuable design information.