Azbil Corporation

Applying SC/Tetra's new simulation functions helps Azbil achieve size miniaturization and noise reduction of control valves

Azbil uses CFD analysis to design control valves and explains how implementation of this highly accurate fluid analysis design system that employs frequently upgraded analysis functions has helped them to successfully reduce cost. Mr. Yoshio Nomaguchi from Azbil (Development 1, Valve Product Development Dept.) tells the story behind Azbil's success.

Azbil Corporation
http://www.azbil.com/index.html

Established	1906
Businesses	Development and designing measurement and control equipment
Representatives	Seiji Onoki (Chairman) Hirozumi Sone (President, CEO)
Headquarters	Chiyoda-ku, Tokyo, Japan
Number of Employees	5,335 (as of March 2013)
Capital	Approx. 10.5 billion JPY (as of April 2013)

Figure 1: Control valves for air-conditioning system developed by Azbil

Azbil Corporation is one of the largest measurement and control equipment manufacturers in Japan. The company officially established its symbol "azbil" and group philosophy in 2006, with the objective "to contribute to global environment preservation through human-centered automation." This was followed by the corporate name change from Yamatake Corporation to Azbil Corporation in 2012.

Azbil mainly consists of three businesses.

- Building Automation: air-conditioning products and services designed for building market,
- Advanced Automation: control equipment and services for plants and factories, and
- Life Automation: products and services related to everyday life, such as gas and water meters, and related to heath care and nursing care.

Mr. Nomaguchi is in charge of developing control valves, one of Azbil's major products, which are inserted between pipes to adjust the fluid flow for transferring liquid and air in pipes for plants, factories and air-conditioning systems. Having sold domestically produced control valves in Japan since 1936, Azbil is known as a pioneer in this field with rich history of successful sales records.

Azbil's control valves can be categorized into two types.

- Process control for plants and factories, and
- Air-conditioning control for buildings (e.g. office buildings, hospitals, etc.).

Mr. Nomaguchi's division deals with the latter.

As illustrated in figure 2, chilled/hot water is pumped to each floor, and when it reaches to the air-conditioner, heat is exchanged, creating cold/hot air. Control valves adjust the amount of chilled/hot water flow in the system. The valves can be small or large depending on system requirements. A valve can fit in one hand or be so large that it weighs over 100kg.

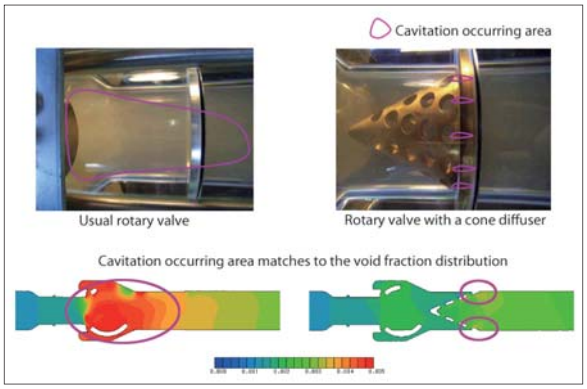


Figure 2: Diagram of air-conditioning system with control valves

Mr. Yoshio Nomaguchi
Azbil Corporation, Assistant Manager Development 1, Valve Product Development Dept.

Demand for Smaller Valvewith Lower Noise

Just as there has been a growing demand in recent years for almost all products to become smaller and lighter, the same applies to control valves. Miniaturizing is also energy efficient for equipment like control valves which are operated by electric motors. Smaller internal components reduce energy consumption. In addition, a smaller valve makes the overall weight lighter and easier to install. Mr. Nomaguchi says that it's essential to design the valve that enables to get the required flow, and meet other design requirements while making the valve as small as possible.

The design must achieve less fluid noise and less cavitation (formation of vapor cavities in liquid when the pressure rapidly decreases). Cavitation creates fluid noise and damages the valves. According to Mr. Nomaguchi, until recently their designing process involved using estimations from their experiences for how much flow can be expected for a certain flow passage area. Since facing the situation where they must take fluid noise and cavitation into consideration, they decided to apply fluid analysis software.

Most Reliable Software Produced by a Japanese Firm

Mr. Nomaguchi claims that what convinced Azbil to employ SC/Tetra compared to other fluid analysis software, were the facts that its analysis and test results are in close agreement with the experimental results and that it is capable of flexibly generating a mesh because of its unstructured mesh. Cradle, the developer of SC/Tetra, was also responsive to Azbil's request for support. This enabled them to solve problems quickly with the respective staffs keeping in touch through emails and phone. Mr. Nomaguchi considered this as excellent customer support.

As a team that undertakes product design, prototype development, and experiment execution all by themselves, Mr. Nomaguchi's division uses SC/Tetra to estimate the flow and velocity distribution within the valve. Analysis models are mainly created by CADthru. "Since upgrading to version 7, SC/Tetra has become much easier to operate, allowing us to specify conditions using the settings wizard. Another change was that if we want to re-analyze using a different condition, we can now easily change input boundary conditions with a text editor without having to restart SC/Tetra," says Mr. Nomaguchi.

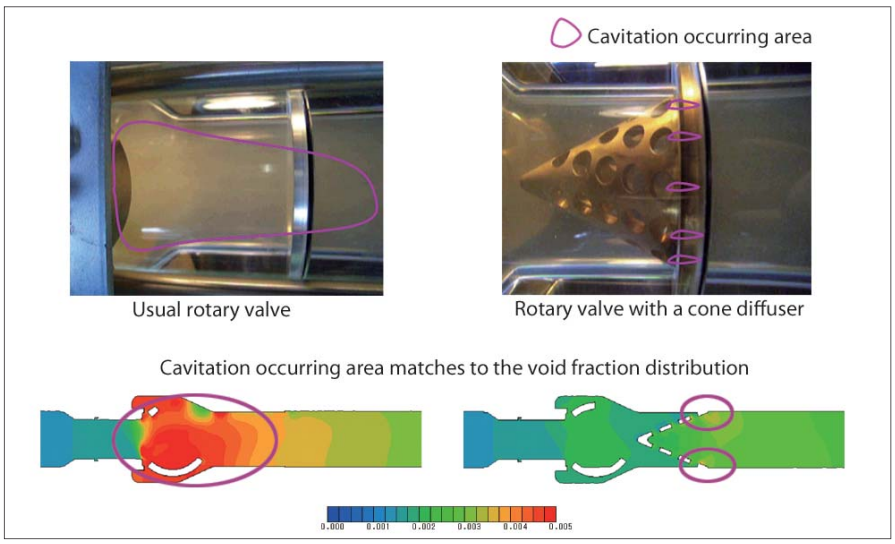


Figure 3: Cavitation experiment (above) and SC/Tetra analysis (below)

Achieved Faster Development

Azbil's traditional design process involved determining the specifications first, then planning the basic structure. Several different valve sizes are designed, depending on the flow conditions and the flow rate required. Sometimes there are more than ten variations. Prototype development and experimental tests after this phase are always costly and time-consuming. But Mr. Nomaguchi says that introducing SC/Tetra reduced the number of prototype tests and shortened the development time dramatically. He further recalls that it also helped engineers to better understand the physical phenomena by reviewing visual results generated by SC/Tetra.

For match-up between the analysis and test results, they use the immense body of data obtained from past experiments. Mr. Nomaguchi notes that the analysis and test values mostly matched, within the error range of plus/minus 5-10%.

Designing a New Model from Scratch with CFD Analysis

Another example that demonstrates how CFD analysis was effective was for the design of the rotary control valve (figure 3). This valve is used to adjust the flow rate by rotation of the inner plug. When the pressure rapidly decreases inside the valve, cavitation is generated. To prevent cavitation, perforated plates are often used, but they have never been enough to prevent cavitation. SC/Tetra was used to help Azbil design a cone-shaped diffuser, which reduced the cavitation and noise while maintaining sufficient flow.

For this particular case, SC/Tetra was used throughout the entire design process, from reviewing the diffuser

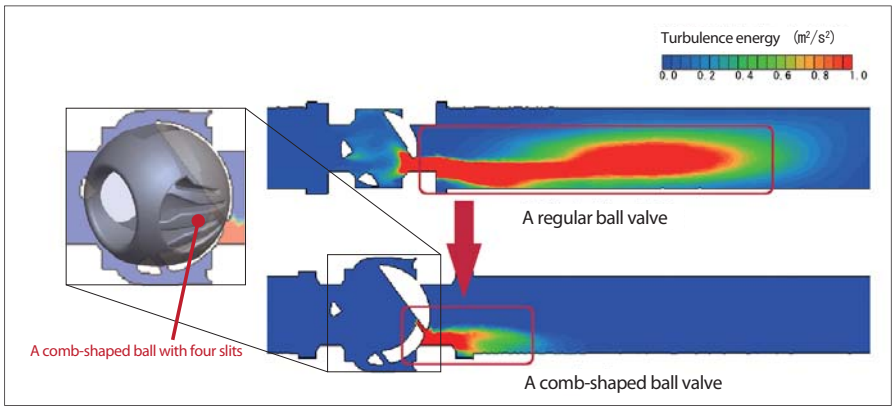


Figure 4: Comparison on analysis and real experimental result (left)
Experimental results of FL (Liquid pressure recovery factor) change (right)

thickness to sizing of the holes, as well as determining manufacturability. Azbil engineers reviewed about ten patterns for each size and finally determined the most fitting design.

As shown in figure 4, the results show a correlation between flow rate and pressure. The place where the results deviate from the straight line on the graph indicates choked flow due to the growth of cavitation. By applying the cavitation model, Azbil was able to match the experimental results with the analytical predictions.

To further demonstrate effectiveness, applying SC/Tetra shortened the time required for prototype testing and experiment, from approximately four weeks to three days when testing five different samples.

* Two Xeon 3.6GHzx2 (installed Dual-CPU) used for analysis

Another example where SC/Tetra has been used involves the design of control valves for fan coil units. A fan coil unit is an air-conditioning unit used for a hotel or hospital room. Fluid noise increases because of turbulence flow and cavitation in control valves. Since fan coil units are usually placed close to the room, near the ceiling in each individual room, the noise must be kept low, although this has always been difficult to achieve.

Attempts have been made to maintain the flow characteristic, such as opening a round or fan-shaped hole on a ball of a rotary control valve, but it was insufficient to satisfy customers' needs for reducing fluid noise. To solve this problem, Mr. Nomaguchi used SC/Tetra to examine various shapes of a hole on the ball inside the control valve. He discovered that applying multiple comb-shaped slits for the hole on the ball would maintain the flow characteristics as well as reduce the fluid noise (shown in figure 5). This led him to successfully design the control valves that reduce turbulence of flow and produce less noise.

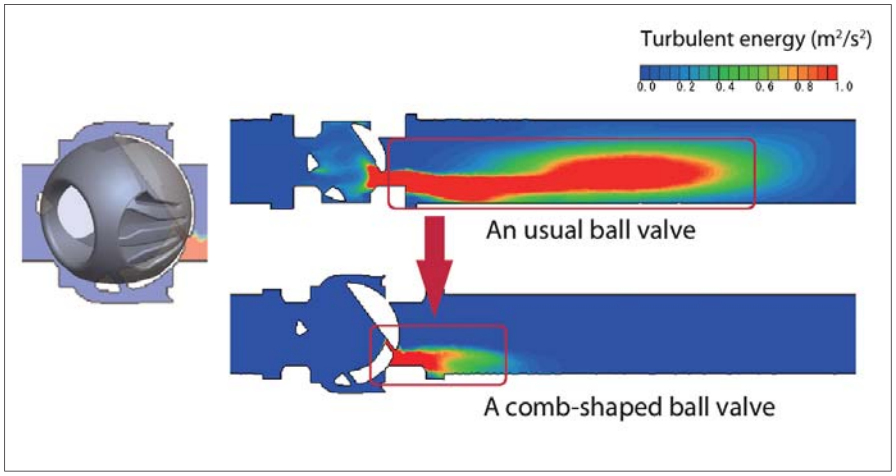


Figure 5: Comparison on analysis results between usual ball valve and comb-shaped ball valve

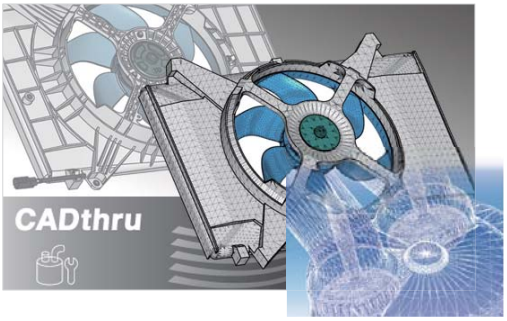
SC/Tetra Evolves Further

Mr. Nomaguchi says that his division actively implemented new analysis functions in the software when they were released (e.g. cavitation model). He expects Cradle to develop further advanced function of SC/Tetra. "It used to take a half hour to generate a mesh when we first started using SC/Tetra, but now, with hardware becoming more improved, it only takes a few minutes. I'm positive that more can be done and I'm looking forward to seeing further development of SC/Tetra."

Featured Software

SC/Tetra

SC/Tetra is a general purpose, unstructured mesh software that is efficiency and high fidelity focused for solving fluid/thermal problems involving complex geometries. It provides a wizard based user interface that guides the user through the step by step set-up process. SC/Tetra also provides a robust interface which directly imports native data from a multitude of CAD software as well as various intermediate files. SC/Tetra contains sophisticated models for simulating complex physical phenomena.



CADthru

CADthru is a data translation tool used to prepare CAD data for CFD analysis. CADthru's robust functions enable fast and automatic repair of geometric and topological data defects that are artifacts of the CAD software. CADthru also includes several data editing functions that provide complete control of the geometry.

Cradle
MSC Software Company

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www.cradle-cfd.com/inquiry/index.html