Extending the Bounds of **Customer Service**

Spray nozzle manufacturer expands value-added services by using simulation to develop and validate gas conditioning solutions in complex pollution control systems.

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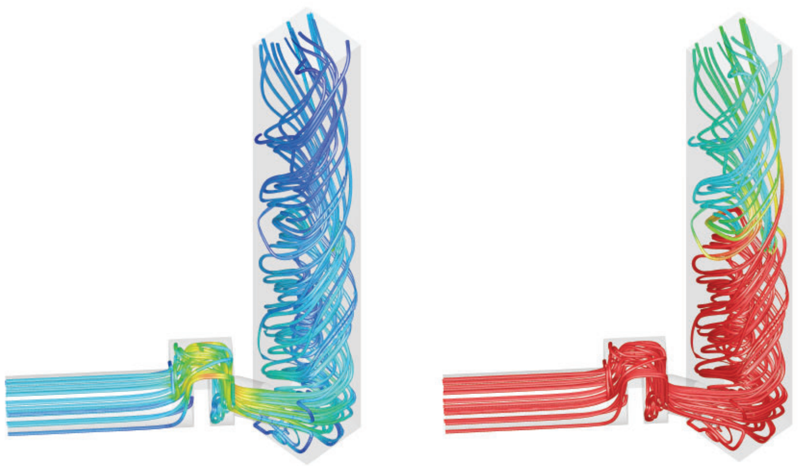
Founded in 1937 in a small converted garage, Spraying Systems Co. is now a worldwide leader in spray technology, producing a wide range of spray nozzles, automated spray systems, specialized fabricated products and accessories. Customers that use this technology are in hundreds of industries, including steel, paper, food, chemical, petrochemical, pharmaceutical and metal fabrication. Spraying Systems Co., always on the lookout for ways to improve product development and expand the value-added services it provides to customers, began using ANSYS FLUENT fluid dynamics software a few years ago in analyzing nozzle behavior. The company quickly discovered that the simulation software is also ideally suited for studying the design of its customers' gas conditioning solutions that utilize nozzles in complex pollution control systems.

Installed in industrial furnaces, burners, refineries, processing facilities, power plants and other sites, gas conditioning systems remove toxins such as nitrous oxide (NO_x) and sulfur dioxide (SO_2) from exhaust gases prior to release into the atmosphere. Spraying Systems Co. manufactures systems that use spray technology to cool and otherwise treat the gas before it enters specialized pollution control equipment. For example, spraying water into an exhaust stream cools the gas from 1,430 degrees F to 620 degrees F — a temperature that ensures optimal performance from downstream pollution control equipment. If the spray does not enter the gas stream at the correct angle, or if too much water is injected, droplets will not fully evaporate. The resulting acid-laden mist can impinge on duct walls, equipment and other parts of the structure, causing erosion and damage.

Sizing and positioning nozzles in these gas conditioning systems to avoid impingement and other spray problems are demanding tasks. Engineers must calculate numerous variables such as flow temperature, gas velocity and exhaust pollutants. Moreover, they must determine effective spray patterns for complex ductwork — especially when retrofitting older exhaust systems that have existing flanges, recesses and twisting geometries. Because there is no standard computational development method available to solve such difficult problems, companies often spend months of time and perhaps millions of dollars in prototype tests and late-stage troubleshooting. Worse yet, some of these poorly designed systems are put into service. Plant owners then may face costly penalties for failure to comply with emission control regulations, as well as expensive downtime for system redesign.

A far better approach to gas conditioning system design uses computational fluid dynamics (CFD).



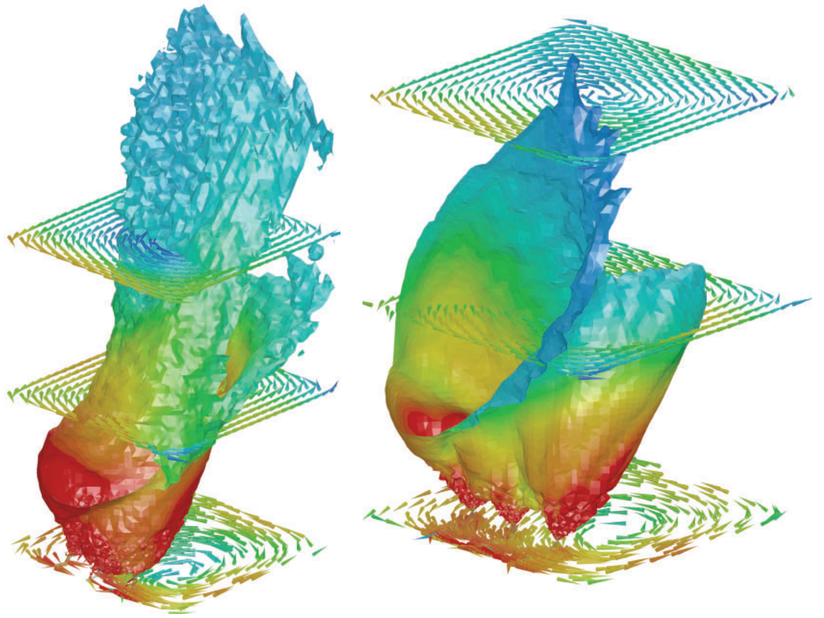
Using fluid dynamics simulation, engineers studied swirling flow and uneven velocity in a gas conditioning system. Design change iterations optimized the design for much more uniform flow velocity (left) and lowered temperature variations in the stack to within a nominal range (right).

In one recent case, engineers performed such work on a gas conditioning system retrofit project for a refinery exhaust tower. Due to physical constraints of the retrofit, the design called for the quench system to be installed and controlled from a fixed height and single side panel of the square tower. The custom solution called for the installation of three FloMax® FM25A air atomizing nozzles from Spraying Systems Co. Numerical calculations accurately determined the resulting nozzle pressure, liquid flow rate, atomization air flow rate, and drop size for the nozzles.

To analyze the performance of the proposed system, the 3-D geometry of the exhaust duct system was generated in CAD based on information provided by the customer. Spraying Systems Co. then imported this geometry into the pre-processing tool from ANSYS to create a mesh using elements small enough to provide a high level of detail for the study. To understand the behavior of the spray, engineers analyzed the model to determine droplet velocities and trajectories, exhaust pressure and temperature distributions and overall spray concentration throughout the duct tower.

The CFD simulation indicated significant problems with the proposed gas conditioning system including strong swirling flow, several regions of low pressure, uneven velocity and temperature profiles, and near-zero flow in some local zones. These conditions would likely result in incomplete droplet evaporation along with impingement of droplets on internal walls, the duct structure and downstream equipment. Using CFD, engineers performed iterative simulations to study and modify the proposed nozzle insertion depth, rotation angle and insertion angle configuration. Various nozzle configurations were evaluated based on the baseline gas flow through the existing tower.

These iterations enabled the engineers to develop a more effective design that optimized gas flow and improved the evenness of the gas velocity. The resulting flow uniformity helped ensure better temperature distribution and droplet evaporation. The final duct design improved evaporation by more than 10 percent with impingement of droplets on walls and other parts of the structure virtually eliminated. In addition, temperature profiles at the duct exit were controlled to within 7.7 percent of nominal temperature requirements — a considerable improvement over the 42 percent variation found in the initial design.



Simulation showed engineers the velocity and spray pattern of liquid emerging from the nozzle and streaming through the air before eventually evaporating. This is indicated in color transitions from red to blue. The extended spray stream of an initial design (left) was shortened considerably in an optimized configuration (right) to reduce damaging impingement of the spray on the stack walls.

Spraying Systems Co. now routinely uses this simulation approach to validate many of its customers' proposed retrofit designs and to design new gas conditioning systems. The method provides a unique value-added service, strengthens the company's relationships with customers and provides an additional source of revenue. Simulation enables engineers to efficiently complete several additional projects each month, ensuring successful performance of installed equipment.

The company continues to investigate opportunities to leverage engineering simulation in enhancing value-added services to customers. Recently, they deployed ANSYS Mechanical software to integrate more structural analysis into the development cycle for determination of stress and deformation of nozzle mounting lances. Also, use of the ANSYS DesignXplorer tool enables engineers to study alternative designs quickly and to help zero in on optimal solutions.

In this manner, simulation has become a key component in the company's design capabilities, and its value has been proven many times over. In addition to providing customers and regulatory agencies with documentation of system performance, simulation has become a powerful new communication tool for the company. Spraying Systems Co. has a 3-D projection studio that allows customers to stand virtually inside the application to see and experience the technical details of the proposed solution. In this respect, simulation is as much a sales tool as a design tool, enabling the company to increase business significantly in this growing market. ■

