

RESEARCH & DEVELOPMENT BY
CONNECTING THE DROPS



Spray Analysis
and Research Services
From *Spraying Systems Co.*

TRANSFORM
INNOVATE

OPTIMIZE
ILLUMINATE

CHARACTERIZE
VALIDATE
VISUALIZE

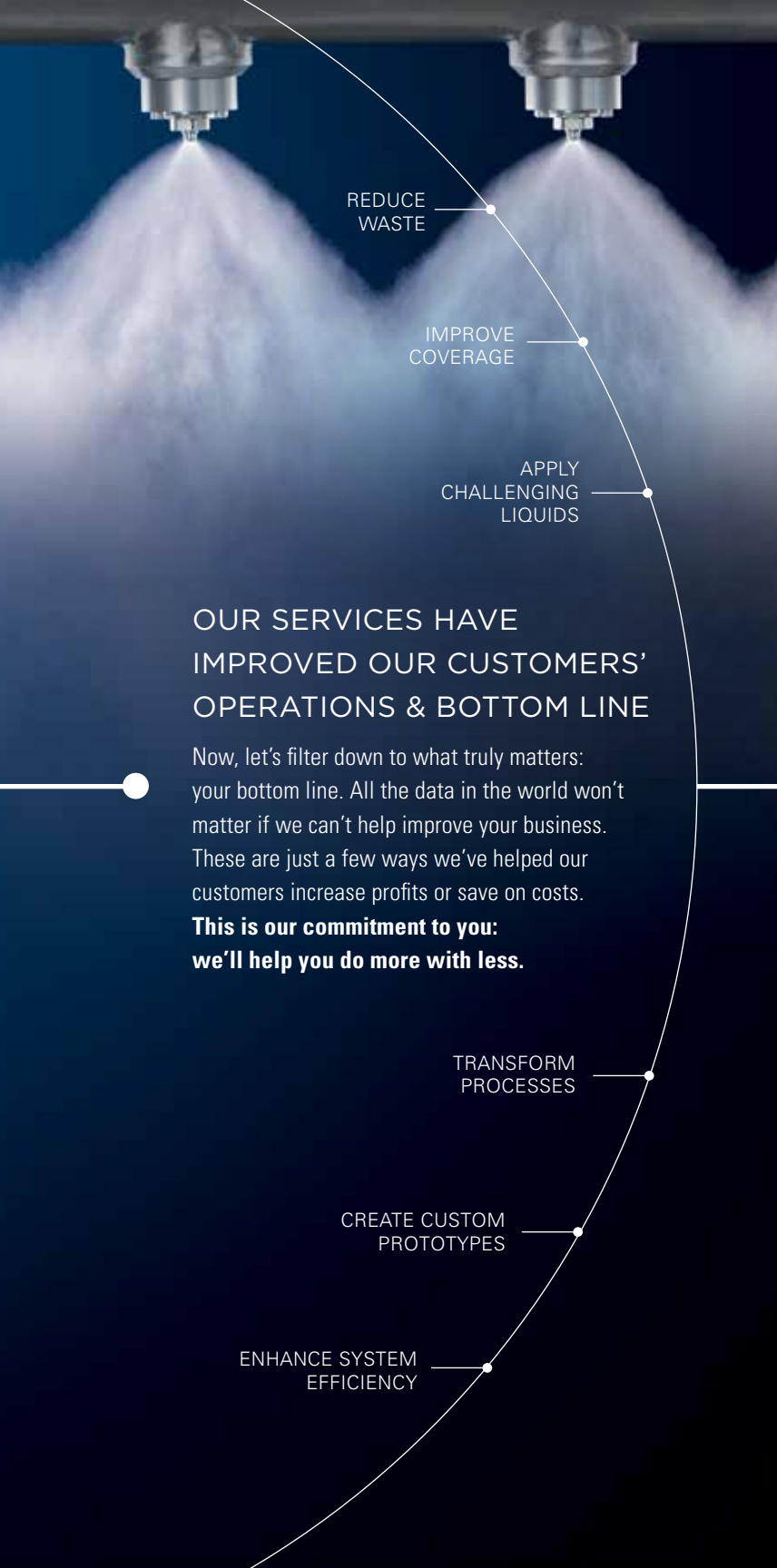


SOLVING APPLICATION PROBLEMS USING THE SCIENCE OF SPRAYS

SYSTEMATIC & EVIDENCE-BASED PROCESS YIELDS RESULTS

Sprays are a unique branch of multiphase fluid dynamics, with a dynamic range of liquid-gas interactions during the atomization process. Atomization is the breakup of a liquid into smaller pieces, called droplets. The collective group of droplets is then referred to as a spray. This spray process occurs at small scales and is bound by certain physical forces. Through precision examination, testing, modeling and analysis of each spray's characteristics, we can deliver data-driven solutions to real world applications.

While theoretical spray calculations can deliver a result, they rarely deliver the best result. For our customers, receiving spray data collected under actual operating conditions provides them with clear, concise results that are immediately applicable. For customers operating under complex process conditions, using a spray to cool noxious gasses for instance, we apply our computational spray models. Where other research services rely on speculative data, we deliver solutions driven by demonstrated nozzle performance data acquired in our labs. This is what makes our ability to serve you distinct. You can leverage advanced tools, without expensive overhead, to receive custom solutions to your spray problems.



REDUCE WASTE

IMPROVE COVERAGE

APPLY CHALLENGING LIQUIDS

OUR SERVICES HAVE IMPROVED OUR CUSTOMERS' OPERATIONS & BOTTOM LINE

Now, let's filter down to what truly matters: your bottom line. All the data in the world won't matter if we can't help improve your business. These are just a few ways we've helped our customers increase profits or save on costs.

This is our commitment to you: we'll help you do more with less.

TRANSFORM PROCESSES

CREATE CUSTOM PROTOTYPES

ENHANCE SYSTEM EFFICIENCY



TRANSFORMING PROCESSES WHILE REDUCING COSTS

CHALLENGE: A chicken feed producer was using a homemade nozzle in the production process. The nozzle consumed an excessive amount of energy. The local power company challenged the producer to reduce consumption. The producer determined it could save more than USD \$1 million on electricity by finding a more efficient spray nozzle.

SOLUTION: Extensive testing in our spray labs identified an air atomizing nozzle that could produce the required drop size under similar operating conditions. However, the energy-efficient design of the new air atomizing nozzle dramatically reduced compressed air consumption. The chicken feed producer was able to significantly reduce costs and improve operating sustainability with no negative impact on production.



IMPLEMENTING SUSTAINABLE PRACTICES BY SAVING WATER

CHALLENGE: Inconsistent application of water on plastic web during production resulted in a high scrap rate. As the plastic webbing traveled through various manufacturing stages, it was unevenly rehydrated. Quality was compromised and the producer was forced to reject the final product.

SOLUTION: Using a multifaceted testing approach, we determined the optimal number of nozzles, nozzle spacing and operating conditions to properly hydrate the plastic webs. This improved the overall process, reducing both plant waste and scrap rate.



CREATING A CUSTOM SPRAY NOZZLE SYSTEM

CHALLENGE: An aerospace company wanted to build a nozzle system to simulate rain. This system would be used to test how aircrafts perform in adverse weather conditions.

SOLUTION: To simulate various rainy conditions, we would need a nozzle that produced a specific drop size distribution and flow rate. We designed, engineered, then tested a prototype nozzle system. Thorough analysis proved the system would simulate many rain conditions and the customer was satisfied with the product.



HELPING APPLY CHALLENGING LIQUIDS TO MAXIMIZE PROFITS

CHALLENGE: A pharmaceutical company developed a new formula for coating tablets. The properties of the coating were different than previous materials and the pharmaceutical company needed to determine the best application method.

SOLUTION: Using a combination of drop size testing and high speed imaging, we evaluated different air-atomizing nozzles and operating conditions. The pharmaceutical company validated our findings and successfully launched the new formula for coating tablets.

WE START WITH DATA

Every piece of information our customer gives us is a data point to validate. We test, refine and re-test each condition to ensure we begin from an objective, evidence-based starting point. Improvements in the process, the operating conditions or the equipment can only be uncovered when we follow this methodology. As the project evolves, we leverage both commercial and proprietary tools to ensure data always drives the scientific process.

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ENGINEERING RESULTS THROUGH RESEARCH, ANALYSIS & DECADES OF EXPERIENCE

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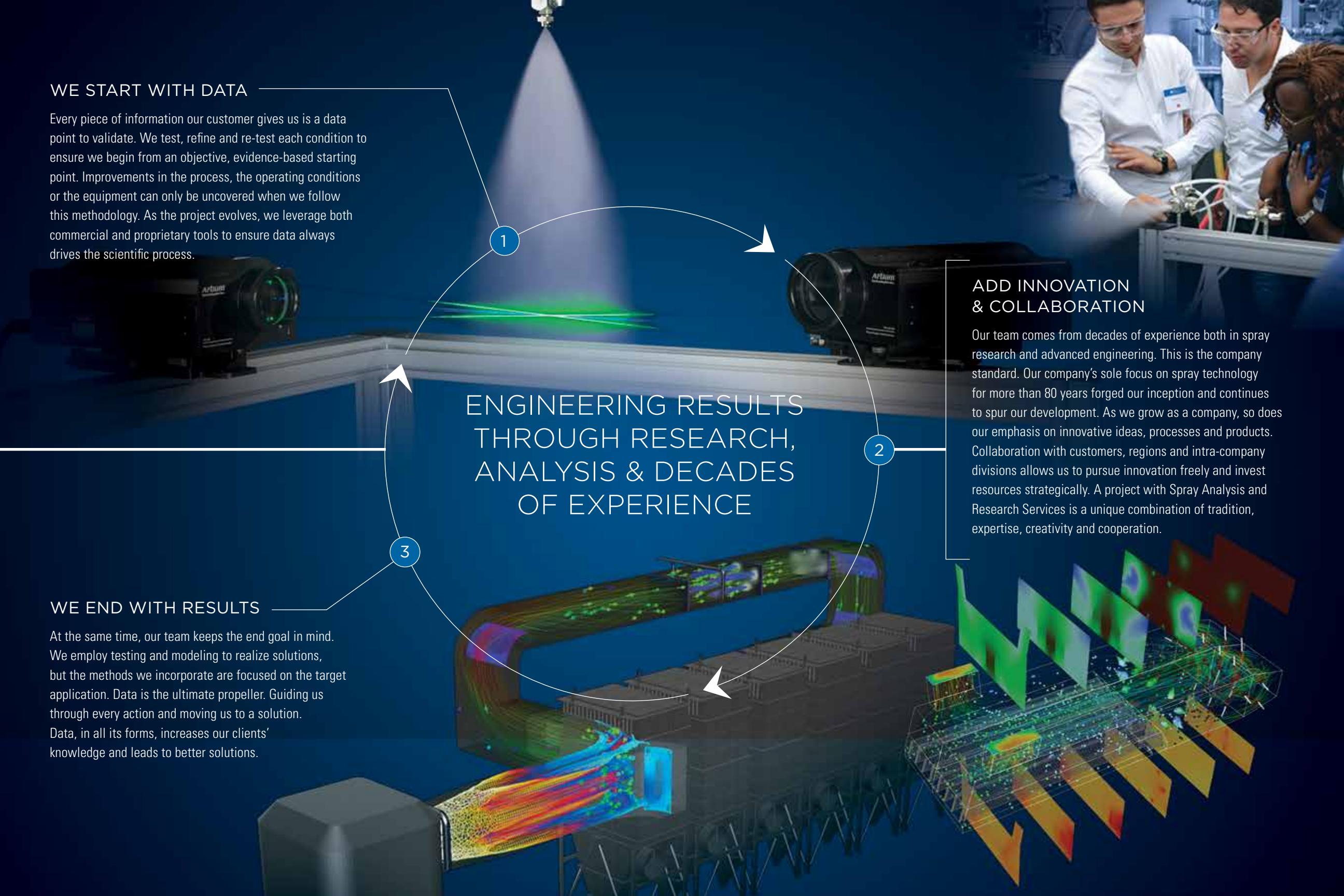
ADD INNOVATION & COLLABORATION

Our team comes from decades of experience both in spray research and advanced engineering. This is the company standard. Our company's sole focus on spray technology for more than 80 years forged our inception and continues to spur our development. As we grow as a company, so does our emphasis on innovative ideas, processes and products. Collaboration with customers, regions and intra-company divisions allows us to pursue innovation freely and invest resources strategically. A project with Spray Analysis and Research Services is a unique combination of tradition, expertise, creativity and cooperation.

3

WE END WITH RESULTS

At the same time, our team keeps the end goal in mind. We employ testing and modeling to realize solutions, but the methods we incorporate are focused on the target application. Data is the ultimate propeller. Guiding us through every action and moving us to a solution. Data, in all its forms, increases our clients' knowledge and leads to better solutions.





ENGINEERING RESULTS THROUGH RESEARCH, ANALYSIS & DECADES OF EXPERIENCE

APPLYING COMPUTATIONAL MODELS TO REVITALIZE A PROCESS

CHALLENGE: A chemical producer in the United States was facing substantial fines or complete shutdown after its Vertical Gas Thermal Oxidizer (VGTO) failed to comply with government emission control regulations. Because the nozzles in use weren't providing proper cooling, the slurry was not fully evaporating, thus eroding the wall lining.

SOLUTION: We used Computational Fluid Dynamics (CFD) modeling to evaluate the process stream and conditions in the tower. Not only did our customer need a better nozzle for cooling, they also needed to properly place the nozzle in the gas stream to avoid eroding the walls. CFD helped validate the parameters required for effective cooling and proper nozzle layout in the tower. The chemical producer is now in compliance with environmental regulations, the tower walls and bottom are completely dry, and the company has the tools to operate more cost-effectively.

CREATING A SAFER WORKPLACE WHILE SAVING ON COSTS

CHALLENGE: A steel manufacturer was experiencing severe dust lumping issues in their Basic Oxygen Furnace (BOF). Because the nozzle produced droplets that were too large, the cooling spray did not evaporate completely, stuck to the walls and collected soot throughout the tower. This caused significant maintenance downtime and a hazard to workers tasked with cleaning out the furnace.

SOLUTION: We performed CFD modeling on the steel company's lance design and pinpointed the dust lumping cause: poor nozzle lance layout. Rather than evenly dispersing the lances around the tower, we reconfigured the lance layout to direct all sprays at the incoming gas stream. This achieved almost 100% evaporation. This solution eliminated the dust lumping problem, saved the company in maintenance and downtime costs, and created a safer working environment for the company's employees.



BUILDING IMMEDIATE ROI THROUGH STRATEGIC MODELING

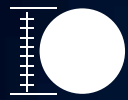
CHALLENGE: A major refinery wanted to install a blending system in a 250,000 barrel petroleum storage tank. However, the density of the additives varied, and the lower density solutions could rise to the top of the tank and vaporize if not properly blended. These issues would weaken the gasoline's quality to below premium grade – a considerable revenue loss for the refinery.

SOLUTION: Using CFD modeling, we designed eductor headers to provide the required mixing in the least amount of time. The refinery installed the new headers and the gasoline maintained its premium grade quality. Considering the potential loss of revenue for fuel that could not be sold as premium grade, the payback on the CFD modeling study and eductor system was immediate. The same system design was subsequently used for five additional blending tanks.

DNA OF A SPRAY

THE WHOLE IS GREATER THAN THE SUM OF THE PARTS

Each spray characteristic evaluated alone has value. Considering a spray's characteristics together is transformative. We've seen countless sprays under myriad operating conditions, and so we understand when, where and why a spray is best considered as a whole rather than by its individual parts.



DROP SIZE

As liquid moves through or exits a nozzle, it breaks into droplets and forms a spray. A spray has a range of droplet sizes, and this distribution may be narrow or wide depending on the liquid flow and pressure, forces acting on the liquid, nozzle geometry and spray material properties.



VELOCITY

When a liquid leaves a nozzle, all droplets are moving at roughly the same speed. However, as the spray distance is increased, larger droplets continue moving faster than the surrounding smaller droplets due to their greater momentum.



PATTERN

As a spray leaves a nozzle, it may be shaped by the geometry of the exit orifice. Typical spray patterns include a full cone, hollow cone, flat fan and multi-orifice sprays.



FLUID PROPERTIES

Fluid rheology characteristics such as density, viscosity, surface tension and solid particulate percentage are critical aspects when choosing a nozzle type and determining the necessary spray operating conditions. The presence of Newtonian and non-Newtonian liquid characteristics can also be important to consider.



EVERY DROP MATTERS

Drops are the defining components of a spray, and every drop in a spray matters. We solve problems by analyzing the individual elements (drops), the relationship between the aggregated drops (a spray), and the factors (gas flow, temp, turbulence, etc.) that affect the overall spray's performance.



IMPACT

High spray impact comes from greater droplet momentum, therefore large droplets and faster moving droplets will provide a higher impact. Impact can also be increased by manipulating the spray angle to ensure perpendicular target impact.



COVERAGE

This refers to the overall size of the spray pattern as it contacts the intended target. Round sprays are recommended when coverage area is important, flat spray are recommended in conveyor applications.

PDI TURNKEY

HIGH SPEED
IMAGING

LASER
DIFFRACTION

RHEOLOGY

LASER SHEET
IMAGING

PHASE DOPPLER
INTERFEROMETER

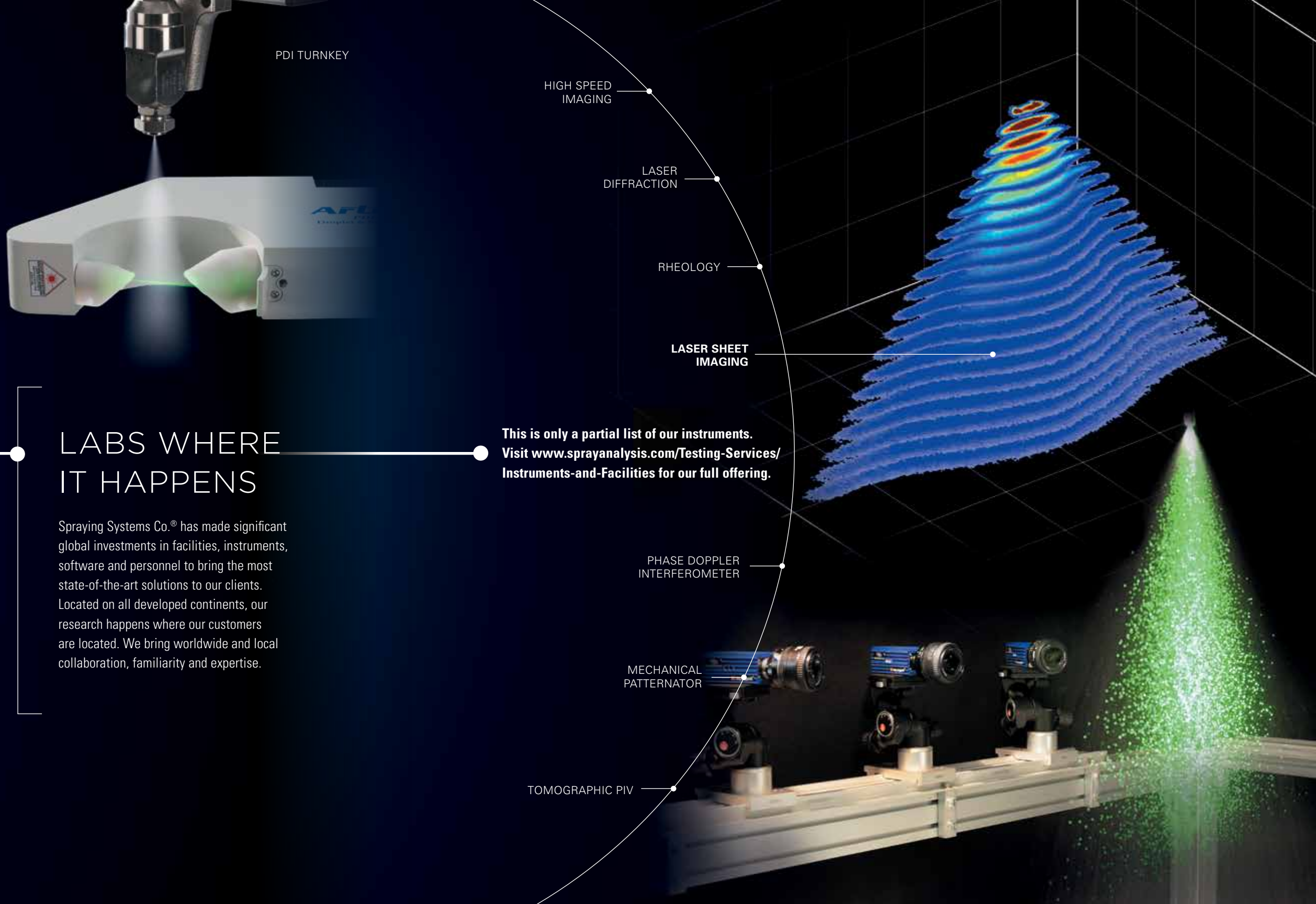
MECHANICAL
PATTERNATOR

TOMOGRAPHIC PIV

LABS WHERE IT HAPPENS

Spraying Systems Co.® has made significant global investments in facilities, instruments, software and personnel to bring the most state-of-the-art solutions to our clients. Located on all developed continents, our research happens where our customers are located. We bring worldwide and local collaboration, familiarity and expertise.

**This is only a partial list of our instruments.
Visit [www.spryanalysis.com/Testing-Services/
Instruments-and-Facilities](http://www.spryanalysis.com/Testing-Services/Instruments-and-Facilities) for our full offering.**



IMPROVING OPERATING SUSTAINABILITY AROUND THE WORLD

During the research and development process, we focus on finding solutions that not only solve the application problem but also help manufacturers conserve resources, reduce waste and protect the environment.

Our technology can have a big impact on water use, energy consumption, worker safety and product/process quality. **Learn more about our sustainability assessment program at www.spray.com/assessment**



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Sustainability Initiatives and Results report,
email us at sustainabilityops@spray.com.

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