Accurate drop size is an important factor in the overall effectiveness of spray nozzle operation. The process of generating drops is called atomization. The process of atomization begins by forcing liquid through a nozzle. Numerous types of nozzles with different shaped orifices produce various spray patterns.

Figure 1

Integrally mounted injection manifold systems as pictured in Figure 1 may be used to incorporate liquids, gases and shortening to many different product applications in the Food, Plastic, Chemical and Mineral Industries. The spray manifold is properly distanced from the material bed surface, which ensures even distribution of liquids or gases added to mixtures.

Spray systems consist of piping, pumps and spray nozzles. Spray nozzles, Figure 2 are precision components designed to yield very specific performance under very specific conditions. Just because a nozzle is spraying doesn’t mean it is working properly.

Sprayed liquids have a wide range of fluid properties, many of which are highly viscous and contain high fraction of solids. Viscosity refers to "thickness". Thus, water is "thin", having a lower viscosity, while vegetable oil is "thick" having a higher viscosity.

Figure 2

Liquid spraying systems typically use V-jet, flood-jet or atomizing nozzles to disperse the sprayed liquid.

The potential energy of the liquid along with the geometry of the nozzle causes the liquid to emerge as small ligaments. These ligaments then break up further into very small “pieces”, which are usually called droplets.
Choosing the Right Pumping System

Having an effective pumping system is essential to the overall performance of the spraying system. It’s important to consider your pressure requirements, flow rate and environment, especially with hard-to-handle fluids like corrosives, viscous, shear-sensitive or abrasive slurries.

With many types of different spray ingredients come many types of different pumps suitable to the application. Some examples include: peristaltic, slurry, air-operated, diaphragm, high pressure and piston-type pumps.

Peristaltic Pumps - A common pump used in many mixing applications is the peristaltic (figure 1). Peristaltic pumps are typically used to pump clean/sterile or aggressive fluids, because cross contamination cannot occur. The fluid is contained within a flexible tube fitted inside a circular pump casing. These pumps are often referred to as a hose or tube pump.

They are designed to pump liquids containing particles and can handle high solid slurries, aggressive chemicals, shear-sensitive products and products with high viscosities and densities. For Example:

Snack Food Processing

Snack food processors often use metered flavorings where a variety of powdered flavorings are blended with oil and pumped into special spray nozzles onto snack products mixed inside a paddle mixer. With low shear pumping action and the ability to totally enclose the pumped media within the tube, his ensures optimum levels of hygiene and product integrity. Also the ability to sustain volumetric accuracy, irrespective of changes in viscosity of the slurry, ensures that consistent dosage of the flavoring is maintained at all times.

Sanitary Food Grade

Peristaltic pumps enable products as diverse as soft fruit and food ingredients, as well as substances containing high concentrations of hard solids in a slurry mix to be pumped and sprayed on ingredients mixed in a horizontal mixer. By virtue of their construction, peristaltic pumps are easily incorporated into full velocity CIP (clean-in-place) or SIP (sterilization-in-place) systems without the need for a bypass, whilst the pumping action ensures that the hose is fully swept with no crevices or dead spots where product residues can accumulate.

Figure 2 - Slurry Pump
Slurry pumps minimize shear forces experienced by the fluid, which may help to keep colloids and slurry fluids from separating.

Figure 3 - Continuous horizontal mixer with peristaltic pump (yellow) & exterior piping, valves and tubing connect to the interior spray manifold system. This mixing system blends liquid fragrances & talc powder.

Diaphragm Pumps - A positive displacement pump that uses a combination of the reciprocating action of a rubber, thermoplastic or Teflon diaphragm and suitable non-return check valve to pump a fluid.

Figure 4 - Hydraulic Pump
High pressure hydraulic and piston pumps efficiently supply flow in a circuit with changing flow and pressure requirements.
CIP/SIP Systems

Cleaning-In-Place (CIP) and Sterilization-In-Place (SIP) are systems designed for automatic cleaning and disinfecting without major disassembly and assembly work.

CIP and SIP is vital to many industries including Meat & Poultry, Dairy, Baking, Produce, Beverage, Fish, Confectionary & Spices, Pharmaceutical, Nutraceutical, Plastics, Cosmetics and many more. CIP and SIP are systems designed for automatic cleaning and disinfecting without disassembly and assembly. This is important to many industries where the processing must take place in a hygienic or aseptic environment.

Fluid-driven trough vessel nozzles as shown in figure 1 are especially suited for CIP systems—no motor source is needed due to the reactionary force of the cleaning liquid to rotate the spray head. Spray angles range from 180° to 360° to meet most application needs. Due to their low impact and ability to withstand harsh chemicals, they are best-suited for final rinse or sanitation applications and can be calibrated to a variety of flow rates and pressures to achieve the required impact. Other features include:

- Rotating and fixed designs
- Sanitary Lances
- Reduced water and chemical use with high-impact cleaning.
- Eliminates post-cleaning tests.

Combine Multiple Processes in One Mixer

Stop wasting......start saving.

New mixer designs now improve productivity considerably by consolidating numerous processes into a single vessel. Custom design mixer manufacturers create equipment that is capable of doing more than just blend ingredients. This will help to lower your capital equipment expense budget. The following accessories allow processors to combine multiple processes in one mixer:

- High Intensity Choppers
- ASME Code Rated Jackets
- Electrical Controls
- Load Cell Weigh Equipment
- Pumping Systems
- Bag Dumps, Surge Bins, Weigh Hoppers
- Mezzanine Structures and Bucket Elevators
- Liquid, Gas and shortening systems
- Air Supply Manifolds

Control Agglomerates with Spray Adjustments

A lump forming in a mixer is an agglomerate, which occurs when particles are held together by a bridge and the bonding of the bridge is stronger than the particle weight. You need to eliminate the bridging to breakup or eliminate lumping in a mixer.

If you are adding liquid to the mixer, especially liquid binders try changing how or where the liquid is added. For example, adding the liquid from multiple points instead of just a single point, or optimizing the liquid stream, will help prevent lumps. In some applications adding high-speed shoppers will also help. Liquid slugging will create wet spots or lumps that need to be dispersed or broken up. Opening and exposing the material surfaces will enable uniform particle coating. If the mixer is unable to break the lumps, try spraying in the liquids with a liquid spray manifold system because smaller droplets are easier to break up.

Specification and position of spray nozzles is challenging. With liquid addition, the material may become stickier and stick onto the equipment also causing agglomeration.
Improving spray nozzle performance and extending nozzle life through proper maintenance is critical to optimizing any spray system. As nozzle orifices wear, the liquid flow increases or the spraying pressure drops, resulting in larger drop sizes. Larger drops result in less total liquid surface area affecting agglomeration. 7 reasons why spray nozzles don’t perform properly:

1. Erosion/wear
2. Corrosion
3. High Temperature
4. Caking/Bearding
5. Accidental Damage
6. Clogging
7. Improper Assembly

Optimization:

When your spray system isn’t performing optimally, you can experience a wide variety of problems—all of which will cost you time and money. For example, you could experience:

- Quality control issues
- Unscheduled Production downtime
- Increased maintenance
- Increased consumption of costly chemicals, water and electricity

If your present mixing system isn’t performing properly, you could experience significant costs in labor, increased scrap and lost production time.

Improving spray nozzle performance and extending nozzle life through proper maintenance is critical to optimizing any spray system.

Automation:

The most efficient way to process liquid spray applications is with an automated system that uses a controller to “manage” performance, Figure 3.

Control Panels - Motor controls are custom designed, assembled and tested at our factory. Explosion proof and wash down designs are available. Each control panel is made with various electrical and safety control features and wired for 230/460 volt 3-phase capacity.

Each installed control panel is energized and operated to inspect the equipment installation and process parameters.

Figure 1 Shows the side view of the liquid spray manifold system in operation.

“When your spray system isn’t performing optimally, you can experience a variety of problems costing you time & money.”

Figure 2 Shows the top-side view of a liquid spray manifold system in operation. Multiple nozzle spray ports with adjustable, precision-controlled spraying will canvas the product envelope for a thorough spray application.

Figure 3 - Automated control panel used in coloring wood chips. Select functions include: tote, conveyor, auto, color, water and mixer.
Pasta Dough Mixing Machine

The two ingredients used to make pasta are semolina wheat and water. Mixed properly (granulometry) the absorbed semolina will produce a high quality glutinous consistency suitable for pasta dough manufacturing.

The kneading of the dough and the mixing of the water into the dough are both important steps in processing.

The liquid spray process consists of the following components:

**Liquid Addition Manifold**
- ¾” T304 stainless steel pipe
- One end fitted with ball valve for cleanout.
- Opposite end threaded to liquid injection devise.
- Two (2) stainless steel floodjet wide angle, low impact flat pattern spray nozzles arranged to provide even spray pattern across the mixer with minimal wetting of agitator components.

Liquid injection devise consists of an optional ASME pressure dispensing tank or connection to municipal water source.

Rubber Mulch Coloring & Drying Mixer

A Midwestern tire recycling company uses a custom designed mixer to coat chunks of car tire with a latex colorant. After applying the colorant, the mixer dries the colorant to prevent rubber off.

The mixer includes a batch sequencing control panel, a liquid metering system, a forced air drying system and two bulk material conveyors. Chunks of ground rubber are loaded into the mixer from pre-weighed super sacks. Undiluted, latex paint is volumetrically metered into the mixer. The mixer’s paddle-style agitators evenly coat the rubber. A variable speed controller slows the speed of the mixer shaft to avoid scrubbing the latex chunks during the drying cycle. Air is then blown through the materials creating a fluidized bed of ingredients to prevent the materials from sticking together during the drying process.

Flyash Conditioning Mixer

In Class F and Class C fly ash conditioning both batch and continuous mixers can be used for conditioning fly ash while containing fugitive dust during the stabilization of waste materials.

Other similar applications using liquid injection systems include: high-grade concrete products, fertilizer from neutralized sewage sludge, gypsum from flue gas desulphurization systems, filler for construction used in lightweight aggregates and resins in the production of high-carbon fuel.

Today fly ash conditioning system are designed to blend biosolids and other biomass feedstock's as well as condition fly ash with water to allow the materials to be transported at 10-15% moisture without emitting dust in a consistent homogenous mix.

This continuous mixer was designed with a 360º cylindrical trough, paddle-style agitator with back mix with trough cleaning actuators. Spray manifold uses (2) 2” NTP nipples to discharge an even spray of water to mixer.

Other Resources

ILASS
www.ilass.org
Spraying Systems Inc.
www.spray.com
Marion Mixers, Inc
www.marionmixers.com
Watson-Marlow Pumps Group
www.watson-marlow.com
BETE Fog Nozzle
www.bete.com
Wiley-VCH
www.wiley-vch.de