Written by Jon Barber, Spraying Systems Co.
Monday, 01 November 2004 19:06

Major savings in time and money can be achieved through an aggressive spray system optimization program.

Spray nozzles are vital components in many production facilities. Their accuracy, durability, and interchangeability are absolutely essential to maximum uptime.

If a spray system is not working optimally, it can drain staggering amounts of money. The cost of wasted water alone can approach $100,000 annually even in a system with relatively minor performance problems.

Factor in all the related expenses—the cost of excess chemicals, wasted energy, extra scrap caused by quality problems, unscheduled production downtime, and additional labor—and the true total can quickly mount to hundreds of thousands of dollars per year.

Once the magnitude of the issue is appreciated, it is time to begin the process of optimizing a spray system. Start by learning about the typical sources of spray problems.

Spray nozzle troubles

They may look simple enough, but in reality spray nozzles are highly engineered precision components that can wear over time, or suffer damage during normal operations or cleaning. The most common problems that cause substandard spray performance include:

• Erosion/wear. Gradual removal of metal causes the spray nozzle orifice and internal flow passages to enlarge and/or become distorted. As a result, flow usually increases, pressure may decrease, the spray pattern becomes irregular, and liquid drops become larger.

• Corrosion. Spray nozzle material can break down due to the chemical qualities of the sprayed material or the environment. The effect is similar to that caused by erosion and wear, with possible additional damage to the outside surfaces of the spray nozzle.

• High temperature. Certain liquids must be sprayed at elevated temperatures or in

high-temperature environments. The spray nozzle may soften and break down unless special temperature-resistant materials are used.

• Caking/bearding. Buildup of material on the inside, on the outer edges, or near the orifice is caused by liquid evaporation. A layer of dried solids remains and obstructs the orifice or internal flow passages.

• Clogging. Unwanted solid particles can block the inside of the orifice. Flow is restricted and spray pattern uniformity disturbed.

• Improper reassembly. Some spray nozzles require careful reassembly after cleaning so that internal components, such as gaskets, o-rings, and valves, are properly aligned. Improper reassembly causes leaking and inefficient spray performance.

• Accidental damage. Damage can occur if a spray nozzle is dropped or scratched during installation, operation, or cleaning.

Detecting worn nozzles

This is more difficult than it sounds. The human eye is a remarkable instrument, but it simply cannot provide the true story when it comes to actual spray nozzle wear.

In the photos , the spray tip on the left is new, and sprays properly. The spray tip on the right is worn, and sprays 30 percent over capacity. The difference is undetectable with the naked eye—but there are other tip-offs that something is amiss.

Watch for these clues:

• Quality control issues and increased scrap. Worn, clogged, and damaged spray nozzles will not perform to specification, and can result in uneven coating, cooling, cleaning, humidifying, and drying.

• Increased maintenance time. Unscheduled spray system downtime, or an increase in cleaning frequency, is an indicator of spray nozzle wear.

• Flow rate change. The flow rate of a spray nozzle will increase as the surfaces of the orifice and/or the internal core begin to deteriorate. In applications using positive displacement pumps, the spraying pressure will decrease as the spray nozzle orifice enlarges. Even small changes in flow rate can have a negative impact on quality, so routine monitoring can reveal potential problems. But in some instances, the spray pattern will look fine so it will be necessary to actually collect and measure the spray fluid output to reveal wear.

• Deterioration of spray pattern quality. When orifice wear occurs in hollow cone spray nozzles, spray pattern uniformity is destroyed. Streaks develop and the pattern becomes heavy or light in the circular ring of fluid. In full cone spray nozzles, the pattern distribution typically deteriorates as more liquid flows into the center of the pattern. In flat fan sprays, streaks and heavier flows will be visible in the center of the pattern and the effective spray angle coverage will decrease.

• Spray drop size increase. Liquid flow will increase, or spraying pressure will decrease, as nozzles wear. The result is larger drops and less total liquid surface area. This is difficult to detect visually, so if a problem is suspected, arrange for drop size testing.

• Lowered spray impact. Worn spray nozzles operate at lower pressure, generally resulting in lower spray impact. (Ironically, in applications with centrifugal-type pumps, impact may actually increase because of increased flow through the spray nozzle.) Special testing may be required.

Preventing and solving problems

A comprehensive spray nozzle maintenance program will help ensure fewer headaches. By setting a regular schedule, key issues can be addressed before they cripple a production line.

The checklist that follows should become the foundation of a spray nozzle maintenance program. Consistent evaluation of these factors will enable early wear detection and

appropriate action. Specific applications will determine how often each factor should be checked. The proper frequency could range from the end of every shift to every few months.

By implementing a nozzle maintenance program and documenting its procedures, the best nozzle maintenance and replacement strategy for achieving optimal performance can be determined.

Flow rate. For centrifugal pumps, monitor flow meter readings to detect increases. Or collect and measure the spray from the spray nozzle for a given period of time at a specific pressure. Compare these readings to the flow rates listed in the manufacturer's catalog or compare them to flow rate readings from new, unused spray nozzles.

For positive displacement pumps, monitor the liquid line pressure for decreases; the flow rate will remain constant.

Spray pressure (in nozzle manifold). For centrifugal pumps, monitor for increases in liquid volume sprayed. The spraying pressure is likely to remain the same.

For positive displacement pumps, monitor the pressure gauge for decreases in pressure and reduction in impact on sprayed surfaces. The liquid volume sprayed is likely to remain the same. Also, monitor for increases in pressure due to clogged spray nozzles.

Spray pattern. Visually inspect the spray pattern for changes. Check the spray angle with a protractor. Measure the width of the spray pattern on the sprayed surface. If the spray nozzle orifice is wearing gradually, changes may not be detected until there is a significant increase in flow rate. If uniform spray coverage is critical to the application, request special testing from the spray nozzle manufacturer.

Drop size. Drop size increases cannot be visually detected in most applications. An increase in flow rate or decrease in spraying pressure will affect drop size.

Nozzle alignment. Check uniformity of spray coverage of flat spray nozzles on a manifold. Spray patterns should be parallel to each other. Spray tips should be rotated 5-10 deg from the manifold centerline.

Product quality/application results. Check for uneven coating, cooling, drying, cleaning, and changes in temperature, dust content, and humidity.

If, after implementing a spray nozzle maintenance program, it is determined that current nozzles are not performing as well as they should, it is time to replace them.

Extending spray nozzle life

There are some proven techniques to prolong the useful life of your spray nozzles.

Improve cleaning procedures. Nozzles are precision instruments. Cleaning should be done regularly but carefully, with materials that are much softer than the nozzle orifice surface. Use plastic bristle brushes, wooden probes, or plastic probes. Never use wire brushes, pocket knives, or welder's tip cleaning rasps. It is easy to damage the critical orifice shape or size and end up with distorted spray patterns or excess flow. If faced with a stubborn clogging problem, try soaking the orifice in a noncorrosive cleaning chemical to soften or dissolve the clogging substance.

Add line strainers, or change to spray nozzles with built-in strainers. Orifice deterioration and clogging is typically caused by solid dirt particles in the sprayed liquid and is particularly common in systems using continuous spray water recirculation. Strainers, or spray nozzles with built-in strainers, are recommended—with a screen mesh size chosen to trap larger particles and prevent debris from entering the spray nozzle orifice or vane.

Decrease spraying pressure. Although it is not always possible to implement, decreasing the pressure—which will slow the liquid velocity through the orifice—may help reduce the wear and corrosion rate.

Reduce the quantity of abrasive particles or concentration of corrosive chemicals. In

some applications, it is possible to reduce the amount of abrasive particles in the feed liquid, and/or change the size and shape of the particles to reduce wear effects. Also, the corrosive activity of a solution can occasionally be reduced by using different concentrations or temperatures, depending on the specific chemicals involved.

Consider durability and resistance issues. It is important to keep in mind that replacing old spray nozzles with the very same type (for example, replacing an aluminum nozzle with an aluminum nozzle) may not be the best option. Obviously a new spray nozzle is superior to a worn nozzle, but the situation may call for replacing current spray nozzles with nozzles that are much better suited to handle the types of liquids and chemicals that are routinely used.

Spray nozzles made of stronger material generally provide longer wear life. Predictably, stainless steel has a greater abrasion resistance ratio than aluminum, while carbides provide far greater abrasion resistance than stainless steel. To determine whether a different material should be considered for nozzles, spray tips, or orifice inserts, consult the chart " Approximate Abrasion Resistance Ratios ."

In addition to abrasion resistance, corrosion resistance may be necessary. The rate of chemical corrosion on a spray nozzle depends on several factors, including the corrosive properties of the liquid being sprayed, its concentration in the solution, its temperature, and the properties of the nozzle material.

Explore special nozzle types. New types of spray nozzles feature extremely convenient, nonslip extensions that are easy to grip and twist even in wet or sticky conditions involving lubricants, oils, or other viscous materials.

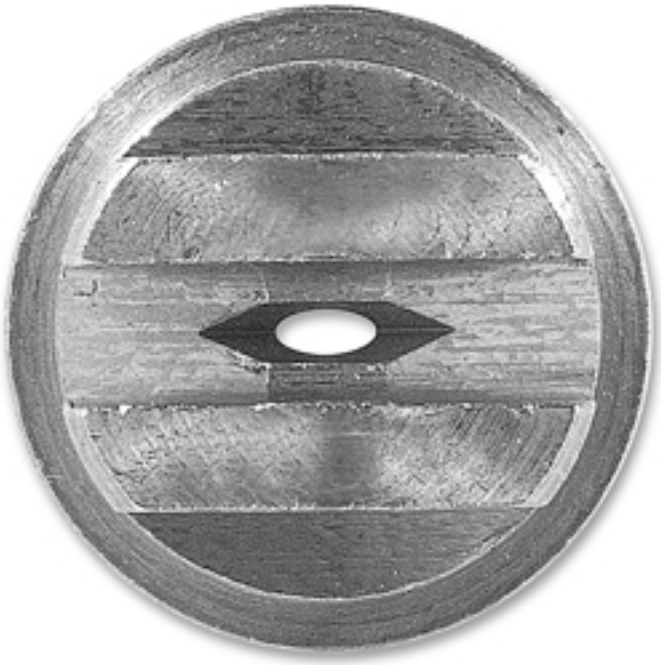
Also, look for single and double pipe clamps that enable a worker to quickly change entire nozzle mounts whenever necessary.

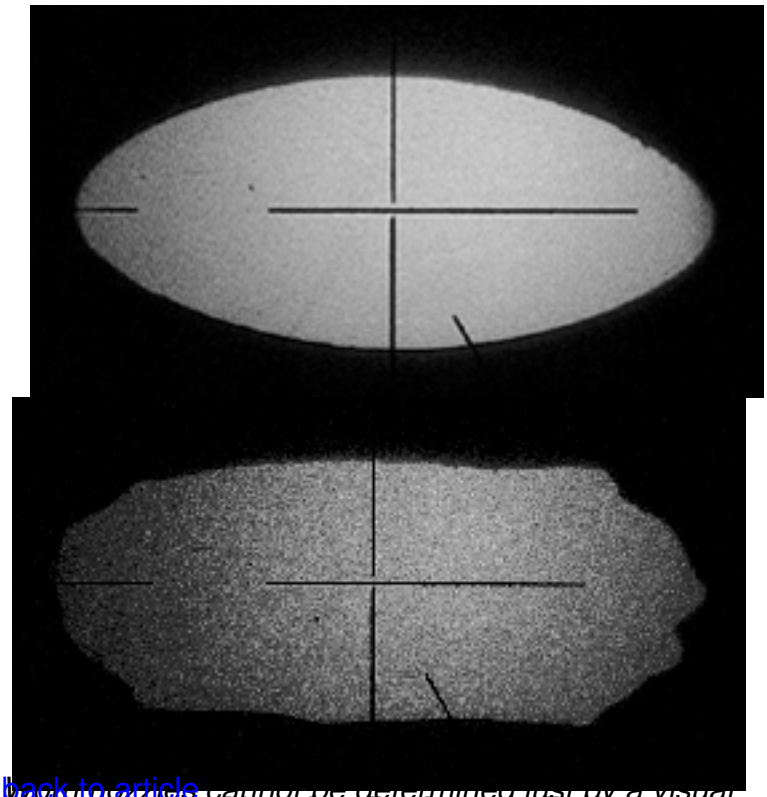
Fortunately, many modern nozzles can be installed and replaced without the use of any tools. This makes the whole process faster, easier, and more reliable than ever.

Get expert assistance. A spray nozzle manufacturer should have the capacity to test and evaluate spray nozzles to help establish baseline performance measures that will guide cleaning, maintenance, and repair schedules. This can minimize downtime significantly, and help avoid quality control issues through timely spray nozzle replacement.

A fast and convenient calculator is available online to help you figure out the actual costs of sub-par spray nozzle performance in your own application.
MT

Jon Barber is a specialist at Spraying Systems Co. , P. O. Box 7900, Wheaton, IL 60189-7900; (630) 665-5000





Wear cannot be determined just by a visual examination. Differences can be seen in a

back to article

Approximate Abrasion Resistance Ratios

Spray Nozzle Material

Resistance Ratio

Aluminum

1

Brass

1

Polypropylene

1-2

Steel

1.5-2

Monel

2-3

Stainless steel

4-6

Hastelloy

4-6

Hardened stainless steel

10-15

Stellite

10-15

Silicon carbide (nitride bonded)

90-130

Ceramics

90-200

Carbides

180-250

Synthetic ruby or sapphire

600-2000

back to article