

The dirt on cleaning anilox rolls

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Over the last decade, flexographers have witnessed the inception of a new industry devoted to developing a solution to one of the most arduous problems plaguing the printing industry: removing dried ink and coating components from the cells of anilox rolls. Approaches have varied from chemical to mechanical to optical. Each has offered its own set of benefits as well as its drawbacks.

Cleaning by hand with powerful chemicals was an early choice for many. Agitated with either a rag or stainless steel roll cleaning brush, a variety of solvents, harsh acids, corrosive bases, and combinations of these were used, putting press operators and helpers at risk for injury, and print shops exposed to substantial liability. Because the bristles on the finest brushes available are about .0025" (approximately 63 microns) wide, the tips of the bristles are barely able to penetrate into the cell opening on a 300 LPI engraving. For linecounts higher than 300, the bristles are only able to agitate the cleaning chemistry on the surface of the cells. Consequently, effectiveness decreases as linecount increases. As OSHA and environmental regulations have become more stringent, printers have looked away from harsh chemicals toward existing technologies such as ultrasonic.

Ultrasonic cleaning has been around for many years. It is a proven technique for cleaning many types of machine parts, electronic circuits, jewelry, and other applications where minute, hard to reach crevices must be cleaned. The success of ultrasonic cleaning is derived from the cavitation action, (momentary microscopic turbulence as bubbles implode on contact with the roll surface).

Ultrasonic waves can penetrate even microscopic openings, so they are able to agitate cleaning solutions deep in cavities and contours of a surface where accessibility is limited. For that reason, it was no surprise when manufacturers started marketing ultrasonic systems to the printing industry, specifically for use with anilox rolls. Most of these systems, however, were off the shelf and not specifically designed for anilox rolls. Unfortunately, in combining a harsh mechanical cleaning action with the unique cell characteristics of anilox rolls, many problems have arisen. Applying industrial ultrasonic systems to the unique challenges of cleaning anilox rolls resulted in a very expensive learning curve littered with the shattered remains of many damaged cell walls.

Ultrasonic cleaning power is determined by the wave frequency. The lower the frequency, the more powerful the cavitation. For example, a 40 Kilohertz system is not

as powerful as a 20 kilohertz system. While the higher power of the 20 kHz system would clean the cells of an anilox roll more quickly, the magnified intensity of the cleaning action can cause cell damage very quickly. The 40 kHz system will take longer to clean a roll, but the gentler action is much less likely to damage the cell walls.

Ultrasonic can be an effective means of removing ink from anilox rolls. Regardless of the operating frequency and the associated aggressiveness of the agitation, ultrasonic systems are still dependant on the cleaning chemistry to soften the ink. Consequently, it is critical that the cleaning chemistry is tuned to the inks being removed. After several cleanings, ink components can cause the cleaning chemistry to become saturated, reducing its effectiveness. To be most effective, the chemistry should be routinely removed from the tank, the tank rinsed thoroughly with clean water, and a fresh chemistry installed in the tank.

1. As a general guideline, pH levels in the ultrasonic should not be below 4 (acidic) or above 11.5 (caustic). The farther out on either end of the pH scale the solution is, the greater potential risk for injury or damage to the roll. It is important to understand that the pH scale is logarithmic; a pH of 3 is ten times more acidic than a pH of 4.
2. pH should be checked daily with high quality and calibrated equipment.
3. pH levels should be checked at the system's operating temperature.
4. Spent solutions should be discarded according to local and federal regulations. (Permits might be required).

Hard particles can be carried in an ultrasonic solution and act as abrasives or even microscopic hammers, chipping away at the cell wall structure. These particles can come from the ink components (agglomerates of pigment and resins), metal shavings from doctor blades, or even ceramic from edge chips on the roll surface. This is why it is imperative that the cleaning solution be filtered.

Another issue commonly associated with ultrasonic cleaning is camouflage. This is actually a misnomer because the camouflage is present before the roll is cleaned. Camouflage occurs as ink components dry in the cells causing light to reflect back differently to the human eye. The "camouflaged appearance" often associated with ultrasonic cleaning is actually an indication that some areas of the roll surface are clean (the light colored areas), while others still contain some ink resins and even trapped pigment (the darker, hazy areas).

In the ultrasonic tank, the transducers create waves of high and low pressure that carry microscopic bubbles which implode with a violent turbulence (cavitation) when they collide with a surface. These waves bounce off of the walls of the tank, the roll, and the carriage assembly. In some areas of the tank, the waves collide and cancel each other out, while in others, they reflect off the same surface and combine energy (hot spots). In the hot spots, the acute activity can clean the cells much more quickly than the deadened areas resulting in the visible color variations referred to as camouflage. It is important to understand that the same violent turbulence that cleans the cells so quickly also can degrade the microscopic cell wall structure in those localized areas.

Camouflage is most prevalent when any of the following conditions occur: the roll is not kept rotating during the cleaning cycle, ink has been allowed to harden in the cells, or when the cleaning chemistry is not working properly due to excessive ink contamination or poor chemical match with the ink chemistry. Unfortunately, if camouflage is occurring and not removed within the context of a cleaning cycle, additional cleaning cycles may not remove it and may even permanently etch the camouflage pattern into the roll.

In an ultrasonic system, the cleaning process is aided with the application of heat. Heat energizes the cleaning chemistry, making it more active and effective, but can also be detrimental if applied in excess. Ceramic is a naturally brittle material. It has a narrow coefficient of expansion while the base metal expands more readily with the same amount of heat. Under extreme conditions, the ceramic will not adequately expand to accommodate the expansion of the core and will crack. This can lead to ceramic delamination as the bonds are stressed beyond their ability to hold the ceramic to the roll surface. Because aluminum has a high coefficient of thermal expansion, engravings on cores manufactured from aluminum are particularly susceptible to stress cracks and ceramic delamination. This should not be an issue when temperatures are kept below 200°F.

Once the roll surface is heated beyond about 130°F, it can cause rapid evaporation of the cleaning chemistry. As the liquid flashes off, ink contaminants in the cleaning solution can be redeposited onto the roll surface. Typically, the resulting “stains” will show up as light areas in solids, tints, and vignettes. Because the ink contaminants are localized in specific areas of the roll, they are often more difficult to remove than the original ink uniformly deposited in the cells.

To overcome some of these issues, ultrasonic systems have been developed specifically for anilox rolls. To provide more uniform agitation and prevent hot spots, these new systems employ multiple sound frequencies. They have built in timers that limit the length of the cleaning cycle. Cleaning solution is recirculated and filtered to remove hard particles that may act as abrasives. The cleaning cycle includes a rinse cycle, which removes the cleaning chemicals and ink contaminants from the roll surface before they can dry back into the cells. While all of these features surely reduce the potential for damage to occur to the roll, most systems still in use do not have these features. Even with a state-of-the-art system, it is still necessary to routinely replace the cleaning solution with fresh chemistry and thoroughly rinse out the tank.

When printers experienced the shortcomings of early ultrasonic systems, many turned to media blast as the answer. Media blast involves propelling particles of media in a stream of air or water at the roll surface. Upon contact with the surface, the particles shatter sending microscopic shrapnel into the cells to chip away at any ink materials that may be present. This is very similar to the sandblasting process used for removing paint, rust, or other materials from surfaces. To date, three different types of media have been used for cleaning anilox rolls: baking soda powder, plastic powder media, and frozen CO₂ pellets.

In each of these cases, the media is less abrasive and of a much smaller particle size than the aluminum oxide typically used for sandblasting. Consequently, the media is much gentler on the delicate cell wall structure.

In most soda jet systems (systems that employ baking soda as the blast media), the roll rotates as the blast nozzle is maneuvered along the length of the roll face forming a spiral blast pattern. The baking soda is fed into the air stream and propelled through the nozzle at the roll. Baking soda is environmentally friendly and no harsh chemicals are needed for the cleaning process. This makes soda jet a popular alternative to other methods.

In a soda jet system, several factors combine to determine the effectiveness of the cleaning cycle and the potential for damage to the cell walls including the distance of the nozzle from the roll, nozzle air pressure, inside diameter of the nozzle bore, angle of incidence (angle at which the blast media strikes the roll face), rotational speed of the roll, and traversal speed of the nozzle. Damage potential is increased when these factors combine to increase the effective exposure time that any given surface of the roll receives.

The cleaning cycle in a soda jet system is very quick and reasonably effective on most inks. Rarely does a roll need multiple cycles to get clean with this approach, however effectiveness does vary by manufacturer and model. Many companies licensed this cleaning technology and developed their own equipment to utilize it.

The baking soda media is spent after one cleaning cycle, which means media must be purchased regularly and disposed of frequently. Even though the baking soda may be environmentally friendly on its own, when combined with ink materials, spent soda may be considered hazardous waste.

Some printers have experienced clumping of the blast media, which results in inconsistent flow through the nozzle. This often occurs when the system is located near an outside garage door where ambient humidity changes dramatically. It also occurs as the result of water in the air lines. This can usually be prevented with the installation of driers in the feed lines coming from the compressor.

Plastic media systems hold the roll stationary as the nozzle traverses past. Once it clears the end of the roll, the face jogs slightly and the nozzle returns to its original position. This process is repeated until the entire surface of the roll has been blasted by the overlapping spray pattern from the series of passes. This approach is quite a bit more time consuming than the spiral blast pattern, which can appear to be a significant drawback to printers under severe time pressure.

Plastic powder media can be reused through multiple cycles. Because the media is reused, it is important to remove all grease and wet ink from the roll prior to installation in the system. This prevents these materials from contaminating the media used for future cycles.

An early problem with this system was the occasional plugging of cells with the blast media. Because the anilox cells were smaller than the media, particles could get stuck in the cells. This problem was addressed through the availability of finer particle size blast media, however, beyond 1000 LPI plugging may still be an issue. In addition, the finer media used to clean these linecounts has been reported to need replacement more frequently than the coarser grade.

Cryogenic blasting uses air pressure to propel frozen CO₂ pellets at the roll surface in a manner similar to soda jet systems. The theoretical benefit of this approach is that the CO₂ pellets dissolve into the air leaving fewer residues for clean-up and disposal. As such, it is a relatively "environmentally friendly" approach that requires no solvents, acids, or corrosives. Early tests with this system showed extensive cell damage, presumably the result of the extremely high air pressure used at the time. While refinements have likely been made with this technology, we have not undertaken further testing of this approach.

In as much as media blast provides answers, it also generates questions. Which type of media is least harmful to the anilox roll? Which manufacturer and model offers the best value in terms of price, features and serviceability? What is the proper nozzle pressure, rotation speed, traverse speed, nozzle to part distance, and particle size? How many cleanings can be undertaken on a given roll before cell damage is detected? The answers vary by system, and even by manufacturer of a given type of system. The "mild" sand blasting effect of media blast does cause erosion of the engraving and prolonged exposure WILL damage the cell walls. That said, media blast can be an effective part of a roll maintenance program as long as the system is set-up and used properly and in accordance with the manufacturer's recommendations and operating procedures.

Pressure wash systems operate in a manner similar to a portable dishwasher where cleaning solution is forced under pressure through a series of nozzles at the roll surface. The roll rotates as the nozzles traverse back and forth. Heat is again used to activate the cleaning chemistry. The solution is stored in a holding tank for multiple cleaning cycles, but filtered as it is pumped back into the system. A rinse cycle prevents residue from drying onto the roll surface. Conceivably, this type of system should not hurt the roll, but because it relies on the cleaning chemistry to do most of the work, its effectiveness can be hampered by a saturated cleaning chemistry.

A relatively obscure approach is cleaning with chemical vapors. In this case, a relatively mild cleaning solution is heated until it becomes vaporous. The chemical steam vapors are drawn past the roll surface, which is said to soften and loosen deeply imbedded inks so they can be wiped away with a clean dry rag. Very little liquid is involved in the cleaning process, resulting in very little hazardous waste to contend with. Chemical vapor is said to be effective for water based inks, but is not applicable for solvent. Because this system does not require removal of the roll from the press, it has been primarily marketed for use with jumbo corrugated rolls. With those large rolls, however, the linecounts are usually much coarser than with wide, mid or narrow web rolls. Consequently its applicability for higher linecounts has not been demonstrated.

On-press closed cavity rinse involves cleaning the rolls on press as well. In this case, traditional doctor blade systems are replaced with special closed cavity chamber units, hooked up to a custom pumping system. The pump feeds ink through the chamber during the printing operation. When the press is shut down, the remaining ink flows back into the reservoir and cleaning solution is pumped through the chamber as the roll rotates. This removes the ink in the most expedient fashion available, but requires a significant capital investment for each press, putting it out of reach of most narrow web print shops. Of concern with this approach is excessive blade pressure, which can damage the cell walls during the cleaning cycle, particularly once the lubricating effect of the ink has been replaced with the less lubricious cleaning chemistry.

Probably the most exotic approach offered involved vaporization of the ink contaminants with laser energy. This approach is only offered as a cleaning service. As this is a proprietary process, (which competitors could conceivably duplicate), few details have been released about the specifics of this approach, its damage potential, or its effectiveness. What we do know is that laser energy is optically directed at the roll surface and is absorbed by the ink and other contaminants in the cells. These materials are burned away by the energy of the laser beam, supposedly leaving the cell walls in tact.

Because anilox cells are originally formed by concentrating laser energy at the roll surface, the laser cleaning process raises concerns about the effect on the cell walls from the application of this type of energy for cleaning. Cases have been reported where the laser energy actually melted the walls of the engraving. The effectiveness of the cleaning cycle may be diminished due to the reflectivity (at the specific operating wavelength of the laser) of the pigment materials trapped in the cells. It is undoubtedly a time-consuming (and presumably correspondingly expensive) process since the entire roll surface has to be again exposed to the laser energy. Because it is not a process that can be performed in a print shop, it requires shipping time and expense.

With all of these manufacturers offering cleaning systems said to be both “safe and effective”, printers have been left scratching their heads wondering what to do. Often the answer was to try this system and then that and then the other, getting more frustrated as each expensive system failed to live up to the advertising hype and leaving many feeling like they have been “taken to the cleaners”. In many cases, however, printers have added to their own misery by neglecting or putting off daily press-side cleanings or misadjusting, failing to properly maintain or misusing cleaning systems.

When rolls do plug badly or ink is allowed to set up in them, how many printers have made the mistake of leaving rolls in aggressive cleaning systems for extended or multiple cycles? How many crank up the air pressure on media blast systems beyond recommended levels to speed the cleaning process? How many place cleaning systems near outside doors, where ambient humidity can cause media to clump and liquid systems to loose the heat that activates their chemistry?

By allowing ink to harden in the first place, they make the cleaning job that much more difficult. Placing rolls dripping with ink into any cleaning system contaminates the cleaning solution or blast media rendering it less and less effective. Repeated cleaning cycles can result in cumulative deterioration of the cell walls. Excessive air pressure accelerates cell damage.

Cleaning systems are meant to augment the regular daily cleanings done on press -not to replace them. Although they vary by approach as well as cost, these systems can be an integral component of a comprehensive press maintenance program. Each system has advantages and drawbacks. How a system is used and maintained will have a significant bearing on how well it performs, but the key to the success of any system is to remove the ink before it hardens. Prevention is the best cure.

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