WHITE PAPER

COULD COMPOUND BE USED JUST AS A COOLANT IN ROBOTIC BUFFING APPLICATIONS?

NORTON | SAINT-GOBAIN ABRASIVES

DECEMBER 10, 2019

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Buffing is an important but often overlooked industrial finishing process that imparts extremely smooth or mirror-like surface finishes onto a variety of parts.

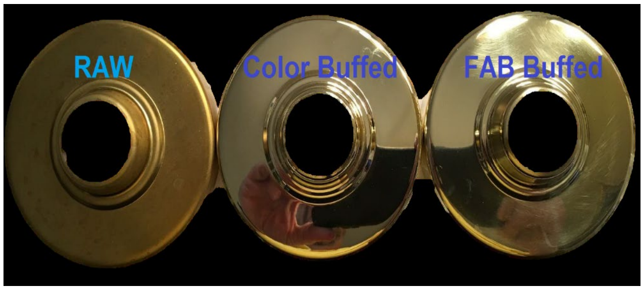

Figure 1. Raw, color buffed and FAB buffed brass rosette parts. Source: Norton | Saint-Gobain Abrasives

A highly reflective, lustrous surface finish is important to achieving the appearance and appeal of many automotive, appliance and consumer products. Buffing is also a critical surface preparation step that determines the quality of plating, painting or other coating processes. Highly reflective buffed surfaces can also impact the performance of products. For instance, surfaces buffed to mirror finishes are important in lighting reflectors and optical devices. Low roughness average (Ra) buffed surfaces tend to collect less dirt and debris and are easy to clean, which makes buffing an important process in surgical instrument and medical device manufacturing.

Smooth, buffed surfaces can reduce drag and improve flow characteristics, which can enhance the performance of impellers and other components in pumps, valves and process equipment. Bearings, gears and other mechanical equipment with contacting surfaces can benefit from the reduced friction of buffed surfaces. The surface finish of a variety of steels, stainless steels, aluminum, brass, zinc, exotic metals and plastics can also be refined through buffing.

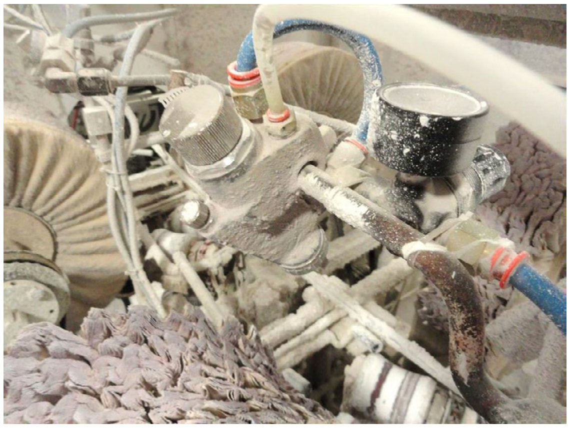

Figure 2. Conventional buffing is a messy, difficult-to-control process. Note the buffing compound splattered onto surrounding equipment and work space. Source: Norton | Saint-Gobain Abrasives

The conventional buffing process uses a buffing wheel, abrasive buffing compound, compound applicator, operator or robot and a buffing machine. The buffing wheel is mounted onto the buffing machine and spun to the appropriate speed for the material and part configuration. The buff receives a coating of the abrasive buffing compound from a stick in manual use and from a liquid applicator in automatic and semi-automatic operations. Compound applicators use a system of tanks or drums, pumps, tubing and nozzles to spray liquid compound onto the buff. After compound application, the part is manually or robotically presented to the buffing wheel to remove scratches and to impart a high-luster surface finish. In addition to some material removal in the buffing process, buffing also moves material around to refine and smooth over scratches and imperfections. Most buffing consists of two buffing steps: cut and color, although combined cut and color buffing into a single step is possible in some applications. Cut buffing removes scratches imparted during previous prep processes and flattens or smooths the surface. Color buffing brings out the full luster or the maximum shine of the metal to produce a mirror-like finish.

While buffed surfaces are highly desirable in many industries, conventional buffing processes are often problematic to control and automate, mainly due to the messy abrasive compound. Any abrasive process with compounds, slurries or loose abrasives presents problems for manufacturing because they are difficult to regulate and contain. For instance, abrasive compounds are often sprayed onto buffing wheels, but only a portion of the compound actually is captured in the wheel and the rest is over-sprayed. The buffing compound may not always be applied uniformly to the buffing wheel, especially when the compound applicator nozzle becomes plugged or erodes and becomes oversized. In addition, some compound is ineffective or not fully utilized because it is lost or flung off the wheel during the buffing process. Manufacturers are challenged with achieving consistent roughness levels of 10 Ra or finer with mirror finishes due to the inherent inconsistencies of conventional buffing.

Figure 3. Nickel chrome plated FAB buffed parts showing a nearly unnoticeable amount of compound residue. Source: Norton | Saint-Gobain Abrasives

Cleaning or removal of the buffing compound is another major drawback to conventional buffing. According to the ASM Surface Engineering Handbook, "Polishing and buffing compounds are difficult to remove because the soil they deposit is composed of burned-on grease, metallic soaps, waxes, and vehicles that are contaminated with fine particles of metal and abrasive."

Tenacious buffing compound residues may require solvent, emulsion or alkaline cleaning depending on the specific composition. Almost every industry attempts to avoid the use of solvents, but hot solvent or vapor degreasing are often needed to remove buffing compounds. The heat during cleaning can sometimes bake on the buffing compound. Removing the buffing residues from crevices or surface details of a part may even require hand brushing, impingement or mechanical agitation, but a thin or delicate part can be damaged in these cleaning processes. In addition, certain alloys such as brass and bronze will tarnish in alkaline cleaning solutions with a pH less than 10. Most manufacturers are attempting to improve the environmental friendliness of the processes by using greener cleaning chemicals, which might not be powerful enough to remove some compound residues.

Excess and used polishing compounds and cleaning solutions are waste streams that require proper remediation, handling and disposal to comply with environmental regulations. Some of the abrasive compound becomes airborne or turns to dust and workers without respirators can breathe in the compound dust, which contains silica, minerals and binders. Reducing or eliminating buffing compound and cleaners would be an ideal step in improving sustainability, productivity and safety in buffing operations.

New Fixed Abrasive Buff (FAB) technology

Norton | Saint-Gobain Abrasives' new Fixed Abrasive Buff (FAB) technology can reduce or eliminate the need to use buffing compounds. Unlike conventional buffs, Norton FAB wheels have pre-adhered abrasive layers. FAB wheels use a waterproof and tear resistant, non-woven nylon (i.e., polyamide) cloth backing, which is a far more durable material compared to conventional cotton buff materials. FAB wheels are less likely to snag and tear when sharper edges are presented to the wheel compared to cotton buffs. The higher durability results in much longer buff life (over 35%) compared to current buffing wheels.

Figure 4. Magnified image of FAB surface showing abrasive slurry coating and non-woven nylon backing. Source: Norton | Saint-Gobain Abrasives

Current FAB wheels use silicon carbide (SiC) abrasive grain with an average micron size of 29 micron. FAB wheels reliably provide finishes between 1 to 5 microns, which is far superior to the 10 to 12 micron finishes of equivalent conventional buffing wheels. Using a patented process, the sharp SiC abrasive grains are adhered onto the durable nylon surfaces with a flexible, waterproof resin. Both sides of the cloth in the buff are uniformly coated with abrasive and resin to consistently present the buffing abrasive grains to the work piece.

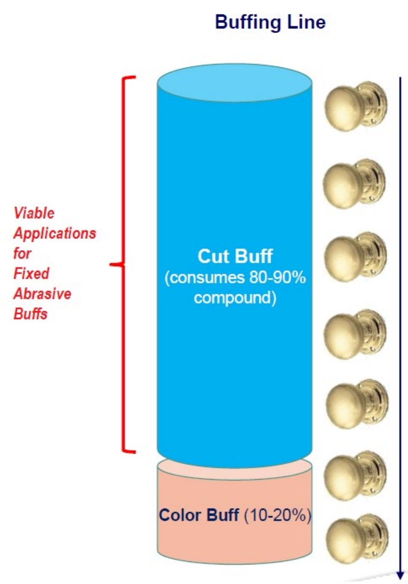

Figure 5. Norton FAB wheels are a viable replacement for conventional buffs in cut buffing, which consumes 90% of the compound. Source: Norton | Saint-Gobain Abrasives

While FAB wheels do generate a glossy surface finish with compound application levels of 60% to 90% less than traditional buffs, FAB products are generally not suitable for final color buffing applications. The FAB products currently introduced are most suitable for cut buffing and can replace airway sisal and cloth buffs, which typically consume 90% of the compound used in a cut and color buffing process. FAB technology is not an anticipated replacement for sewn sisal buffs. Sewn sisal buffs provide aggressive cutting when deep scratch removal is required, especially on steel, stainless steel and hard metals. However, they also require a large amount of compound sprayed during that process. FAB wheels are effective on hard alloys as well as soft metals such as aluminum and brass. For example, FAB wheels have shown promise in deburring and edge contour generation on broached slots in very hard turbine disks.

Coolant choices with FAB wheels

Since the abrasive and cutting capability is contained within the FAB wheel, the application of buffing compound is really only required to keep the buff cool and, in some cases, for final luster generation. Compared to a conventional buffing process, the FAB process generally requires only 25% to 33% of the traditional buffing compound amount, and sometimes as little as 10%. Heat generation is the enemy of the buffing wheel and abrasive finishing processes. Excessive heat can discolor metals, reduce abrasive product life and even start fires. For instance, conventional buffs used on aluminum can start to burn when insufficient amounts of compound are applied.

Figure 6. Liquid buffing compound (or water in select cases) is sprayed through nozzles (circled) and onto the buffing wheel to maintain coolness.
Source: Norton | Saint-Gobain Abrasives

Buffing compounds act as a coolant when used with FAB wheels. If another coolant can be applied, then buffing could occur with zero compound usage. In cases such as buffing hard polyurethane plastic parts (e.g., bowling balls), specialized adaptations with water coolant have enabled buffing without any compound. However, FAB wheels will provide large productivity gains and quality improvements in the majority of industrial applications by reducing compound consumption by 60% to 90%. In addition, a small amount of buffing compound (e.g., 10%) brings out the luster or shine on metal parts.

Advantages of FAB technology

While reduced annual buffing compound consumption and expenditures are the most significant benefits of FAB wheels, FAB technology provides additional advantages.

Compound applicators only need to spray every 60 seconds during FAB buffing compared to the 3 to 6-second intervals used in conventional buffing. The reduced flow of compound through compound guns, nozzles and pumps curtails wear in these components, which lowers maintenance and part replacement costs as well as the productivity cost from downtime. Lower compound flow also reduces the build-up of compound and clogging of the spray nozzle, which translates into improved buffing consistency.

Fixed Abrasive Buff (FAB) Wheel Advantages	
Compound Consumption	Up to 90% Less
Buff Life	Up to 35% Longer
Surface Finish	Lower Ra (1 to 5 microns)
Finish Consistency	Higher consistency and less dependent on compound
Buff Durability	Tear Resistant & Waterproof
Applicator Function & Maintenance	Lower compound consumption reduces plugging, wear & failures
Compound Residue Removal or Cleaning	Minimal compound residue reduces cleaning requirements
Health & Safety	Less compound in air & lower fire risk on aluminum
Environmental	Used compound and cleaning solution waste streams reduced

Figure 7. The advantages of FAB compared to traditional buffing wheels.

Another important aspect of reduced compound use is the minimization or elimination of downstream cleaning. Since little compound needs to be removed from the surface, the chemical cleaning solutions in immersion baths, spray impingement and other part washers have longer lives. In some cases, the amount of compound remaining after buffing is almost undetectable and cleaning is not required beyond light wiping or brushing.

Buffing operations are often undesirable to many operators due to the use of messy compound, which covers everything, including workers. FAB wheels improve the buffing workplace environment, which might help retain employees. The 60% to 90% reduction compound consumption lowers fire risks, lessens equipment and part clean-up efforts, reduces compound and cleaner waste handling and disposal tasks, and reduces worker exposure to airborne compound particles.

FAB wheels have superior finish generation performance. In typical surface refining processes, a series of increasingly fine abrasive belts, discs or wheels are used to remove the scratches from the previous, coarser grit. This produces a flatter and finer scratch pattern. With conventional buffs, final coated abrasive preparation stops at a 360 or even 400 grit to produce a polished surface that can then be easily buffed to a mirror finish. FABs on the other hand provide high luster and consistent finishes in a 1 to 5 Ra range from a coarse 280 grit prepped surface. When pre-buff coated abrasive polishing with 320 grit, FAB wheels regularly generate 1 to 3 micron finishes. The ability to produce a mirror polish on workpieces with coarser prepped surface finishes can eliminate several finishing steps, which provides additional cost savings.

FAB wheels demonstrate increased life compared to conventional buffs, because the FAB wheel uses a more durable, waterproof cloth. In addition, the abrasive layers reduce wear of the cloth. The longer buff life has the added benefit of reducing downtime required for wheel changeovers.

Leveraging FAB wheels in automated or robotic processes

Long life, low compound usage and several other attributes of FABs make this new technology highly amenable to automatic and semi-automatic buffing operations. FAB wheels works with the existing setup, so no mechanical changes are required to install higher performing FAB wheels. Compounds are messy and difficult to control, so the low compound consumption of FAB reduces and in some cases nearly eliminates this problem. Process steps can also be eliminated with FAB wheel buffing, such as pre-buffing finishing steps with coated abrasives. Buffing can begin after 280 grit belt, disc or flapwheel. Post buffing cleaning can be greatly reduced or eliminated as well. Fewer steps means fewer processes to automate and fewer tools and

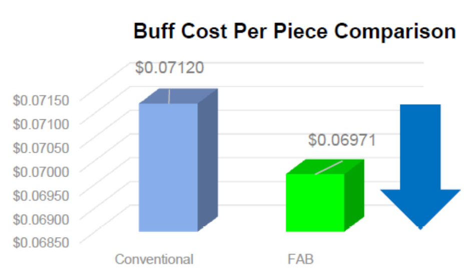

Figure 8. Buffing cost per piece comparison.
Source: Norton | Saint-Gobain Abrasives

materials to handle. FAB's ability to provide surface finishes more consistently increases the viability of automating finishing and buffing operations because operator intervention to compensate for surface finish variations are minimized with FAB.

Buff speeds, part handling methods and other finishing system parameters should also be optimized to maximize the benefits of automation. For instance, lower speeds or surface feet per minute allow workpieces to mush or push deeper into the buff, which engages more of the fixed abrasive particles with the metal surface. Fixed abrasive buffs still provide an advantage at higher speeds, but a lower or variable speed motor drive is desirable on the buffing machine because they gain the fullest advantage from FAB technology.

Fixed Abrasive Buff Cost, Productivity & Sustainability Benefits
Lower compound and & cleaner costs
Lower downtime & cost for applicator repairs
Lower down time for wheel changes
Elimination of pre-buff coated abrasive steps
Higher employee retention from safer and cleaner environment
Reduced compound & cleaner waste disposal costs
Lower annual wheel cost from increased wheel life
Lower total cost ownership

Figure 9. FAB cost, productivity and sustainability benefits.

Next steps

In summary, Norton FAB wheels offer several advantages over conventional buffing products, including increased life, reduced compound consumption, more consistent finishing, improved control and automation, minimized post cleaning, healthier environment and reduced waste. While the patented FAB wheel may have a higher initial cost compared to conventional buffs, the buffing cost per piece is reduced due to the cost savings from reduced compound and cleaning solution consumption as well as increased buff life. A total cost benefit analysis will demonstrate the cost savings, productivity and sustainability benefits gained from implementing FAB wheels in a variety of finishing facilities.

Norton | Saint-Gobain Abrasives partners with customers to customize and optimize FAB technology, and can develop tailored solutions to meet the needs of automated buffing applications. To better understand and evaluate how Norton FAB wheels can lower costs, improve quality and enhance productivity in a variety of applications, contact Mike Shappell, senior application engineer, Norton | Saint-Gobain Abrasives at Mike.D.Shappell@saint-gobain.com or visit www.nortonabrasives.com.