The Power of Crystals

The Kinder, Gentler Strength Of Baking Soda

by Paul G. Arle

Today, sodium bicarbonate is at home in the hands of pastry chefs and parts cleaning technicians alike. By the tablespoonful or by the blast pot full, baking soda is showing up in places you might least expect in the cleaning industry, manufacturers are discovering the attractive benefits of a low-impact blasting process known as "soda blasting."

Blast cleaning is a technology that carries with it many misconceptions. One of the most common is that for blasting to be a cost-effective process, the media must be recycled. Recycled media cleaning operations are multistep processes and, in many cases, parts must be free of oil an grease before blasting can be done. Soils will contaminate the blast media and make recycling much more difficult, therefore, some type of prewashing is typically required. After blasting with most recyled media, an additional washing and/or rinsing step is required to remove retained media from bolt holes and other internal cavities.

Most multistep processes can be simplified by using a single-pass media. Most part can be blasted without a precleaning phase (so oil and grease on parts becomes inconsequential). The washer is therefore freed up to clean parts that do not require blasting or, in some cases, the washer can be eliminated altogether.

In ideal liquid cleaning scenarios, parts washers are loaded, the timer is set, and the operator is available for other work while the washer cycles. Unfortunately, in many cases where systems are not well-suited to the operation or incoming materials frequently vary in nature, the operator can spend a great deal of time had-detailing parts that have not been properly cleaned. This hand-detailing commonly includes gasket removal, paint removal, and removing soils the washer missed. Since labor represents the highest cost in a cleaning department's budget, reducing the labor to produce clean parts is indeed an attractive opportunity.

One alternative to such labor-intensive operations is a low-impact blasting process called "soda blasting." The process uses a specially formulated sodium bicarbonate (baking soda) as the blast media. The media is especially effective in situations where the proper equipment is matched to the correct cleaning application.

Sifting Through the Crystals

Baking soda, $NaHCO_3$ is a pure white, free-flowing, crystalline material. It is produced in a batch process in which a slurry consisting of pure water and filtered soda ash (Na_2CO_3) is injected with carbon dioxide (CO_2) Crystals from 50 to 275 microns are used to produce blast media. Blast media is formulated from four crystal sizes. **Table I** demonstrates the appropriate cleaning applications based on crystal size.

Crystals are screened to ensure consistency of particle size. The percentage of crystals available for the formulation of different blast media is a small portion of what constitutes a typical batch. In an average batch, the crystals extracted for use in blast media range from 10% (for 275.micron blast media) to 15% (for 50- and 70-micron formulations) to 35% (for 150-micron batches).

Incorrect cleaning agent selection can damage substrates, endanger workers, and result in low productivity and higher cleaning costs. This is especially relevant today, when federal and local regulations restricting chemical use and exhaust emissions have made it more challenging to find safe chemical alternatives that perform as well as their predecessors. Pure sodium bicarbonate is becoming a popular alternative because it is:

- nontoxic to both workers and the environment;
- slightly alkaline at a pH of 8.2;
- noncorrosive to almost all substrates;
- relatively soft, measuring only 2.5 on the Mohs hardness scale (0-10);
- friable (easily fractured);
- water-soluble (8-10% in cold water), which allows it to be easily rinsed from parts; and
- nonabrasive and safe for most substrates, including bearings, mechanical seals, hydraulic cylinders, and rotating elements.

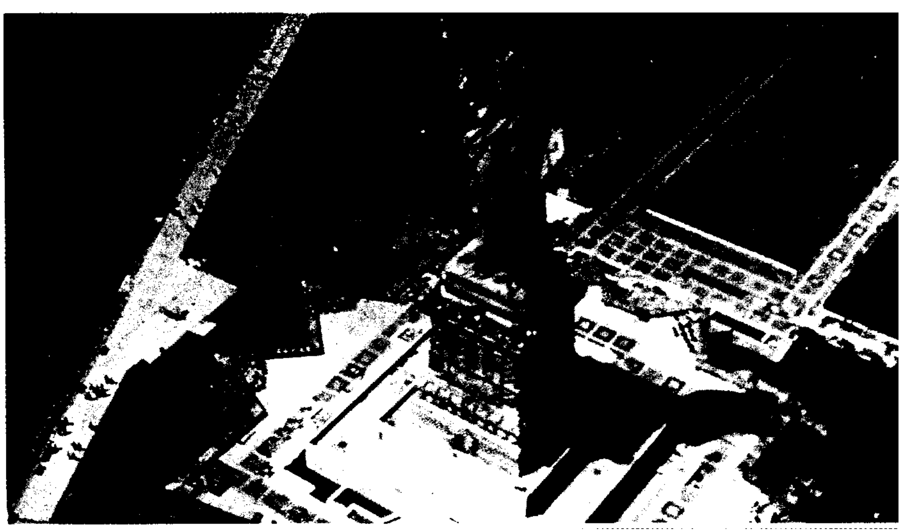

Figure 1. The Statue of Liberty restoration saw the first utilization of baking soda as a blast media.

From Historic Beginnings

Baking soda was first used as a blast media during the renovation of the Statue of Liberty, which was carried out from 1982 to 1986 (see Figure 1). The interior skin of the Statue was covered with six coats of' paint and a coat of coal tar. The interior passages are very convoluted, making it impossible to ventilate, and this prevented the use of chemical strippers. Furthermore, traditional abrasive blasting was not permitted because the skin of the statue is made of copper and measures roughly the thickness of a silver dollar.

A foreman on the project suggested that baking soda blasting might be a feasible option. The formulation of this idea came from his own experience of having his teeth blasted by his dentist. The technique cleaned his teeth without damaging the surface or the surrounding gums.

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Design Changes Invite New Applications

In 1988, available blast systems could not regulate media flow, and this made sodium bicarbonate more costly to use than abrasive media. Moisture in the compressed air caused flow problems and existing nozzles (not designed for bicarbonate) provided low productivity. It was obvious that something had to be done if baking soda were to become a cost-effective blast media. In 1989, the first blast system designed for baking soda was developed. It was quite large and rather expensive. The design featured a dual regulator control system, which required two people to operate (see **Figure 2,** page 18). The process was slow, loud, and dusty. Media flow control was improved, but not yet optimized.

Because sodium bicarbonate is noncorrosive to most substrates and nonsparking (when properly used), it will not damage rotating equipment, bearings, or mechanical seals. As such, the method gained popularity with the petrochemical industry along the Gulf Coast. Soon after, the pulp and paper industry found they could reduce the hours of machine downtime by starting the cleaning process before shutting the paper machine down. Soda blasting allowed this precleaning step, one not previously possible with the original pressure washing technique.

From 1991 to 1996, new bicarbonate formulations increased productivity, eliminated flow problems, and expanded the use of baking soda as a blast media. By 1992, various sized systems were available with a single regulator, and soda blasting units had become inexpensive and simple to operate. Many were portable, required little maintenance, and allowed media flow regulation to ½ pound per minute.

In 1993, nozzles were developed and designed specifically for use with baking soda media (see **Figure 3,** page 18). This increased productivity over existing blast nozzles by more than 30%. By the end of that year, the use of baking soda had gained reputability as an ideal blast media for open-blasting applications. The process was used on architectural projects, plant shut downs, fire restoration, and general maintenance. Unfortunately, the dust and noise associated with the technique made it an unattractive option for most manufacturing environments.

In 1996, it became clear that soda blasting would never be a method of choice for manufacturers unless dust and noise containment issues were resolved. So came the engineering of system designs that focused on these previous drawhacks. One design that featured a wet blast cabinet found early acceptance in the aerospace industry for cleaning expensive aircraft parts in remanufacturing operations and surface preparation prior to nondestructive testing. AlliedSignal and American Airlines were the first to adopt soda blasting into their operations, and the method soon spread to other related companies.

Between 1996 and 1997, equipment manufacturers recognized signs of an emerging market for sodium bicarbonate blasting systems. Several blast system manufacturers began to offer equipment that put abrasive blast media and baking soda media on a relatively level "playing field." At this point, baking soda truly became a viable replacement for hazardous chemicals, abrasive blast media, and costly hand sanding. Today, there are a number of formulations that cover a wide range of applications.

Remanufacturers Reap Rewards of Soda Blasting

The cleaning phase of remanufacturing operations is generally more critical than that of most other manufacturing operations. Every piece of core material must be

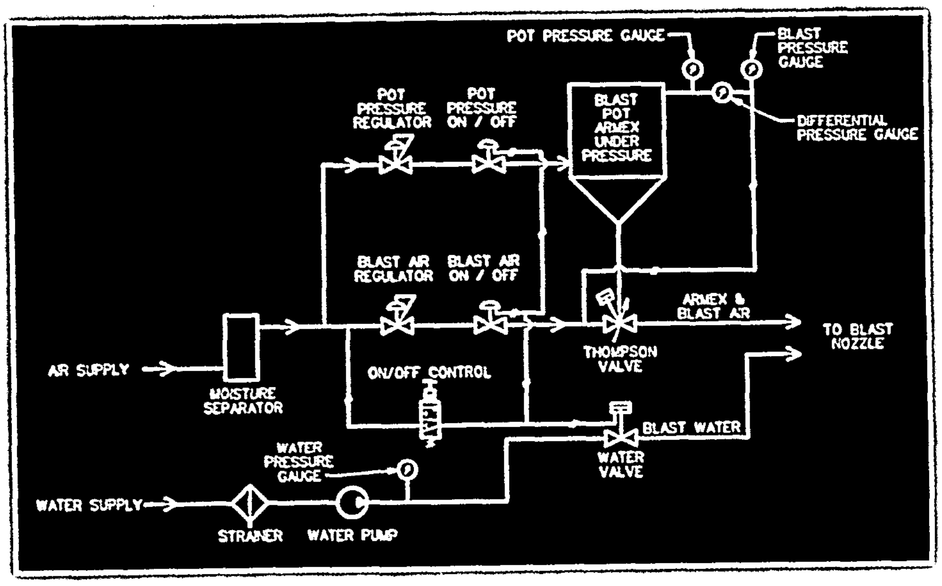

Figure 2. A diagram demonstrating an early blast system designed for baking soda. The system was large, expensive, and required two operators.

cleaned before it can be judged fit to reuse and then recycled. Remanufacturers expend a greater percentage of their operating budgets on cleaning than do original equipment manufacturers. In fact, some of soda blasting's greatest successes have been in this sector.

One of the world's largest remanufacturers of diesel engines and associated equipment realized significant savings with soda blasting. Engineers at the company first saw a demonstration of soda blasting at a test facility in December 1995 and became interested in its ability to clean pistons and detail steel and aluminum engine components. During January 1996, tests were conducted in which parts were cleaned in both wet and dry systems.

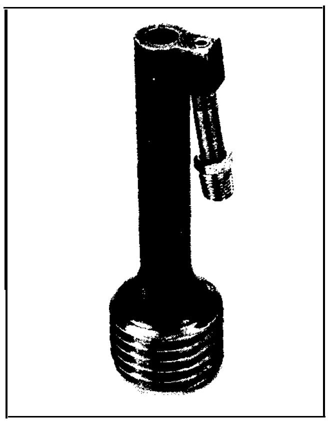

Figure 3. Nozzles designed specifically for use with baking soda blast media.

In April, the company purchased two wet blast cabinet systems for its remanufacturing facility. The systems were used to clean aluminum- and steel-crowned pistons by blasting with a sodium bicarbonate formula and then rinsing and drying (see Figure 4). The old cleaning process replaced by soda blasting consisted of the following steps:

- 180°F aqueous, alkaline wash
- installation of rubber plugs to prevent damage to wrist pin bores
- hand blasting with glass bead
- a second blasting in an automated glass bead machine
- removal of rubber plugs
- 180°F final rinse with tap water
- belt sanding of steel ring groove area
- application of rust preventative

Table II (page 20) shows the first-year cost reductions per part as reported by the company.

In January 1997, the company's remanufacturing plant began to detail engine components downstream of a multistaged washer and a hot salt bath. Before the installation of a soda-blasting process, detailing was done by hand. The tools used for this included: wire brushes on air motors; abrasive discs on side grinders; scrapers; sandpaper; and other tools. This detailing was carried out to remove gasket material, clean bolt holes, and remove soils and paint not removed in the washer and hot salt bath.

The switch to soda blasting improved the quality of the parts (see **Figure 5),** but noise and dust levels were above the acceptable level. To resolve the problem, the company

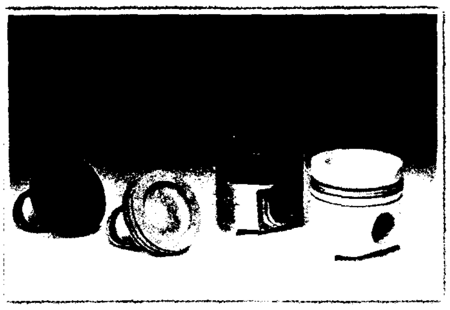

Figure 4. Aluminum and steel-crowned pistons, before and after soda blasting.

installed a 60-inch by 60-inch blast cabinet, which instantly resolved the noise and dust problem and greatly increased operator comfort. The company reported 1998 savings on the blast cabinet over hand-detailing as follows:

Labor reduction	$168,000
Overtime reduction	$ 21,000
Expendables	$ 26,600
Total	$215,600

They then added two 36-inch by 48-inch cabinet systems to replace a glass bead cabinet and an indexing glass bead turntable. Tests are being conducted on a

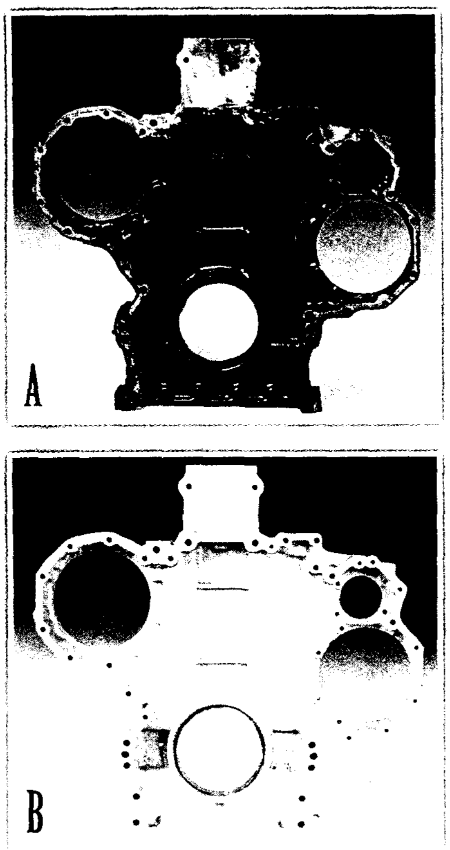

Figure 5. Engine covers (A) before and (B) after soda blasting.

Table II: First-Year Cost Reduction per Part

	OLD SYSTEM	SODA BLASTING	COST REDUCTION
Labor	7.6 min.	1.8 min.	76%
Electricity	22KW/Hrs	0.3KW/Hrs	86%
Chemicals	$0.42	- 0 -	100%
Media	$1.40	$0.90	36%

number of other applications as this article goes to press. In January 1999, the company replaced the two wet-blast cabinet systems with a dual-chamber, automated dry blast system.

Matching Method to Application

As the technology of sodium bicarbonate blast cleaning progressed, it became apparent that knowing when and where to apply this method is the best way to ensure success. Blasting with any type of media is a line-of-sight mechanical cleaning process. In other words, if you can see it, you can clean it. As such, blasting is not recommended for internal cavities and convoluted parts.

A good example of inappropriate application of the technique would be attempting to blast clean the oil galleys in an engine block. So much of the surface area would be missed by the blast stream that successful blast cleaning would be impossible. The flow of air and media through the internals would not provide a clean surface. In line-of-sight cleaning, the surface must be struck directly by the “hot spot” in the blast pattern.

As with most cleaning processes, matching the proper equipment with the correct cleaning agent is critical. To determine soda blasting’s “correct matches,” it is important to understand the specific strengths of the medium. Since baking soda is soft and will not damage most substrates, rotating elements, mechanical seals, and hydraulic cylinders, it will not remove anodized and galvanized coatings. Soda blasting is a logical consideration for any manufacturer who answers “yes” to the following questions:

- Are there delicate substrates that are being damaged by alternative methods, causing scrap rates to be unacceptably high?
- Is a part with a delicate substrate not being recycled because a safe way to clean it has not been identified?
- Are there assemblies being disassembled and then reassembled because the core materials of various parts vary in their susceptibility to damage by present cleaning methods?

Some parts cleaning operations that use abrasive blasting experience excessive waste disposal costs due to high concentrations of heavy metals in the waste stream. This can occur because traditional abrasive blasting often removes metal from the surface of parts, sending it into the waste stream. Switching to a softer, gentler blast medium results in only the grease, oil, and

Table III: Specialty Formulas

MOISTURE CONTROL	RINSE ENHANCERS	OIL AND GREASE EMULSIFIER	HARD ABRASIVE
Premium additives ensure media flow in humid environments or where poor compressed air quality is a problem.	For applications where no residue is tolerated. Uniquely suited for parts with internal cavities, bolt holes, etc. Allows a reduction in rinsewater volume. Insures 100% adhesion for recoated parts.	Recommended for use with high-pressure water applications. The additive prevents the grease and oils from redepositing on parts or surrounding areas.	When application calls for a white metal surface and a 1.5 to 4.0 mil profile. Removal of heavy corrosion and mineral deposits.

particulate soils being removed from the part, which can be filtered or skimmed before dumping. The waste is no longer classified as hazardous, and disposal costs are significantly reduced.

There are various ways to control the aggressiveness of the blast. First, select the correct size of baking soda crystal for the application. As previously mentioned, all baking soda crystals register 2.5 on the Mohs hardness scale, regardless of size. Larger crystals result in a more aggressive blast due to simple mass/energy transfer. For more delicate substrates, a crystal size of 70 microns is recommended. For higher rates of productivity and more robust substrates, media with crystal sizes of 150 and 275 microns are available.

Equipment designed for soda blasting allows the operator to adjust the blast pressure from 15 to 100 psig. Reducing the blast pressure is recommended when blasting delicate substrates. The stand-off distance is the distance from the blast nozzle to the work piece; increasing this distance is another way to reduce the possibility of damage to the substrate.

Unique Media Formulations

As mentioned, crystal size can define baking soda media in terms of cleaning power and substrate compatibility. In addition to this, there are special formulations that have been uniquely developed for a range of specific applications (see Table III).

One such formulation is designed specifically to remove greases and oils via a high-pressure washer without relocating the soils on the part or other surfaces. The media, which contains a surfactant, is injected into the high-pressure water stream, facilitating cleaning while emulsiEying the grease and oil. The grease and oil remain trapped in the effluent and are not redeposited on the parts or on walls, floors, and ceilings.

Media with special rinse enhancers are also available. These formulations require less rinse water and are popular in the southwest region of the country, where water is at a premium. If the end-user recoats the parts and requires 100% adhesion, these formulations can be a great insurance policy.

For applications that require the removal of heavy corrosion, mill scale, or welding discoloration, there are formulations that contain hardened abrasives. To overcome high humidity conditions or large amounts of condensation in compressed air streams, a blasting formulation with a super-flow aid is available.

The water-soluble nature of baking soda provides additional opportunities to reduce cleaning costs. Many cleaning operations employ the use of glass bead or plastic media blasting. In addition to having to wash the parts before blasting, most of these operations include an inspection step whereby technicians pick, brush, and blow retained media out of bolt holes and internal compartments. With soda blasting, a quick aqueous rinse ensures that nothing remains on or in the part.

Because baking soda is water soluble, waste disposal costs can be minimized in many manufacturing operations. Spent media can be converted into an effluent by adding water. When passed through appropriate filtration, the resulting effluent contains water, dissociated sodium bicarbonate, and other water-soluble components; waste is trapped in the filters. In some regions, the effluent can be sent to the sewer, which significantly reduces waste volume and disposal costs. Remember, however, that every waste disposal application must he reviewed on a case-by-case basis to ensure compliance with local, state, and federal regulations.

Putting Spent Media to Use

Baking soda has a pH of 8.2 and is an excellent buffering agent. Once the blast media has been used, it remains baking soda. Depending on what the cleaning application adds to the baking soda (ie, hazardous or nonhazardous material), the spent media may still have value.

For example, a New England-based paper mill eliminated the need to purchase soda ash when they began using spent blast media to huffer their wastewater. An automotive component manufacturer in the Midwest likewise reduced their waste disposal costs by donating their spent media to the local waste treatment plant. The city is happy to haul the waste away at no charge. In Michigan, a large manufacturer of automotive brakes uses spent media as a buffering agent in their waste treatment system and to neutralize the acid in their foundry's dust collectors. Turning waste into a commodity can reduce cost, but there must first be value in the waste.

A Unique Alternative

Soda blasting has come a long way in the past 10 years. Results produced in the laboratory can now he easily reproduced in the field. Matching the strengths of baking soda to the application is the best way to ensure a winner. More than ever, equipment manufacturers are including baking soda among the media that can he used in their systems.

Baking soda is safe for the environment, the worker, and the parts. As evidenced in the preceding examples, soda blasting is a very cost-effective technique when employed in appropriate applications. The nature of sodium bicarbonate (ie, its solubility, softness, and versatility) has made it an ideal alternative to hazardous chemical processes and more aggressive blasting techniques. System designs over recent years have allowed its expanded use among a wide range of parts cleaning operations. ■

About the Author

Paul Arle is the national accounts manager for The ArmaKleen Co, a joint venture between Church & Dwight Co, Inc (Princeton, NJ), and Safety-Kleen (Elgin, III). Church & Dwight is a leading manufacturer of sodium biocarbonate and has produced the Arm & Hummer@ brand of products for over 152 years.

Using inorganic carbonates and bicarbonates, Church & Dwight scientists have developed a range of alternatives to replace toxic s&stances traditionally used for paint stripping, heavy-duty degreasing, and precision and parts cleaning. For more information on sodium bicarbonate blast cleaning, call (800) 332-5424.

Table I: Baking Soda Media—Standard Formulations

50-MICRON	70-MICRON	150-MICRON	275-MICRON
Uniform crystal size for microblasters. Most used in the electronics industry.	Recommended for use on delicate substrates to clean and remove coatings from composites, glass, copper, brass, magnesium, and aluminum parts. Also recommended to clean anodized and galvanized coated parts.	General purpose cleaning of carbon, grease, and oil from most substrates.	Recommended for the removal of heavy coatings and corrosion from all but delicate substrates.

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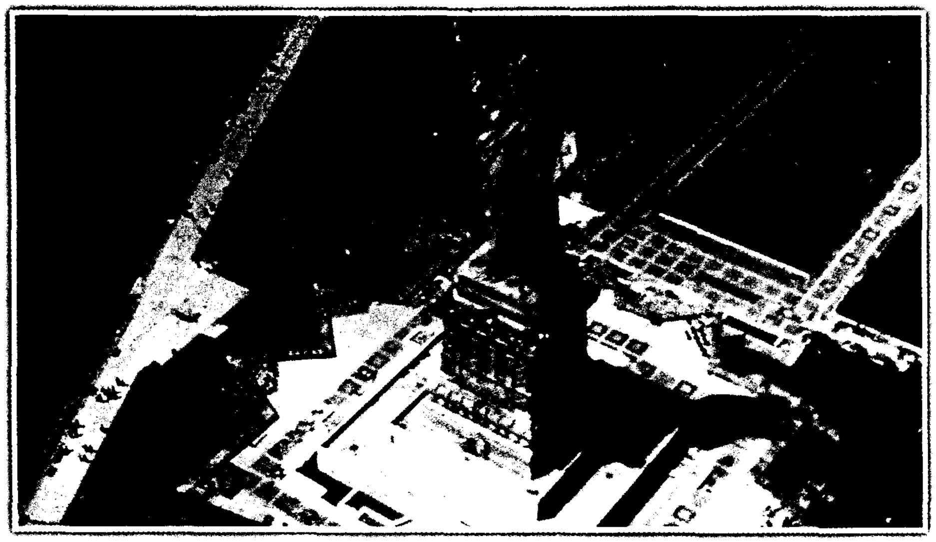

Figure 1. The Statue of Liberty restoration saw the first utilization of baking soda as a blast media.

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