Spring 2017
Volume 31, Issue 2 | ISSN 1069-2010

The Shot Peener

Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

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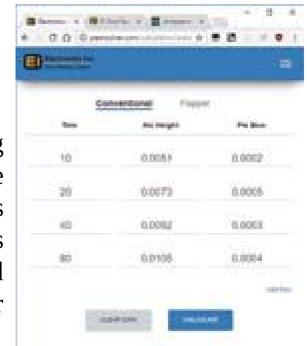

THE SHOT PEENER
Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

Notes From Tokyo

I WROTE THIS ARTICLE while in Japan for the Eleventh Annual Shot Peening Seminar at Meiji University, Toyko in February. As you will see, some of these topics relate to this *Shot Peener* magazine, some relate to the people I talked with during the seminar, and some have to do with the industry in general.


JACK CHAMPAIGNE

Congratulations
Congratulations to Professor Dr. Martin Lévesque for his recent inauguration into the International Scientific Committee for Shot Peening. Professor Lévesque teaches at Polytechnique Montréal and he is the host and chairman of the next International Conference on Shot Peening (ICSP-13) September 18-21, 2017 in Montreal.

Congratulations to Fred Blackman as he celebrates his 50th year at Peening Technologies. Fred has led an impressive career at Peening Technologies and has made a significant contribution to the company. Low turnover is a sign of a healthy organization and Peening Technologies should be proud of Fred's longevity. Three other employees have been with the company 40 or more years.

Professor Dr. Helmut Wohlfahrt
I'm sad to share the news of the passing of a dear friend and colleague, Professor Dr. Helmut Wohlfahrt. He passed away on Feb 2, 2017. Professor Wohlfahrt taught for many years at the Technical University of Braunschweig and was one of the founding members of the International Scientific Committee for Shot Peening. He was awarded the *Shot Peener of the Year* award in 2005 for his work on coordinating and guiding the growth of the triennial International Conferences on Shot Peening.

Product Announcements
Sintokogio of Nagoya, Japan is introducing a robotic manipulator for automatic surface stress measurements using X-Ray technology. Watch for more information in future issues of *The Shot Peener*.

Saint Gobain is announcing a high-density ceramic bead called Zirshot HDC for peening in the mid- to high-"A" intensity ranges. The material has a density of 210 pounds per cubic foot which is 30% denser than standard Zirshot ceramic beads. North American sales manager Jeff Girman of Saint-Gobain said that Zirshot HDC will provide a deeper level of compressive stress with an excellent surface finish and no iron contamination.

Read about the new web-based PeenSolver Web App from Electronics Inc. on page 22. Dave Barkley, EI Shot Peening Training Director, spearheaded the development of this product. The Peen Solver calculates peening intensity as defined in SAE J443. It evolved from the Almen Saturation Curve Solver spreadsheet program developed by Dr. David Kirk and used worldwide. Like Dr. Kirk's program, it generates a fitted curve through the given data points. Then, using the corrected arc heights from the curve, it locates the one arc height that increases by 10% for the doubling of exposure time. This arc height is the intensity value.

PeenSolver is available at www.peensolver.com. Dr. Kirk's Excel versions of his Almen Saturation Curve Solver Program and Peening Coverage Predictor Program are available at www.shotpeener.com.

THE SHOT PEENER

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For a free subscription of the *The Shot Peener*, go to www.theshotpeenermagazine.com

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Shot Peening Systems by Engineered Abrasives® Are Ready to Work 24/7/365

ENGINEERED ABRASIVES® recently delivered three workhorses to a US automotive manufacturer. The shot peening systems will peen 8-, 9-, and 10-speed transmission gears 24 hours a day, 7 days a week, 365 days a year. Given the requirements of such a work schedule, Engineered Abrasives® holds a unique position in shot peening equipment manufacturing. Not many OEMs can design, build, and install robust machinery on the scale required to meet such demanding workloads. And not only is Engineered Abrasives® capable of building these machines, the work is done entirely in-house. The three machines are identical and have the following features and benefits:

- Each machine has multiple nozzles with a double chamber pressure vessel for continuous operation. Each pressure vessel has special, customized features built just for high-volume shot peen operations. "EA® has developed these pressure vessels over the many years we've been building high-volume index units for the automotive industry," said Mike Wern, President of Engineered Abrasives®.
- The machines are made from the highest-quality American steel. They are welded and have ground seams. Roofs are 1" steel plate and side walls are ½" steel plate. Machines are lined with EA's special Red polyurethane sheets and durometer material that will outlast rubber 30 to 1. The polyurethane sheets also reduce noise.
- A bucket elevator system for the air blast unit allows the mounting of the Sweco screen separator unit on the floor for easier maintenance and reduced downtime. This is very important when peening 1,000 to 1,500 gears per hour: If no gears are peened, no transmissions are built, no cars are assembled.
- Camco index unit drives designed for precision stopping of robot or gantry loading. The EA®-designed Red solid polyurethane is molded to a 1-1/2" thick aluminum table and will outlast any table and reduce the sound levels. These machines run at 77 DBA.
- Three different gantries on each system. EA® installed and interfaced all three units on their shop floor before shipping.
- Media specially designed for these machines gives very good KSI at a lower air pressure which is a big energy savings.

"There are many other features on machines from Engineered Abrasives® that no other air peen manufacturer offers. The reason we can say this is because no other machine manufacturer in the world has a job shop operation like ours that peens gears seven days a week. We also have a washing process to meet the cleanliness specifications of the new programs for transmission and axle gears. The eleven machines in our job shop allow us to make improvements in machine design through real-life testing," said Mr. Wern.

In addition, the in-house facility can meet production schedules over and above the capabilities of the three machines. They are able to duplicate production processes and this tandem approach assures high-quality and consistent production runs. Engineered Abrasives® also has a support team within an hour of the customer and EA® maintains a large spare parts inventory specifically for these machines.

What Does It Take to Run 24/7/365?

Engineered Abrasives® has ensured that these machines are capable of running 24/7/365. But what about the responsibilities of the end user? The following are just a few of the complex details of a maintaining a high-production shot peening facility:

- A well-stocked parts and supplies inventory, including media, Almen strips and other consumables
- A streamlined and connected workflow throughout the entire facility
- Well-trained machine operators for every shift
- Electric generators and other fail-safe systems
- Redundant production services, like the shot peening service provided by Engineered Abrasives®
- Strict adherence to specifications, regulations and laws
- Dependable suppliers

About Engineered Abrasives®

Engineered Abrasives® is a ISO/TS 16949, ISO 14001, Ford Q1 certified job shop. Founded in 1935, Engineered Abrasives® designs and fabricates standard or custom automated abrasive and shot peening systems. Engineered Abrasives® can analyze any situation and design a machine to meet production requirements. Complete turnkey systems are also available.

Brigitte Labelle | Co-Owner | Shockform Aeronautique Inc.

How a New Product is Developed

I REMEMBER THIS IDEA came during a chilly afternoon in Monterey, California, after the AMEC Surface Enhancement annual committee meeting. I was sitting outside with Holger Polanetsky, Process Engineer of Surface Enhancement Processes at MTU, and we were discussing the issues with repairing parts in-situ. The committee was spending a lot of time and ink looking for ways to write a specification on manual peening.

Shockform has experience with manual peening because the company developed the FlapSpeed® PRO—the only dedicated tool for flapper peening. The FlapSpeed® PRO brought control and repeatability to a manual process that the industry was growing hesitant to use due to the lack of control and visibility. Because FlapSpeed® PRO uses a closed-loop system to control the RPM and a USB key to track all the parameters in real time, the industry welcomed this invention and the use of flapper peening was on the climb again.

While flapper peening was being used on aircraft structures and landing gears, even this new tool was no help to MTU or other engine manufacturers as flapper peening is not officially approved for rotary parts due to the risk of a shot detaching from the flap and lodging itself inside an assembled engine. This is often referred to as FOD (Foreign Object Damage).

Holger started explaining that it would be great to develop a small tool that didn't use shot or flaps, thus avoiding the risk of FOD. Holger knew we had invented, designed and manufactured the FlapSpeed® PRO and we were investing a lot of resources in R&D. He asked me if we could help. We started drafting and discussing the mechanism and approach and soon we had a project and an image quickly drafted on a piece of paper. Holger mentioned that he would be happy with something that could look like an electric toothbrush. This was the beginning of the SPIKER®.

Side Story: The Spiker® was originally called the Mosquito because of the very distinct noise made by the needles. We even had a nice logo made, but the Mosquito name was already registered so we changed the name to SPIKER®.

After a few years of work, including many alterations, different designs, proof of concepts and hundreds of emails, the first prototype was made. Shockform met with MTU's team in Germany and preliminary tests were made at the University of Technology Clausthal by Dr. Lothar Wagner and his team.

Flat specimens were used for Roughness Measurement, Residual Stress Measurement, and Metallographic Examination. A Flap-Bar Bending Test specimen was used for Cyclic Bending Tests. Conventional Peening using CCW14 media and flapper peening using the FlapSpeed® PRO were compared to the performance of the SPIKER®. The SPIKER® used newly designed needles that matched CCW14 .

Tests were performed on Nickel-Based Super Alloy DA718 and Titanium TI-6246. The results were beyond expectations. Both Flapper Peening and the SPIKER® (needle peening) provide better surface roughness on both materials.

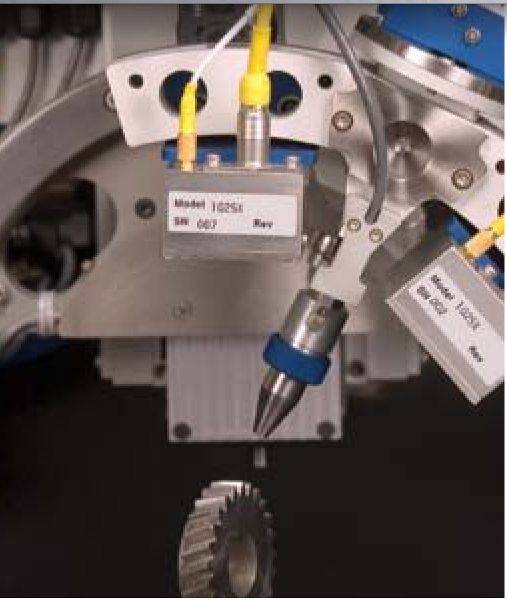
The Residual Stress Distribution showed no significant differences between the three techniques. The Compressive Residual Stress performances of the SPIKER® were comparable to both Conventional and Flapper Peening.

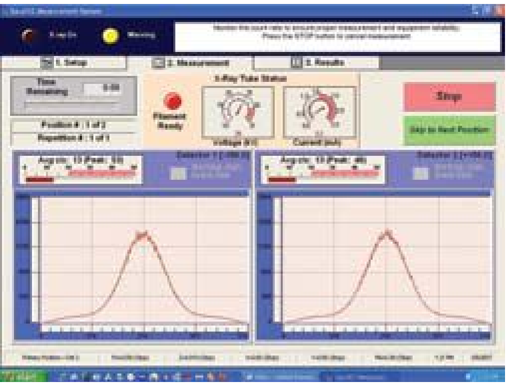
Following these tests and encouraged by the results, Shockform continued to work on the development of the SPIKER®. Needles made of full carbide were designed and manufactured to avoid any contamination and a diamond coating was applied to ensure better performance. An intensity between 4A and 14A was reached using these improvements.

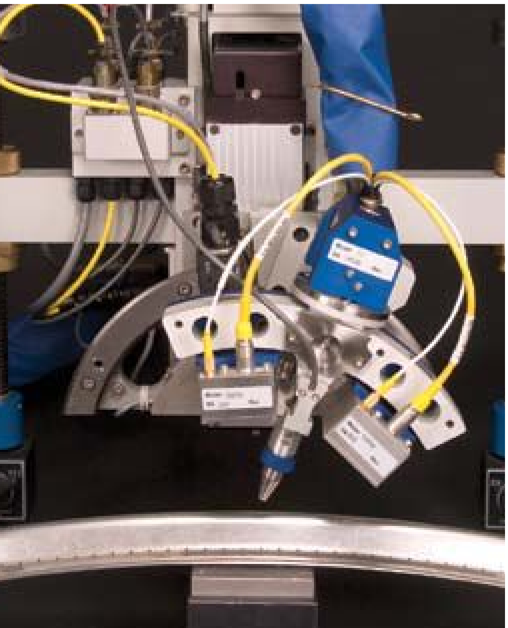
The handpiece was slightly modified to be smaller, more flexible and with no sharp edges. A new casing that prevented a broken needle from escaping was incorporated, thus preventing the risk of FOD.

Shockform designed a new connector, combining electricity and air, to make the tool more convenient for the operator. This new connector will allow a quick and easy change of the hand pieces from the round head to a linear head (in line needle) for radius applications.

Materials Testing Services







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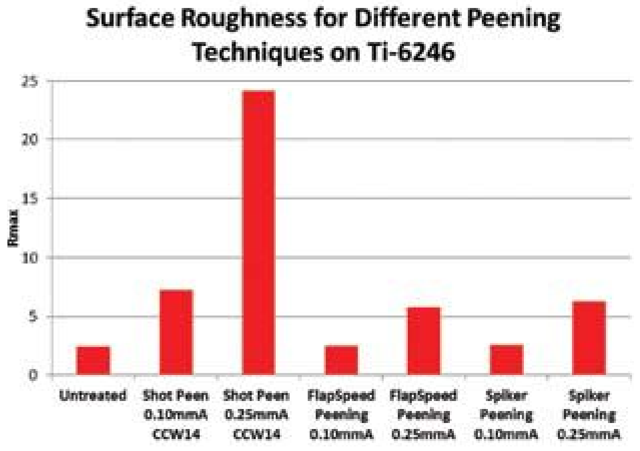
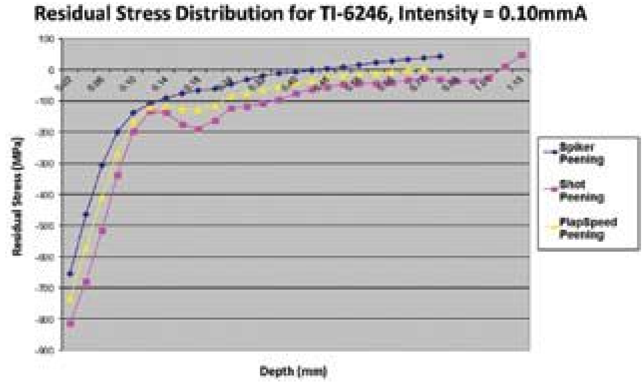
We are just about to close the loop. The SPIKER® is undergoing tests at MTU in Munich and will be available soon. The specification for a "Computer Controlled Pneumatic Needle Peening, Straightening and Forming" was under review at the AMEC Surface Enhancement meeting last fall.

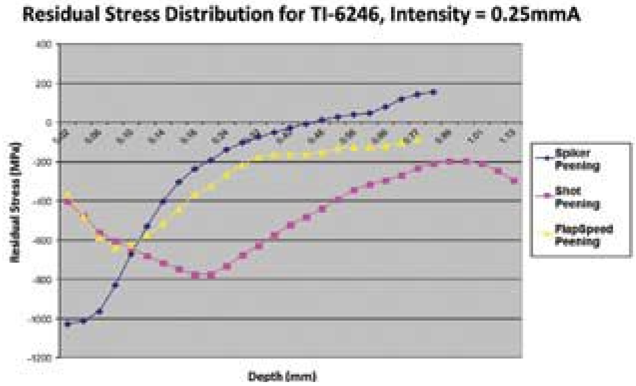
The only thing missing is for me and Holger to get together and think of new products!

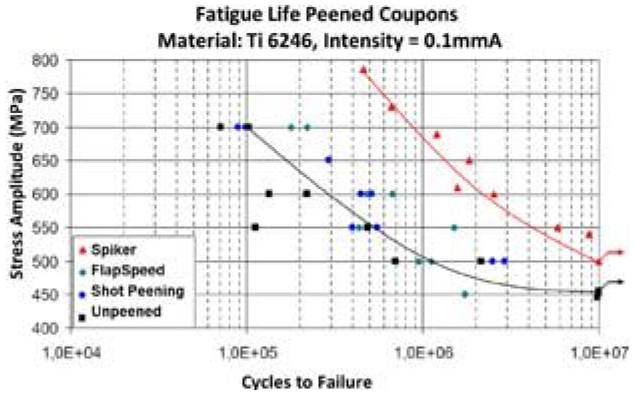
Special thanks to:

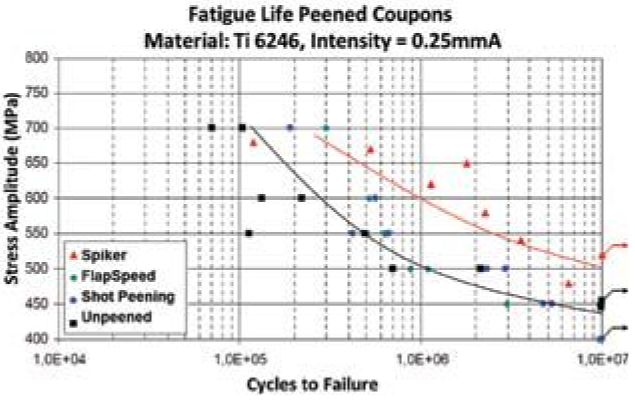
- Mr. Norbert Huber and Götz Lebküchner for their support and helpful consultation during the early development of the head for the SPIKER® tool.
- Prof. Dr. Lothar Wagner and his team at the Institute of Material Technology at the University of Technology Clausthal for their support and realization of the scientific investigations.
- Shockform's employees for their commitment to innovation.

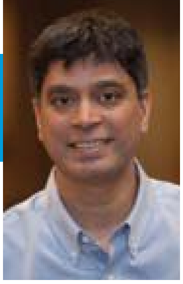












AN INSIDER'S PERSPECTIVE

Kumar Balan | Blast Cleaning and Shot Peening Specialist

The Role of Wheelblast in Shot Peening – Part I

THE INTRODUCTORY CLASS at the EI Shot Peening Workshop covers the history of shot peening. The instructor explains that engine valve springs were blast cleaned in a tumble-type wheelblast machine (commonly known as the tumblast) to remove paint. As an unintended consequence of cleaning, the springs also received the fatigue strength benefits of shot peening, prompting further measurement and validation of the process. Therefore, apart from the blacksmith who inadvertently shot peened buggy springs manually with his hammer, the first known shot peening practice was in a wheelblast machine! However, when visualizing shot peening equipment today, the image of a blast nozzle held by a robot or an articulating arm processing an aerospace component is more common than multiple blast wheels shot peening connecting rods.

Though Aerospace has embraced shot peening in a large scale, shot peening was initially more widely used in Automotive as part of their production process. Production volumes being significantly higher in Automotive as compared to Aerospace, the Automotive industry has traditionally used wheel blast machines, and for obvious reasons.

Peening coverage is directly proportional to the amount of blast media targeted onto a component. This makes wheelblast machines a good choice to address the high productivity goals of the Automotive industry. Aerospace applications are typically low volume, but high precision, and more often use airblast peening machines.

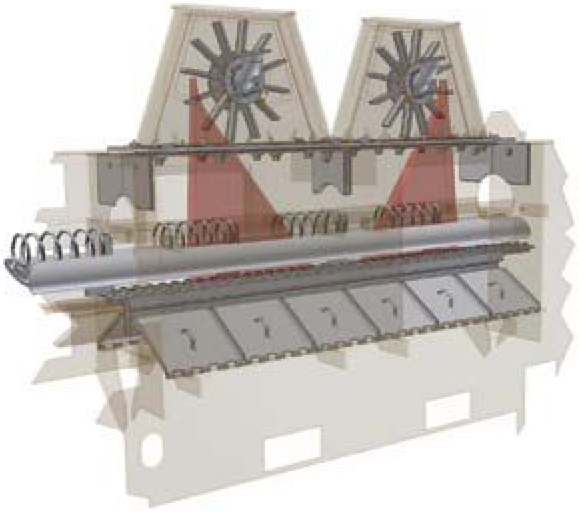
Our discussions here will be limited to shot peening applications only. Blast cleaning with wheel machines, though a very important discussion, will require in-depth reviews and may not necessarily interest our readers using only shot peening equipment.

Automotive and Aerospace - Wheelblast

Joe McGreal, Vice President of Sales and Marketing at Ervin Industries, a leading manufacturer of steel abrasives, explains that, "An understanding of impact/kinetic energy is paramount to appreciating blast cleaning and shot peening." Impact energy is calculated as the product of two parameters of the blast media—its mass and velocity. *Effective Use of Steel Shot and Grit for Blast Cleaning* by E.A. Borch, Ervin Industries, Inc. (found on ervinindustries.com) is an excellent resource to learn more about the impact of blast media. The second factor is velocity, which is directly proportional to the air pressure in an airblast machine, and wheel diameter and rotational speed in a wheelblast machine.

"Ervin supplies media to users of wheelblast and airblast equipment. As an example, we know our automotive customers that shot peen hundreds of coil springs per hour rely on their wheelblast machines with multiple wheels that collectively flow over 2,000 lb per minute. This is only possible with blast wheels driven by high horsepower motors," said Mr. McGreal.

An elaboration of the points made by Mr. McGreal will help us understand the choice of wheelblast over airblast. Shot peening large surface areas, such as the entire cross-section of coil springs, leaf springs, connecting rods, etc., at high throughputs common in automotive, requires a high flow rate of abrasive. Coverage is achieved faster with wheels capable of flowing large quantities of abrasive. The number of nozzles required to match a wheel's flow rate, and the corresponding compressed air requirement, make airblast an impractical solution. It is important to note that in the examples of parts



Inline Coil Spring Peening Machine
(Image is courtesy of Wheelabrator Group)

listed earlier, the surface is "open" and without geometric intricacies such as holes and slots, making it possible for a fixed, properly targeted wheel to always hit the exposed areas. Also, such automotive components are always shot peened with ferrous blast media, another factor that justifies the use of blast wheels for peening.

Several other Automotive components, such as crankshafts, valve springs, valve stems, transmission gears and shafts, are shot peened in wheelblast machines. Some of these components could also be processed in airblast machines, with the preference driven by local plant choices, commonality with existing machines, effort invested in process development with the existing wheelblast or airblast machine, and so on. Let's discuss one such application in a bit more detail—transmission gears.

Transmission gears are shot peened to prevent cracking at their root. It's common to see stacks of planetary gears being processed in wheelblast machines. Equally common are gears peened with airblast nozzles that reciprocate along the stack height. While the wheelblast argument is in favor of increased throughput, the airblast machine promises a more targeted blast impacting the root. Therefore, it won't do justice to generalize the effectiveness of one machine type over the other. Smaller gears with a tight space near the tooth could benefit from a lower flow rate possible with blast nozzles.

This could also reduce possibilities of "flooding" with abrasive, and the risk of "abrasive on abrasive" impact instead of "abrasive on part." However, with proper wheel positioning and managing flow rates, this issue could be mitigated in a wheelblast machine even when peening a small gear. This is less of a concern in larger gears, found in differential and truck transmissions, with more open tooth areas. The industry has a rich history of both types of media propulsion systems effectively peening transmission gears and shafts.

Almost all metallic parts in an automobile pass through a blast cleaning process prior to downstream coating. Greater volumes of Automotive parts and part types are blast cleaned compared to Automotive components that are shot peened.

The Aerospace industry shot peens its aircraft components, landing gear, structures and wheels with both wheelblast and airblast machines. When an application calls for shot peening with non-ferrous blast media such as glass bead or ceramic, it is always an airblast machine that fits the bill. Most Aerospace components, particularly in engines, have holes, slots, and bores, and areas that need to be protected (masked). This dismisses the suitability of a wheelblast machine. Therefore, an airblast machine is almost always used for peening engine components.

Landing gear peening applications could be served by wheelblast or airblast equipment; the process details being the deciding factor. New landing gear components when peened in their entirety offer a large enough surface area to justify peening with a wheelblast machine. One such example of a suitable machine is a vertical spinner hanger that spins the main gear about its own axis in the vertical plane, which is an ideal way to peen the cylindrical shape of the forging.

MROs that service and refurbish landing gear as part of an authorized maintenance procedure rely on airblast machines to "spot" peen specific areas on the gear. This is because nozzles allow better targeting of smaller areas on the gear as compared to blast wheels that cover all exposed areas with abrasive impact. New landing gear could also be peened in an airblast machine with a single or multiple nozzles. However, as discussed earlier, the relatively slower pace could be a limiting factor.

Aircraft structures, like landing gear components, can be processed in wheelblast or airblast peening machines. The latter is preferred when the structure has complicated geometry making it a challenge to locate wheels at angles to achieve the minimum required 45-degree angle of impingement. Nozzles mounted on articulating, robotic arms make that task more practical and manageable.

Abrasive Type and Media Propulsion

Steel shot with a weight of around 280 lb/cubic feet generates greater impact energy than glass bead with a weight of around 100 lb/cubic feet. Though both media types have their relevance in shot peening applications, non-ferrous media is not usually propelled by blast wheels. This is largely due to the potentially lower momentum created by a blast wheel propelling non-ferrous abrasive as compared to a blast nozzle that fluidizes and creates a better blast pattern at higher momentum. Ferrous abrasives such as steel shot and conditioned cut wire, commonly used in shot peening, can be propelled using airblast nozzles as well as blast wheels, with selection criteria as discussed earlier and in paragraphs that follow.

High-Intensity Peening

The shot peening industry presents us with some special applications such as peening Heavy-Duty Transmission Gears and Mining Bits to intensities in the C scale. Though these components could be peened in wheelblast machines, some of these high ranges (> 0.012" C) are better served by an airblast machine. The limitations posed by the wheel diameter and speed (velocity in a wheelblast machine is calculated by diameter x speed/180) are non-existent in an airblast machine where the combination of nozzle bore and air pressure could develop considerably high velocities as compared to a wheelblast machine.

Impact energy is directly proportional to the intensity, and high energy values are achieved using a combination of high velocity and large blast media size. Blast wheels flow large abrasive sizes with minor adjustments to the internal

AN INSIDER'S PERSPECTIVE

Continued

wheel parts. In an airblast machine, blast nozzles and interconnecting hoses will need to be upsized to handle large media sizes. The high flow rate experienced in wheelblast machines also leads to a very different style of reclaim system as compared to airblast machines. In general, all blast machines are characterized by their five essential elements:

(1) media delivery (nozzles, hoses, blast wheels),

(2) media reclaim (mechanical or vacuum),

(3) work handling (rollers, hangers etc.),

(4) ventilation and dust collection, and

(5) controls to automatically sequence all earlier activities and achieve desired and consistent results.

(For more information on this topic, see "Machine Profiling: A Guide," *The Shot Peener*, Fall 2016).

Since a common size of blast wheel (say 15" diameter driven by a 15 HP motor) flows more abrasive than a common size nozzle (say 3/8" diameter at 60 PSI) by at least 10 times, the next step is to understand the needs of the reclaim system in a wheelblast machine. The media reclaim system in a wheelblast machine is always of a mechanical type, with a bucket elevator and airwash separator to clean the media prior to re-use. A majority of airblast machines employ vacuum reclaim systems with a cyclonic reclaimer and downstream dust collector with exhaust fan for media reclaim and ventilation. Vacuum reclaim systems are less maintenance prone since they lack mechanical moving elements as in a bucket elevator. However, vacuum reclaim systems are limited by the abrasive size and volume that they can recover.

Our discussions until now were intended to provide an application-based background in the use of wheelblast machines for shot peening. Since a large part of the industry's revenue is from the sale of wheelblast machines, it's important for us to educate ourselves on such machines and ask those relevant shot peening related questions:

- What are the critical process parameters in wheelblast machines, and how can they be controlled?
- How does wear affect peening results?
- What are the comparable parameters between both systems?

Let us continue our discussions in Part II in the summer issue of *The Shot Peener*.

Fred Blackman Celebrates 50 Years with Peening Technologies

IN THE SHOT PEENING BUSINESS, only a handful of things have lasted for 50 years: Almen strips, Almen gages, Almen blocks—and Fred Blackman.

Peening Technologies of Connecticut employee Wilfred "Fred" Blackman marked a major milestone this year, celebrating 50 years with the company. A native of St. Philip, Barbados, he began working at Peening Technologies, known then as Hydro-Honing Laboratories, in 1967. He had come to Hartford, Connecticut because his sister lived there, and just two weeks after arriving landed a job with the fledgling company. Blackman was one of the first employees in Hydro-Honing Laboratories' South Windsor location, liked the job, and decided to stay. He became a US citizen in 1981 and now resides in Bloomfield, Connecticut.

Fred Blackman has been with Peening Technologies for 50 years.

An energetic 73-year-old, with a wicked sense of humor, Blackman recalled his early days with the company. "Coming to the US to work was a big deal," he said. "When I started working at Hydro-Honing, it was, as the saying goes, just a hole in the wall in South Windsor. We had three operators, and the equipment used for shot peening had been built on-site, both automated and manual. It was a far cry from what we build today."

As the company grew, moving from South Windsor to its present location in East Hartford, Blackman worked side-by-side with Walter A. Beach Sr., then the company President. "We were working on Mack Truck axles and spindles," he recalled. "When the others went home, I stayed to work with Mr. Beach. People thought I was part owner of the company, I was there so much."

Starting as a machine operator, Blackman rose through the ranks to become Lead Man, Foreman, Plant Manager, Inspector, and then Chief Inspector before leaving the job shop side of the business in 2010 to help launch Peening Technologies Equipment Company. Along the way he earned his FAA Repairman credentials and qualified as a Category H Inspector for Sikorsky. "I'm not sure what my title is now," he said. "I'm the last of the original employees. The others have retired or passed away."

One of his first production jobs was peening automobile universal joints, something the company no longer does. He could not have imagined he would one day be inspecting the peening on parts for NASA's Space Shuttle (the company peened Pratt & Whitney's shuttle Turbopumps). In between, he has worked on everything from jet engine parts to oil exploration equipment, and at one time or another he worked in almost every area of the company. "I even had training in electronics, I was the electrician here for a while, I was also the company carpenter for a while. I've done a little bit of everything."

For a number of years, Blackman was responsible for a dedicated, 80 foot-long machine that shot peened 32 foot-long drill pipes (ID and OD) used for oil and gas exploration. Eventually, the customer purchased the machine from Peening Technologies and moved the line back in-house, relying on Blackman to smooth the transition. Once the machinery was set up, they turned to him to train their own employees. "They sent a private car and a plane for me," he said, "That was something."

Blackman has seen the business change dramatically over the five decades he has spent with Peening Technologies. "The biggest change is the robotic machines," he said. "At the beginning, there were no computers, and only a little automation. Back then we did commercial work and manually peened parts. Now everything is automated." He described the shift to computerized equipment as "a happy transition," making the jobs less physically stressful. He is now a key player on the team that builds shot peening machines from the ground up for outside customers.

Over the years, Blackman has become indispensable to the company. Peening Technologies President Tom Beach recalls his late father, Walter Beach Sr., telling him bluntly that if things got tough for the company financially, "you'll be laid off before Fred will."

"Happily, that didn't happen," Beach joked. "I've known Fred my whole life. I started working for my Dad summers as a teenager, and Fred was my boss. He has been a friend, a mentor, always more than just an employee. He is still my go-to guy when there's a problem. He's wise, experienced, he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doesn't give up. I'm thrilled he's working with me to build our newest machines."

Walter Beach, Jr., added, "When I was a teenager our father also had me work with Fred. He told me, "Fred can tell you everything there is to know about shot peening," and he was right. Fred is one of the hardest working people I've ever known."

"I like the people," said Blackman. "There are great memories and great respect here. I'm dedicated to this company. I've never wanted to go anywhere else, so I just decided to stay. I could go another fifty years with the kids."

Three other employees, Roberto Colon, Sr., Jesus Torres, and Tomas Perez, have reached or surpassed the 40-year mark with the company, but only Blackman can boast 50. And he has no plans to retire any time soon. "As long as I've got my health," he said with a shrug, "I'm not going anywhere."

For a number of years, Blackman was responsible for a dedicated, 80 foot-long machine that shot peened 32 foot-long drill pipes (ID and OD) used for oil and gas exploration.

Peening Technologies has several employees that have been with the company for many years. From left to right: Tomas Perez (40 years), Fred Blackman (50 years), Roberto Colon (40 years) and Jesus Torres (40 years).

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Aims and Scope

The purpose of this conference is to foster exchanges between the academic and industrial community on processes inducing beneficial residual stresses, as well as their effects, with an emphasis on traditional shot peening. While this is not an exhaustive list, deep rolling, laser peening, ultrasonic peening, cavitation peening, flapper peening and needle peening fit within the conference's scope. In addition, talks dealing with fundamental or applied aspects, modeling, experimental methods, fatigue life, forming and industrial applications are sought so as to generate fruitful discussions between world experts in order to address current and forthcoming issues.

Presentation of Papers

The organizing committee aims at offering at least 75 paper presentations with a question and answer period.

Proceedings

The conference papers will be compiled into a Conference Proceedings booklet.

Best Student Presentation Award

Students (undergraduate, graduate and post-doctoral fellows) are encouraged to present their works at the conference. A jury will evaluate oral presentations made by students and will distribute three "best presentation awards" during the banquet.

Exhibition

An exhibition of commercial products will be held during the conference.

Site Visits to Local Aerospace Companies

Montréal is an aerospace hub and local aerospace companies have agreed to offer site visits as part of the conference. At this time, Bell Helicopter Textron, Bombardier Aerospace, Pratt and Whitney Canada and L3-Communications MAS have agreed to open their doors to conference attendees. Site visits will be included in the registration fee.

Banquet

The conference banquet will feature a three-hour cruise in a Bateau-Mouche on the St. Lawrence river. The river cruise in an open excursion boat includes a gourmet dinner and jazz concert.

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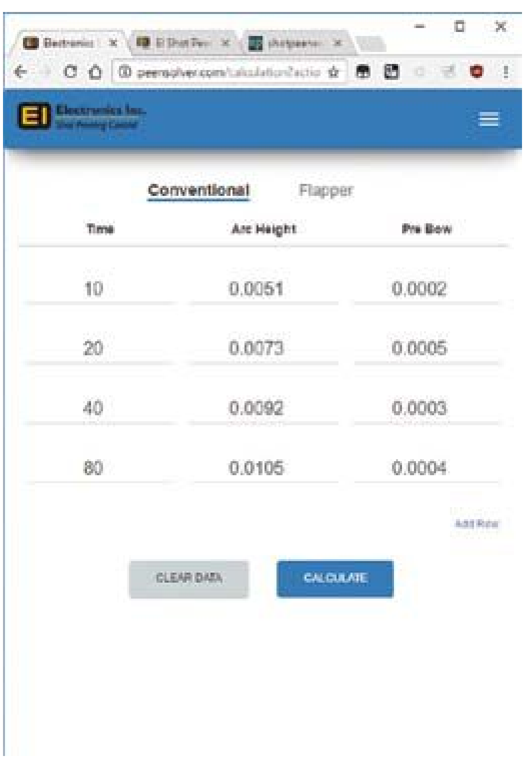
CREATING AND SOLVING a saturation curve manually can be quite frustrating when you're first introduced to saturation curves and the 10% rule. Most people are delighted when they learn there are programs that do the plotting, drawing and math for them. They're even happier when they learn a program is available free of charge from Electronics Inc. Dr. David Kirk introduced his computer-based Almen saturation curve analysis program in a 2006 issue of this magazine. It has been the most widely used program of its kind over the last decade and it is a testament to Dr. Kirk's knowledge of the shot peening process and to his talent with Microsoft's Excel program. (The program is available as a free download at www.shotpeener.com.)

Electronics Inc. has now added the new PeenSolver Web App to its list of shot peening control products. Like Curve Solver, it's free, SAE J2597 compliant, and uses the same curve-fitting feature and equations Dr. Kirk developed for the Excel-based program. The new PeenSolver Web App isn't meant to replace Dr. Kirk's Curve Solver but it can quickly generate a saturation curve and solve intensity on an array of devices. It has been tested on desktops, laptops, tablets, iPhones, Androids, and even a Blackberry. It requires only a supported web browser. PeenSolver works with Window's Explorer, Google Chrome and Apple Safari.

The PeenSolver solves conventional and rotary-flap saturation curves. It has optional pre-bow input and solutions can be output to a PNG image file. It's 100% free.

Give it a try by pointing your device's browser to www.PeenSolver.com.



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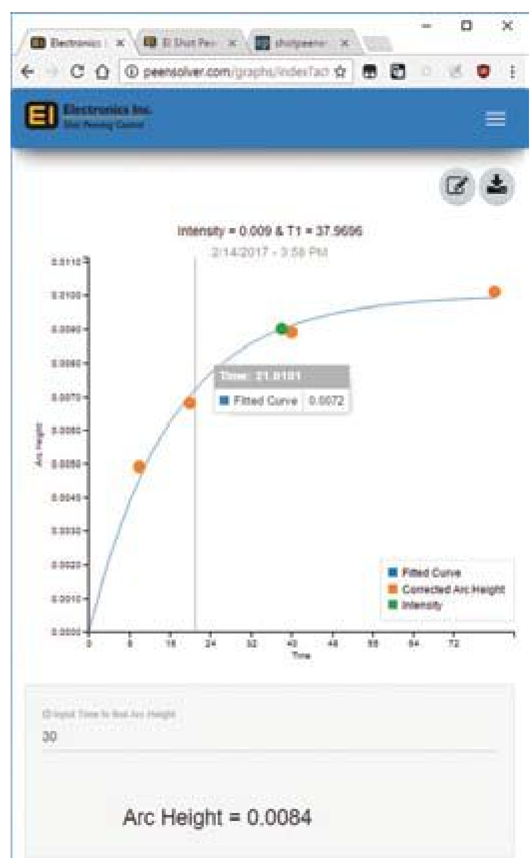

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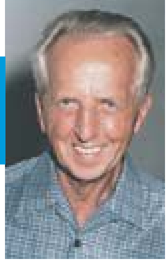

ACADEMIC STUDY
Dr. David Kirk | Coventry University

The Importance of Work

INTRODUCTION

Work and rate of doing work are, arguably, the most important parameters in the Universe. No event can happen unless some work is done at a measurable rate. Even blinking an eye requires that some work is done. Shot peening simply could not happen without work being done on components.

The basic unit of work is the Joule. It is named after the English physicist James Prescott Joule (1818–1889). A joule is equal to the work done to an object when a force of one Newton pushes that object through a distance of one meter. Work is, however, more commonly expressed directly in N.m rather than in joules.

The author's favorite demonstration of Newton meters is illustrated in fig.(1). Imagine that a typical apple is exerting a force of 1 Newton when resting on a table (as happens when there are 10 apples per kilogram). Raising that apple through a distance of 1 meter requires that 1 N.m of work is done on the apple. If the apple is released, it converts that work into kinetic energy, falling with increasing velocity until it lands on the table.

Fig.1. 1 Newton.meter of work done when this apple is raised by 1 meter.

Shot peening is, essentially, a metalworking process. Work has to be done on components in order to generate the "magic skin" of work-hardened, compressively-stressed, material. "Other things being equal," the more peening work done on any component the greater is both peening intensity and indent coverage. It follows that work is of fundamental importance in shot peening. It is also important to realize that units are as important as the magnitudes of quantified parameters.

This article has two objectives: (1) to explain the units that dominate shot peening and (2) to show how the amount and rate of work done affects every shot peening parameter. Only simple arithmetic is invoked—no finite element analysis!

UNITS RELEVANT TO SHOT PEENING

Work done

One Newton is defined as the force needed to accelerate one kilogram of mass at the rate of one meter per second squared in the direction of the applied force. Hence the units for a Newton can be expressed as $kg.m.s^{-2}$.

Imagine a 10 kg bag of steel shot has been lifted 1 meter onto a table. What does the "10 kg" really mean? In the absence of gravity, the 10 kg would not have offered any resistance to being lifted. If, however, gravity is exerting an acceleration of $10m.s^{-2}$ (normal at the Earth's surface) then it will exert a force of 10N on each kilogram. The work done to lift the 10 kg bag 1 meter onto the table is therefore 100N.m.

In terms of the units involved, we have that:

$$\text{Work} = \text{N.m which is also}$$
$$= kg.m.s^{-2}.m \text{ so that}$$
$$\mathbf{Work = kg.m^2.s^{-2}} \qquad (1)$$

Kinetic energy

Consider next that the bag of shot is dropped onto the shop floor. As it falls, the bag of shot particles accelerates and therefore achieves kinetic energy. Kinetic energy, K.E., is quantified as half of the object's mass multiplied by the square of its velocity. Velocity has units of $m.s^{-1}$ so that velocity squared has units of $m^2.s^{-2}$. In terms of units we therefore have that:

$$\mathbf{K.E. = kg.m^2.s^{-2}} \qquad (2)$$

The units in (1) and (2) are identical, showing that kinetic energy and work units are interchangeable. This interchangeability is of fundamental importance in understanding shot peening.

In order to quantify the kinetic energy of a given mass of shot we use:

$$K.E. = kg.m^2.s^{-2}/2 \qquad (3)$$

Equation (3) is simply expressing that the kinetic energy of an object is "half of its mass multiplied by the square of its velocity."

Heat energy

When a shot particle dents a component, about 90% of the absorbed kinetic energy is turned into heat. The most familiar heat unit is the calorie, for which:

$$1 \text{ calorie} = 4.2.kg.m^2.s^{-2} = 4.2 \text{ N.m}$$

This equivalence of heat, kinetic energy and work allows us to understand the distribution of the work absorbed when dents are formed.

Work rate

Work rate is often expressed in watts. One watt, **w**, is defined as one N.m of work being done every second or

$$1w = 1N.m.s^{-1} \qquad (4)$$

The principal power generators for shot peening (air compressors and electric motors) are sometimes rated in horsepower. Horsepower was a unit introduced by James Watt in the eighteenth century to compare the output of his steam engines with the power of horses. It had the advantage of allowing mental images to be created of, for example, a 20 horse-power steam engine being able to work as hard as a team of twenty plow horses. Most countries now prefer work rate to be expressed in watts:

1 horsepower = 750 watts.

By way of an example, consider a situation where a 40 H.P. motor is driving a single blasting wheel. A 40 H.P. motor working flat out is consuming 30,000 watts (40 x 750). Assume that the motor drive just cuts out (due to overload) when the wheel is trying to accelerate 4 kg of shot every second to a velocity of 100 m.s^{-1}. The kinetic energy possessed by 4kg of shot flying at 100 m.s^{-1} is 20,000 N.m (4.100^2/2 - using equation (3)). The effective work rate is then 20,000 N.m.s^{-1} or 20,000 watts. That begs the question "why does the motor drive cut out?" No wheel blast system can possibly run at 100% efficiency in terms of motor energy being converted into K.E. of accelerated shot particles. Energy losses include those due to friction. For this example we can, therefore, rate the motor's efficiency at two-thirds (20,000/30,000). If that efficiency is constant at different wheel speeds then the situation can be represented as shown in fig.2 (which uses a non-linear wheel speed scale for simplicity). As the required kinetic energy per second of the shot stream increases so does the necessary wheel speed (shown as a green line). At a maximum of 20 kw, the wheel cuts out.

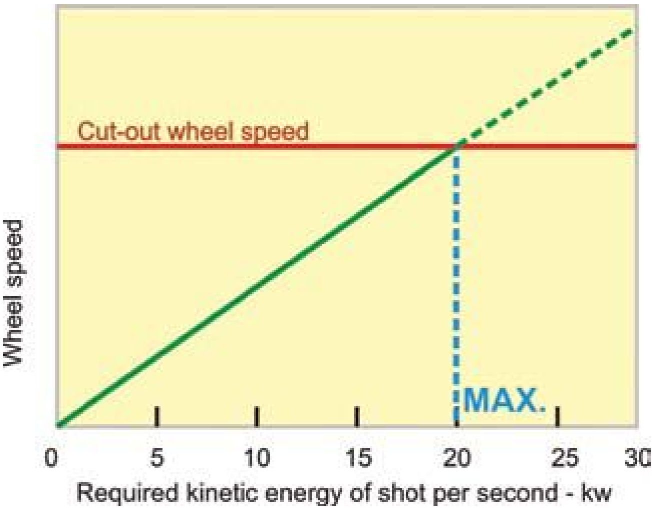

Fig.2. Relationship between wheel speed and kinetic energy per second of a shot stream.

SHOT CHARACTERISTICS CONTROLLING AVAILABLE WORK

Shot density and size

Shot density and size both vary for the major shot peening media: steel, glass and ceramic.

Density is mass divided by volume

For a spherical shot particle, density is mass x 6 /(π x diameter cubed)

Measured density values for steel shot are all about 7,800 kg.m^{-3} whereas those for glass and ceramic shot are about half of that value but do vary significantly with composition.

Table 1, on the next page, is an Excel spreadsheet for steel shot that estimates significant variable parameters.

The estimates shown in Table 1 indicate vast ranges. For example: With a feed rate of 10 kg/minute for S110 (reasonable for air-blast peening) we are throwing more than 100 million shot particles every minute! That compares with about 100 thousand for S1110. Upping the feed rate to 100 kg/minute (reasonable for wheel-blast peening) we would be throwing more than four billion S70 shot particles every minute!

Work absorbed by an impacting shot particle

When a flying shot particle strikes a component, part of its kinetic energy is absorbed by the component and part is retained as the kinetic energy of the rebounding particle. This important principle is illustrated in fig.3. Imagine a large ball bearing being dropped from a height of 1 m onto a steel plate. If it rebounds to height of 0.5 m then half of the impacting

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Table 1. Cast steel shot parameters

	CAST STEEL SHOT					
S Number	Size	Density	Mass per particle	Particles per kilogram	Feed Rate	Particles per minute
	mm	kg per m^3	$g.10^{-3}$		kg/minute	
70	0.18	7800	0.023	43,562,371	10	435,623,706
110	0.28	7800	0.089	11,226,065	10	112,260,654
170	0.43	7800	0.329	3,041,297	10	30,412,972
230	0.58	7800	0.814	1,228,067	10	12,280,672
280	0.71	7800	1.469	680,662	10	6,806,620
330	0.84	7800	2.405	415,780	10	4,157,802
350	0.89	7800	2.869	348,499	10	3,484,990
460	1.17	7800	6.514	153,508	10	1,535,084
550	1.40	7800	11.135	89,809	10	898,085
660	1.68	7800	19.241	51,973	10	519,725
780	1.98	7800	31.760	31,486	10	314,863
930	2.36	7800	53.832	18,576	10	185,762
1110	2.82	7800	91.530	10,925	10	109,254
1320	3.35	7800	153.927	6,497	10	64,966
		7800			10	

kinetic energy has been absorbed. This ratio has been shown, by experiment, to be realistic for steel shot striking steel components.

If we know the mass and velocity of impacting particles, we can then estimate the amount of work that is absorbed. It was shown earlier that the kinetic energy possessed by 4 kg of shot flying at 100 $m.s^{-1}$ is 20,000 Nm. If half of this is absorbed on impact, 10,000 Nm of energy will have been absorbed. With 90% of these 10,000 Nm being converted into 2000 calories of heat (9,000/4.2) we have only 1,000 Nm left for permanent plastic deformation work.

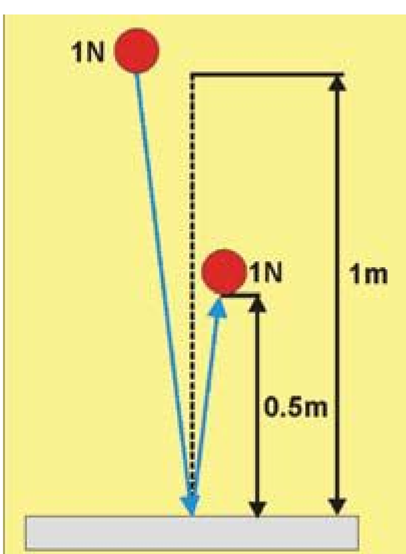

Fig.3. Kinetic energy absorption on impact with a component's surface.

Work required to produce dents

It is an inevitable consequence of conventional shot peening that dents are made by impacting shot particles. The size of these dents depends mainly on shot size, shot velocity, shot hardness and component hardness. For any given combination of these factors, the larger the dent the more work has had to be done to create it. The following analogy is intended to emphasize the relationship between dent size and the work needed to create it.

Navvies digging holes.

Fig.4 is of navvies - as depicted in Ford Madox Brown's painting "Work."

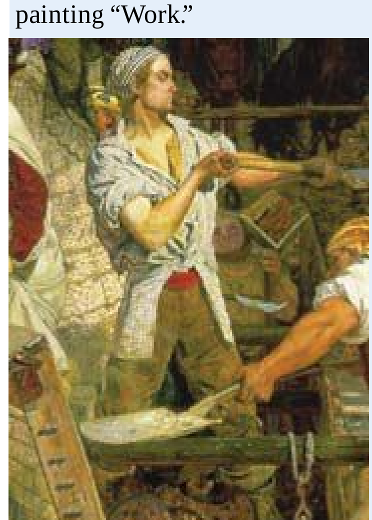

Fig.4 "Work" by Ford Madox Brown depicting navvies.

Imagine that we have a team of twelve navvies that can be employed (for one day only) to dig holes. The volume of each hole would depend upon how many were assigned to dig each hole. With all twelve digging a single hole, the hole's volume would be twice that of each hole generated by two teams of six digging two holes, three times that for teams of four, four times that for teams of three and six times that for teams of two. In other words the volume of each hole depends directly on the amount of work that has been done to create it.

SHOT PEENING PARAMETERS AFFECTED BY AMOUNT OF WORK DONE

Dent Size

It was shown in an earlier article ("Prediction and Control of Indent Diameter", TSP, Spring 2004) that the amount of work that has to be done to create each unit of indent volume is equal to the Brinell hardness value, B, of the component. The work done creating a given indent is therefore the Brinell value multiplied by the volume of the indent. In terms of units, Brinell value can be expressed as N/m^2. Multiplying N/m^{-2} by indent volume units (m^3) we have N.m - which are our basic work units. Using the navvy analogy, the harder the soil being excavated the smaller will be the volume of the hole dug using a fixed amount of work.

The volume, V, of an indent is related to the indent and shot diameters, d and D, as illustrated in fig.5.

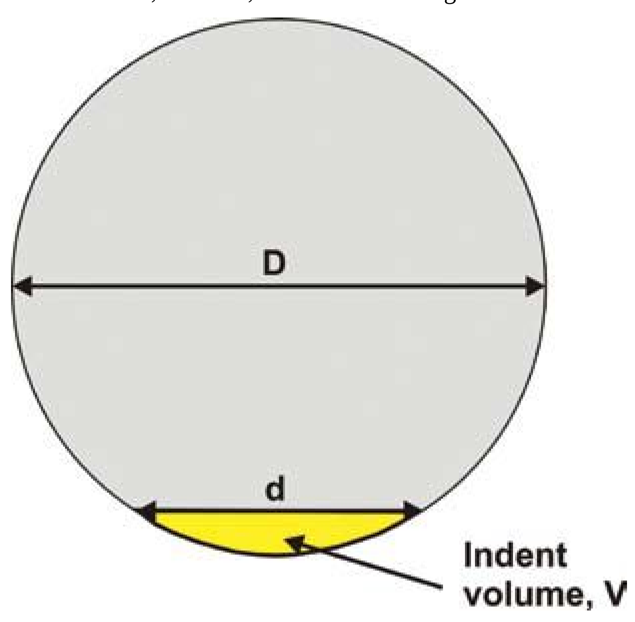

Fig.5. Indent diameter, d, and shot diameter, D.

We have that:

$$V = \pi.d^4/32D \tag{5}$$

Equation (5) is of huge practical significance. **V** is the volume of the indent. Hence it represents the amount of deformation work that the impacting particle has to do in order to create the indent. It is important to note that this depends on the fourth power of the dent's diameter. Imagine that we want to double the diameter, d, of indents made by shot of a fixed diameter D. Two raised to the fourth power is sixteen (2 x 2 x 2 x 2). That means that we would have to give each shot particle sixteen times as much kinetic energy if the dent is to have a doubled diameter.

The TSP article listed earlier also showed that dent diameter varied with four parameters: shot diameter, velocity and density together with the component's Brinell hardness. A graphical illustration is given as Fig.6 which illustrates the effect of changing the magnitude of each of the four parameters independently. The axis ranges have been deliberately chosen to emphasize the d^4 factor in equation (5).

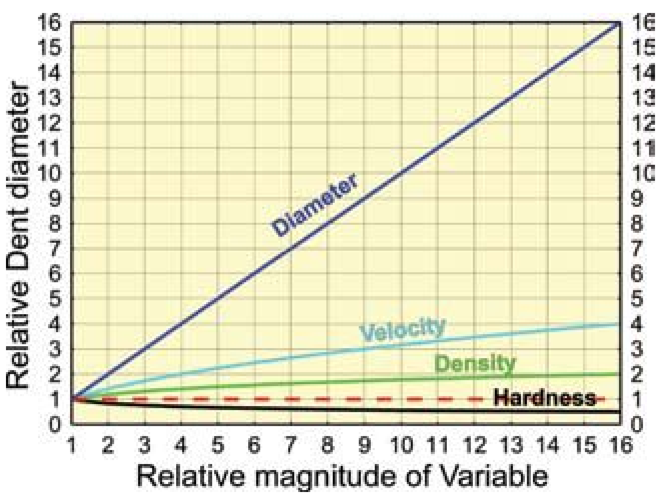

Fig.6. Effect of shot properties and component hardness on dent diameter.

The effects shown in fig.6 can be considered either in isolation or in combination.

In isolation, the other three factors are constant. For example, increasing the shot diameter increases the dent diameter linearly (provided that shot velocity, shot density and component hardness are kept constant). The rate of increase is to the power of one. In other words, doubling the shot diameter doubles the dent diameter. Hence multiplying the diameter of the shot being used by a factor of sixteen will increase the dent diameter by a factor of sixteen. As another example, increasing the shot density (in isolation) by a factor of sixteen only doubles the dent diameter. That is because the increase is proportional to the fourth root ($D^{0.25}$) of density. The fourth root of sixteen is 2 (16 = 2x2x2x2). Dent diameter increase is inversely proportional to the fourth root of the component's hardness. Hence a sixteen fold increase in


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component hardness halves the dent diameter—other factors being kept constant. Finally, the effect of shot velocity depends on its square root with the square root of sixteen being four. The kinetic energy of a shot particle is proportional to the square of its velocity so the fourth power effect in equation (5) is halved to become a two power effect.

The factors shown in fig.6 can be considered in combination. For example: multiplying both shot diameter and shot velocity by 16 will increase the dent diameter by a factor of sixty-four (16x4).

Overlapping indents are more complicated than isolated dents. Consider the situation illustrated by fig.7. Imagine dent A is produced first, followed by dent B. Because of the overlap, the volume of dent B is less than that for A. It might therefore be expected that the diameter of dent B would have to be slightly larger than that of dent A (to make up for the overlap volume). In practice, dent A causes work-hardening that reduces the volume of dent B produced by a given amount of work. Using the navvy analogy, a team digging dent B would find that the soil adjacent to dent A had become harder to dig.

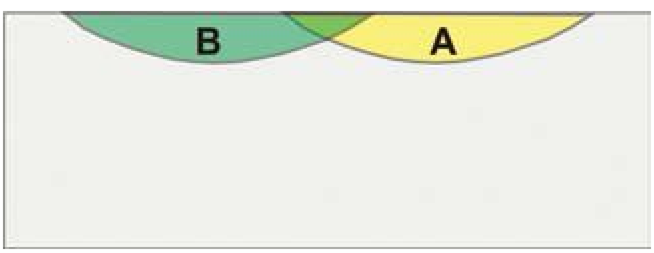

Fig.7. Overlapping dents.

Coverage

The diameter of an individual dent depends on the amount of work done during its creation. Coverage, on the other hand, depends on both average dent diameter and the number of dents generated in each unit area of the component. The increase of overlapping with increased peening is also a vital consideration. Numerous articles have appeared that explain the mathematical basis for the way in which coverage develops with peening time. As a light-hearted alternative, consider the following analogy.

Poppy Field Bombing.

Imagine a scenario in which an air force general decides to test the possibility of destroying opium poppy fields using several bombers. The first bomber drops seven nominally-identical bombs in a random fashion, aimed so that each crater occupies at least part of the poppy field as illustrated schematically in fig.8. Only two craters have contributed wholly to poppy field destruction—one overlaps and four are only partially damaging the poppy field.

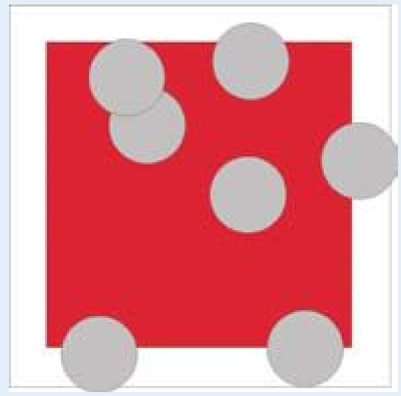

Fig.8. Seven craters distributed randomly.

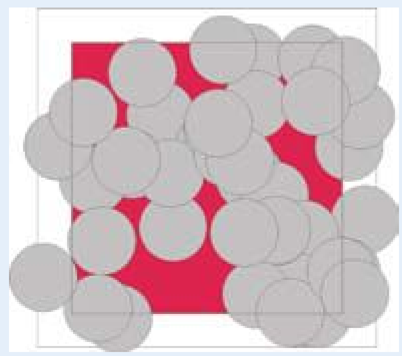

Figure 9. Forty-two craters distributed randomly.

The air force general orders another six identical bombing runs resulting in a total of forty-two randomly-positioned craters as illustrated in fig.9. This does not, however, satisfy the general who is determined to achieve complete poppy destruction and declares so at his staff meeting, adding "Has anyone got any useful suggestions?" Up stood a bright young engineering lieutenant saying, somewhat nervously:

"I've just been to a shot peening Workshop to find out why peening is so useful for prolonging the life of our aircraft parts. They have a similar problem of covering an area with miniature craters. Using a standard equation they can predict how coverage increases with increasing number of dents per unit area. Instead of trying to get 100% coverage they often aim for 98%. It is argued that this may correspond to inducing maximum benefit. Hardening and compressive stress are induced around each of their miniature craters. In our case we might think that with 98% cratering the surrounding poppies might be so damaged that no farmer would feel it worth attempting any harvesting."

"Very useful example of lateral thinking," said the general. "I'll give it some thought. Meeting over."


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Peening Intensity

Peening intensity is quantified by the amount of deflection imposed on an Almen strip when it has been peened so that this deflection would have increased by 10% if the amount of peening had been doubled. The greater the peening intensity deflection, the greater is the amount of work that has had to be done on the strip. This work is stored in the strip in two ways. One is the recoverable elastic work associated with the characteristic residual stress profile. The other is the non-recoverable work done to plastically deform the strip. Research, involving applying stress-relieving heat treatment, has shown that the two ways are approximately equal in magnitude.

Fig.10 illustrates the two components of peened strip curvature. Cold-working and residual stress both contribute h/2 to the combined deflection, h. Both components increase with the amount of work that has been done.

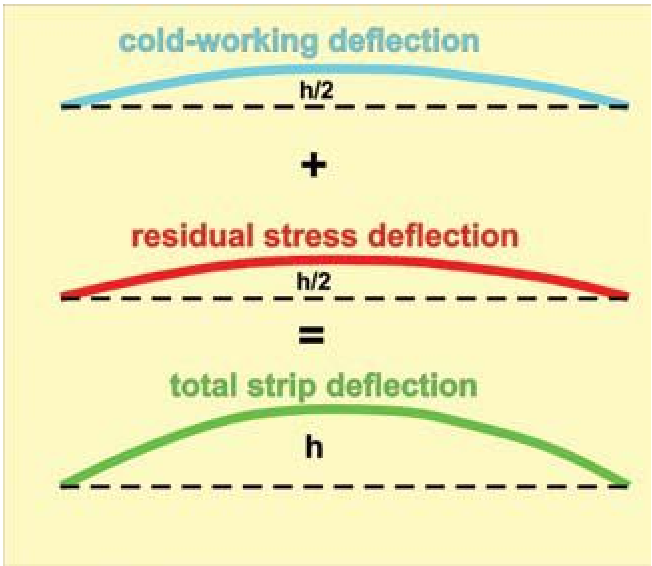

Fig.10. Schematic representation of Almen strip deflection components.

Cold-Working Deflection

Under each dent is a region that has been cold-worked. This corresponds to work having been done. The mechanics of dent formation are quite complicated so consider the parallel example of a tensile test. Fig.11 illustrates a typical tensile force versus plastic extension curve. The work done on the test piece is equal to the area under the load/extension curve.

Residual Stress Deflection

The amount of deflection depends on the work-equivalent of the residual stress profile. It is not stress that causes Almen strip deflection but the force associated with the stress profile. Imagine a large person, weighing say 100 kgs (about 225 lbs. or 16 stones) standing on a plank that is supported at each end. The plank will bend under the weight due to the downward force of about 1000 Newtons. If the plank deflects by a tenth of a meter then 100 Nm of work will have been done.

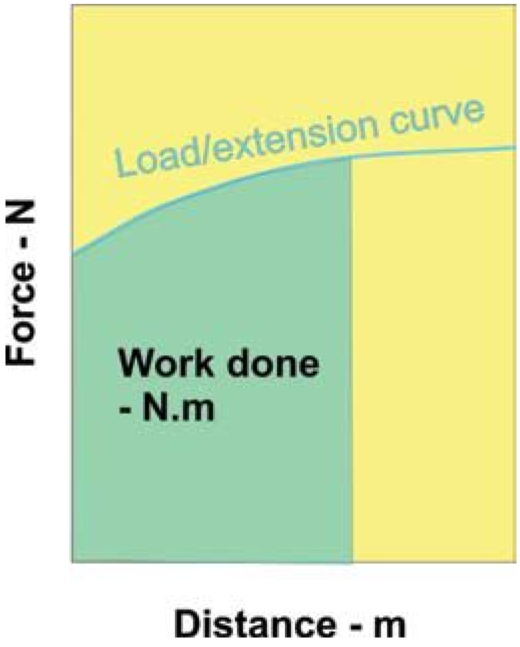

Fig.11. Force multiplied by distance equals work done.

Deflection due to shot peening of an Almen strip is caused by forces parallel to the strip's surface. If, for example, an average compressive stress of 500 Nmm^{-2} exists to a depth of 0.1 mm, we can estimate the magnitudes of the corresponding forces. For the end section of the strip the force will be 20mm x 0.1mm x 500 Nmm^{-2} which equals 1000 Newtons—the same as is exerted by our "large person"! For the side section we have 76 mm x 0.1 mm x 500 Nmm^{-2} which equals 3800 Newtons. The work done in bending the strip to a deflection of, say 0.1 mm, involves complex bending mechanics calculations. Some idea of the work's magnitude can, however, be obtained by simply multiplying the sum of the two forces by 0.1 mm which gives 480 Nm.

SUMMARY

Work and work rate are the unifying parameters that connect all aspects of shot peening. The metric definitions of work (in Nm) and work rate (in Nms^{-1}), can be used to quantify aspects of dent formation, coverage, peening intensity and the capacity of equipment needed to achieve satisfactory peening rates. Of particular significance is the equivalence of heat, kinetic energy and work units. This allows us to understand the distribution of the work absorbed when dents are formed.

The work rate capacity of compressors and wheel-blast motors are essential features of a peening plant's profile. This profile dictates the feasibility of carrying out required peening procedures.


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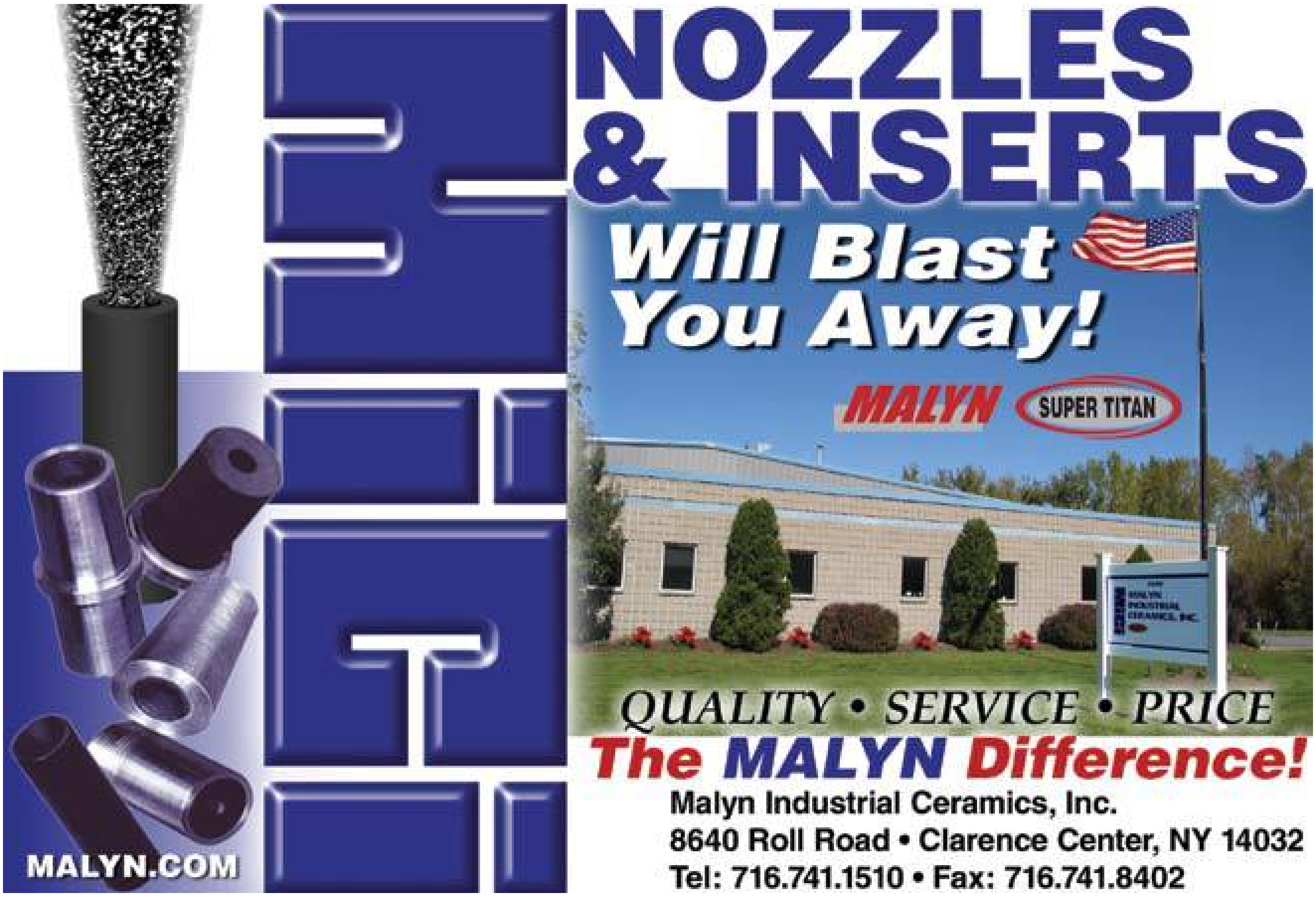
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Dave Barkley | EI Shot Peening Training Director & SAE Committee B Board Member

SAE AMS2590A

The First Revision of the Modern Rotary Flap Peening Specification

AS THE SPONSOR of the AMS2590 specification's five-year review, I took the opportunity to improve on its clarity and guidance. I'm happy that revision A was released in November of 2016 after over two years of work. To help you understand the what and why of the revision, I'll outline the changes to each of the relevant sections.

Section 1 outlines the "scope" of the specification. Changes to 1.2 (application) includes conformance to AMS2430. The initial peening of parts as well as peening for plating adhesion was added to its process applications. Even though the application additions were added per the request of another board member, AMS2590 has always allowed the application of the Rotary Flap peening as a replacement to automated or manual peening with customer approval.

Section 3 is "technical requirements" and contains the bulk of the changes in this revision. In 3.1.1 (tools), Table 1 was removed as it outlined required tool speeds for a given flap size. A tool's speed capability shouldn't be restricted as long as it can produce and maintain the RPM required to obtain a desired intensity. As in the original specification, the tool's speed must stay within ±100 RPM while under load from application to the work piece or the Almen test strip.

Section 3.1.4 (test strip holder) is what initially caused me to volunteer as the sponsor of AMS2590's five-year review. I had noticed in 2010 that a dimension error from the 1972 MIL specification had been carried over to AMS2590. The initial goal was to correct only this dimension error, but I realized I had the opportunity to make improvements inspired by the rotary flap peening training I've conducted over the years. I felt the magnetic test strip holder was too restrictive in design while not being specific enough on its proper use. Before I outline these changes, it's important to note that care was taken to include these design improvements without obsoleting the existing magnetic strip holder.

The magnetic holder uses a needlessly long block of aluminum as its base. The extra length is required only to permanently affix a full-size Almen strip next to the location of the actual test strip as it sits atop the magnets. The permanent strip's original purpose was to provide a backstop, preventing the test strip from sliding off the magnets when the spinning flap applied a slight horizontal force. It doesn't make sense to use a full-size Almen strip to serve only as a backstop, so I

updated the drawing and text to allow any form of backstop, as long as it keeps the strip in place. A shorter backstop allows the length of the aluminum block to be reduced.

When AMS2590 first replaced the MIL specification, it changed the role of the permanent strip. It was originally used as a backstop as explained above, but the shot on the flap could become dislodged when striking the exposed end of a test strip. AMS2590 allowed reversing the direction of flap rotation to create a "level approach" between the permanent strip and the test strip, thus increasing the longevity of the flap. The downside to this method is the absence of a backstop, which may allow slight movement of the test strip. To get the benefits of each method, the new specification has the option of a second backstop at the opposite end of the test strip. This provides a "level approach" from either flap direction while keeping the test strip in place.

Another issue I've seen as a trainer is when a technician tightens the magnetic strip holder's brass screws, limiting the magnet's ability to rise above the surface of the strip holder. This wasn't addressed in previous specifications, so the technician likely didn't know that doing this corrupts arc height values. The magnets must be allowed to move up and down in order to maintain contact with the test strip as it bends upwards. A strong magnetic force will prevent the strip from curving to a proper arc height when contact is broken between the magnet and the test strip.

To prove this I conducted a test with three conditions: The first used a standard magnetic strip holder, with its

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magnets free to travel well above the aluminum surface of the strip holder. For the second condition, I tightened the brass screws to prevent the magnets from protruding above the surface of the strip holder, thus breaking contact when the test strip bends. For the final condition, I removed the center magnet completely to eliminate any influence (magnetic or otherwise) on the center of the test strip. I flap peened six strips under each condition for five minutes at 3,000 RPM. The standard magnetic strip holder and the strip holder with its center magnet removed exhibited similar results with averaged arc heights of 0.0153" and 0.0151" respectively. The holder with the tightened brass screw had an averaged arc height of 0.0135". This proved that restricting contact between the magnets and the test strip will lead to inaccurate arc height readings, so proper magnet operation was added to the specification.

Section 3.3.6 (intensity verification) was formerly section 3.3.2.8. The method of verifying intensity did not change. Intensity is still verified in accordance with J443 by achieving an expected arc height found at the peening time of "T" from an established saturation curve. The frequency of intensity verification was removed and replaced with the new requirement to verify tool speed, which is outlined in the next section.

Section 3.4.1.1 (verification of tool speed) is new. It was established because a tool's speed is far easier to verify than intensity on regular intervals. The direct relationship between intensity and RPM will insure the proper intensity is maintained by verifying the tool's desired RPM and that it is constant. Tachometers and stroboscopes are now listed as tools used to verify RPM prior to saturation curve generation, intensity verification and application of the process to any single work area. If a single work area is very large, the elapsed time between RPM verification cannot exceed 60 minutes. Intervaled RPM verification is not required if a closed-loop rotary tool is used.

Much of section 3.4.3 (flap operation) is unchanged, however, flap defection is now more strictly defined as the "standoff distance from the bottom of the mandrel to the part surface." The operator may use any standoff within the range of 0.05" to 0.150".

Section 3.5 (coverage) was formerly labelled 3.4.4. The wording for coverage requirements now sources engineering drawings, but the rest remains basically the same with compliance to SAE J2277. The requirement of visual inspection with magnification from 5-30X is moved to section 4 along with the requirement of a suitable tool for coverage inspection inside holes. Section 3.5.1 (peening time) was formerly 3.4.5. This section is largely unchanged outside of the section number change and the modern term of "full" coverage used where 100% coverage was used before.

The content of section 3.6 (post peening operations) was removed and replaced with a reference to post peening operations as outlined in AMS2430. Section 3.8 (tolerances), formerly labelled as section 3.7, was also replaced by a reference to AMS2430.

Section 4 outlines quality assurance. The only change here was to 4.3.1 (intensity tests). This section now outlines only the frequency of intensity determination and verification. Much of the section was removed due to changing to an easier method of monitoring RPM to insure proper intensity. Other requirements in this section were removed because they repeated intensity verification requirements outlined in section 3.7.1.2.

Section 8 (notes) are not actual requirements of the specification, but rather general notes and recommendations to help people perform the process. The only change was to section 8.3 and was renamed "Equipment Recommendations" to draw more attention to its contents. This may be the most beneficial part of this article for some. This section previously discussed only how increasing a pneumatic tool's torque capabilities may cure variations in tool RPM, however this isn't a sure fix.

My travels around the world have found too many shops that are not properly regulating the air pressure to the tool. A good high-torque tool will only be as good as the air supplied to it. Using only a single regulator, or flow controller, to set a tool's target RPM will not maintain a consistent RPM. A second regulator upstream from the tool is needed to stop cycling system pressure from getting to the tool. If system pressure cycles between 100 and 120 psi, the upstream regulator can be set to 90 psi and fed to the tool with a dedicated hose. I recommend everyone with pneumatic rotary tools do this in effort to keep consistent tool RPM—confirmed with a tachometer or stroboscope.

Unfortunately, not all air systems can maintain enough pressure and/or volume and varying RPM may remain an issue. Small pipe diameters, the distance from the compressor, and other factors might make a fix impossible. If this is the case for your pneumatic (or electric) rotary tools, I highly recommend investing in a tool with closed-loop RPM control. Especially, if you repair planes. I fly a lot.

This article loosely describes the changes to the Rotary Flap peening specification. We highly encourage you to obtain your own copy of the new AMS2590A by visiting the SAE website (http://standards.sae.org/ams2590a).


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Mike Wright | CEO | Wisdom Environmental, Inc.

Recycling Abrasives

ANY FACILITY that uses abrasives, whether it is shot, cut wire, aluminum oxide or other types of media, faces the challenge of what do to with the by-products from the abrasive blasting processes. The by-products produced from these operations can include spent shot, dust collector fines, the dust collector filters—right down to the floor sweeps from the areas around equipment. Many facilities have a number of areas where multiple operations occur in the same facility and utilize different media for different phases of the manufacturing process.

We all want to avoid disposing of anything in the waste stream that ends up in local landfills. In some cases, a few simple changes to collection processes and a plan on how to handle these items can lead to cost savings by reducing the amount waste produced. What once was considered waste might be converted into a revenue-generating item.

Recycling these items is possible and is currently being done in many facilities. A successful recycling program begins with the end in mind. Before you begin and dive right into sweeping up everything in the area, you must determine what by-products you produce, how much you generate over a period of time, how you will collect the materials (drums, boxes, or super sacks), and where you will store your collected materials. Most by-products of the abrasive blasting process must be kept dry or they will not be usable in a process downstream.

Collecting information about the waste streams is very important when working with your recycling partner. Providing as much information as possible about the by-products helps create an accurate profile of your materials. Once you have identified your by-products and determined your approximate generation, such as ten 1,000 lb drums per month, or two truckloads per month, you need to gather all relevant information about the specific by-product such as data sheets generated by the provider of the raw materials, SDS Forms, and any other information about the by-product that can be used by your recycling partner to find a home for your materials. In addition, a sampling of these materials is a key component to finding a buyer for your by-product. Expect to provide anything from small quantities to larger samples to the markets that will test your materials and determine if your materials are a feasible "feedstock." It's also very helpful to provide photos of the materials with a ruler or any item that helps provide a size reference. The completeness of the package that you prepare will have a direct effect on how quickly answers come back to you about the recyclability of your materials. Sometimes you will quickly find a person willing to take your material or the process is agonizingly slow, as your by-product may be interesting to only a few select individuals.

Super sacks are ideal for holding recyclable materials

Spent Steel Shot for Recycling

Have patience and tenacity. I've worked on by-products for years only to one day have an opportunity present itself and solve my client's problems with a single phone call.

Waste streams such as spent steel shot are fairly easy to recycle as the materials have ready markets established and they traditionally yield a return for recycling. Dust by-products become more difficult to recycle as there are fewer markets for these materials and things like the chemical make-up of the dust, density, particle size, and packaging all become factors that determine the recyclability of these materials. If the products being treated have elements like Nickel, the dust may yield a value because dust from these operations is used by a few companies to produce new products. If the dusts are composed of only Iron, then it becomes more difficult and depends on the condition of the steel industry where much of this material is recycled. Spent Aluminum Oxide has multiple outlets for recycling and is used for its Alumina content, depending on how pure the material is and what contaminates have been introduced into the waste stream.


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This leads to the next issue—the cleaner the material the better chance for recycling. Since most recycled products are used to produce other products, the cleaner and closer the materials are to their original composition the better the chances are of finding a home for these by-products. When thinking about a recycling program for abrasive by-products, it's important to keep the individual by-products as separate as possible. For example, mixing spent steel shot and aluminum oxide can make it very difficult to recycle as other separation processes must be done to make the material marketable. The additional processes add cost to the end product that the final market may not be able to support. Keeping trash out of the products is very important to do as well. Ear plugs, wood, gloves, nuts and bolts are just a few of the items we have seen that have led to the rejection of a perfectly good by-product. Maintaining a clean waste stream requires a few things including a good labeling program, covering and protecting the material once the drum or sack is full, and a methodology for collecting and storing these materials at the facility. These steps will go a long way to getting the best value out of your materials.

Another overlooked item is the filters in your dust collector systems. In many cases, there are options for cleaning these filters and re-using them instead of throwing them out after one use. These filters can cost hundreds of dollars and companies spend thousands of dollars per year

Dust Collector with Cyclone

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on new replacement filters. Finding a company that can "clean" your filters and allow you to reuse them will save you considerable money. Many filters can be cleaned multiple times and can easily become part of your overall abrasives recycling program.

While I have presented a rough outline of the recycling of abrasives, as an owner of an industrial recycling company specializing in difficult to recycle by-products, the recycling of these items has a path that goes much further than I can address here. One thing that you should keep in mind is not to focus on a single by-product and see success or failure in that one stream. A successful recycling program is holistic and seeks to achieve the goal of landfill avoidance and the minimization of cost to the company. If one looks at all the recycling options for their company's by-products and finds a few that generate revenue, a few that eliminate a disposal cost, but generate no revenue, and a few that cost money to recycle, in the end your company will benefit from having a recycling program that achieves landfill avoidance, reduces costs, and makes a few dollars that adds up year after year.

Wisdom Environmental, Inc. specializes in the development of recycling programs for the business and manufacturing sectors. As the world moves toward a more environmentally friendly mindset and as landfills continue to fill and close down, Wisdom Environmental serves the needs of both business and society. Wisdom Filter Clean is a division of Wisdom Environmental and specializes in the cleaning of industrial dust collector filters.

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