

The Shot Peener

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



PROGRESSIVE SURFACE CELEBRATES 50 YEARS OF GROWTH

PLUS: ■ THE CRITICAL ROLE OF METALLIC SHOT ■ VARIATIONS OF ALMEN TECHNIQUE ■ THE NEW ZIRSHOT®HDC PEENING SHOT

Peening Innovation

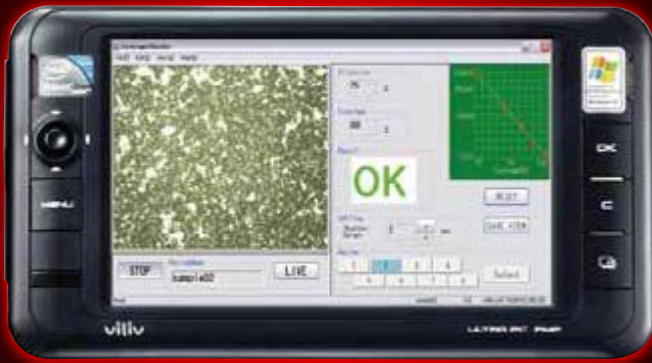
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COVERAGE CHECKER

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Application

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Specification

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THE SHOT PEENER

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A Trip Down Memory Lane

READING THE ARTICLE from Progressive Surface reminded me of my efforts to write memoirs of the Electronics Incorporated journey that started in 1974. I had a project to supply Boeing with media flow rate controls for a very largepeen forming machine. That was my introduction into the shot peening community. I had discovered a niche industry that looked to be very interesting. I had no idea how exciting (and sometimes frustrating) it would be.

I cultivated relationships with wheelblast and airblast equipment suppliers and then media manufacturers. From there I wandered into membership of SAE and got involved with the Surface Enhancement Division of the Fatigue Design and Evaluation Committee. I started to understand issues with media: Cast steel shot, cut wire media, glass bead, ceramic bead, and so on. It's the media that does the work. You cannot do good shot peening with not-so-good media—right, Kumar? (Don't miss Kumar Balan's excellent article on page 12 about the crucial role media plays in a quality shot peening program.)

I developed a magnetic valve in early 1980 and since I couldn't find a suitable place for advertising, I launched *The Shot Peener* newsletter (now *The Shot Peener* magazine). To offset the cost of this free publication, we started selling Almen strips.

The sales axiom "You can lead a horse to water but you cannot make him drink" was followed by "It's your job to make him thirsty" so I decided to hold a shot peening workshop in September of 1991 in Atlanta, Georgia. That was our chance to educate users about the process. If they could appreciate it and respect it they may wish to control it (it's called a MagnaValve). I guess the rest is history. If you joined us in Orlando, I suspect you heard more of my EI stories. ●



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THE SHOT PEENER

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Progressive for 50 Years: Projects That Defined Our Path

THE BEGINNING

Progressive opened in 1967 in Holland, Michigan, about 35 miles from our current location in Grand Rapids. The company was a small machine shop, primarily building part holding jigs and fixtures for the die cast polishing industry. Back in those days, chrome plating of plastics did not exist, so any small chrome-plated part of your car or industrial product was die cast, polished, and then chrome plated. The surface of the die cast part had to be polished prior to plating. There were many polishing facilities back in those days. In addition to the die cast polishing tooling, Progressive Engineering, as it was called then, also did job shop machining and fabrication for a company who built small manual abrasive blasting systems.

Shortly after Progressive Engineering got off the ground, someone finally figured out how to chrome plate plastic, and overnight, the die cast polishing industry evaporated—as did most of Progressive’s revenue. At the same time as the fall of the die cast polishing world, Progressive’s customer, the small blasting and peening company, also went out of business. Since peening and blasting seemed to have a future and there was now an opening in the marketplace,

Progressive chose this direction for the company and changed its name to Progressive Blasting Systems. Its primary business became the building of blasting and peening systems. One of Progressive Blasting’s first projects was a machine for Timex to cosmetically bead blast the wristbands of their watches. And to borrow the old Timex tag line, in those first few years of business, Progressive “took a licking but kept on ticking.”

Progressive’s early roots in machining formed the kind of equipment we build today. Where many of the early peening and blasting companies made machines from bent sheet metal, Progressive did not have sheet metal fabrication capability so we utilized our machining and welding capabilities and made our systems from machined and welded ½-inch steel plate. What we found was the welded plate construction created a structurally stronger, quieter, and more durable cabinet for the harsh and abusive pneumatic blasting processes. Through the years, as we added more manufacturing capabilities, this welded machined plate construction remained and has become part of our brand.

FIRST BREAKTHROUGH PROJECT

Through the late '60s to early '70s, most of our work was in support of the automotive and heavy equipment industry. We built many rotary index machines. At that time, indexing multi-spindle machines did not have automatic doors that opened and closed between indexing. Machine manufacturers used simple rubber curtains in an attempt to contain the media and sound. In 1968, Progressive was the first to put automatic doors on these machines, making the machines quiet and clean. Although it seems like an insignificant advancement, this started the movement of shot peening from a dirty, noisy, and problematic requirement to a much more respected and advanced surface enhancement process. During the rest of the 1970s, Progressive built many systems for large and small companies, from hand cabinets, to simple one-axis gun-mover systems with spindles, to rotary index-style machines. These machines went throughout the US to many different industries, including the aerospace industry.



Progressive got its start as Progressive Engineering in Holland, Michigan in 1967.

Challenge with Our Originality!

技 極 匠

WAZA
[technique]

KIWAMI
[extremely]

TAKUMI
[artisan]

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AUTOMATION OVER HANDS

Late in the 1970s, Progressive was contacted by one of our aerospace customers with a big problem. They had a large fan case for an aircraft engine that required grit blasting as part of the manufacturing operation. This part was currently blasted manually. They were unhappy with the inconsistency they were getting with this manual process, not to mention the operator fatigue caused by the long cycle times. This customer wanted to know if there was an automated solution for processing this part.

Progressive needed to figure out how to coordinate two axis of required nozzle motion with an indexing turntable. The result was the first blasting machine with coordinated motion. The machine was a huge success because it improved process consistency and decreased cycle time. This machine cracked the barrier on automation, making it flexible enough to intricately blast orpeen complex aircraft engine components.

WELCOME TO THE AGE OF ROBOTICS

Shortly after our first simple coordinated motion grit blasting machine, we were approached by Atlantic Machine Tool Works, a machine shop in Connecticut that produced turbine disks. Atlantic also peened the turbine disks that it machined in a conventional multi-nozzle peening system. Setup time consumed 50-60% of the hours Atlantic spent peening these disks. They had heard of our capabilities with simple coordinated nozzle motion and wanted us to build a two-axis machine to help reduce setup time.

Instead, Progressive convinced this customer that we could replace the five existing gravity suction nozzles with a single pressure nozzle on a five-axis robotic machine and get their parts done in half the time of the current process. That might be the standard sales pitch today for those who sell robotic systems, but back in 1982, this was unheard of and had never been accomplished before.



Progressive's first robotic machine was built in 1982.

After many meetings, Atlantic believed in Progressive's idea and the first multi-axis robotic shot peening machine was delivered and put into service in early 1983. This was the first of the over 1,000 robotic machines that Progressive would deliver during the next 35 years. Oh, and yes, not only did this machine deliver on the promise of eliminating setup time, saving 50-60% of the hours spent on the part, it went beyond the original goal. By robotically controlling that single nozzle, the part was peened more uniformly and closer to the 100% coverage requirement, and it lowered the actual peening time.

IF ONE IS GOOD, TWO IS BETTER

Word quickly spread about our first robotic peening machine and soon we were working arm in arm with a major aircraft engine manufacturer. We were called in to work with their design engineering team to define the parameters topeen the first multi-stage compressor spool/drum rotor. This required us to develop the first dual-robot system—one robot topeen the outside diameter, the other robot to simultaneouslypeen the internal surfaces. The inside was especially challenging since it required that the robot reach inside a six-inch diameter opening and articulate a peening nozzle topeen the internal surfaces of the multi-stage spool. Of course, once we figured out how to get a peening nozzle into that small space, we had to solve the next problem—how to extract the media from the inside of the spool. To tackle this problem, Progressive developed the first hollow spindle with integral media reclaim.

Necessity was definitely the mother of this invention.

WHAT GOES UP MUST COME DOWN

After the first single-robot and dual-robot systems were introduced, the rest of the early 1980s were spent refining the designs of these systems and improving the robotic controls. Since most of these machines were being delivered to aircraft engine manufacturers, Progressive began to understand the needs of an industry that was starting to appreciate the benefits of shot peening and wanted more process control.

Early in these collaborative years, Progressive was presented with a problem and a concept. An engineer at a major aircraft engine manufacturer had the idea of using round, smooth, and very large media—ball bearings—topeen parts. He needed to densify a thermal sprayed coating and wanted to improve the surface finish of the final product.

Other methods of surface finish improvement after peening, such as tumbling, were not acceptable since they would remove this protective coating. This engineer mocked up his idea but needed help in taking this new process from concept to reality. The engineers at Progressive got busy and quickly designed and built the world's first Gravity Accelerated Shot Peening (GASP) system. There were many technical challenges along the way, including the transport of 10,000 pounds of media per minute and then distributing this

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media in a uniform curtain. This project was a true testament to Progressive's philosophy of working with customers to help them bring ideas to reality.

WE NEED CONTROL

In addition to the high volume of peening work in the 1980s, Progressive was also busy developing high-technology thermal spray coating systems for aerospace customers. We were the first to design and build a closed-loop process controller for plasma spraying that incorporated closed-loop control of the plasma gases and powder feed rates. This was significant for the peening world since this work on our thermal spray process controller was the predecessor to PRIMS, our industry-leading Process, Reporting, and Integrated Monitoring System.

PRIMS monitored all the key peening process variables, alarming the operator and shutting down the machine if these variables went out of range. It also collected data to produce end-of-run reports. These reports were important to customers who were peening critical components and wanted verification that the peening was done correctly. Over the years, PRIMS has been continually improved by adding many user interface functions and preventative maintenance tools.

LASERS COME TO PEENING

The robotic systems Progressive produced during the 1980s and early 1990s established the company as a technology leader. There were many examples of Progressive working with customers to come up with innovative solutions for the peening of complex hardware. The problem with these accomplishments is that customers started to expect the impossible.



Progressive's latest "intelligent" machine with tool changer and robot vision.

Early in the 1990s, engineers from a large aircraft manufacturer wanted to roboticallypeen the edges of very large aluminum wing skins, including the inside surface of cut outs within the skin. This was a challenge way beyond thinking. Not only did the special right-angle duck-bill nozzles have to be developed, but somehow we would have to track the edge of the skin to know where it was and how far away it was in order to maintain a consistent standoff distance.

After an exhaustive R&D effort, Progressive figured out how to utilize a laser to track the edge of the wing skin and then to integrate the feedback from the laser to automatically adjust the robot program to allow tracking of the part. Of course, all of this high-tech equipment needed to be on the end of a robot arm that could survive the harsh peening environment. These systems were a huge success and are still in operation 25 years after the initial installation.

TODAY AND THE NEXT 50 YEARS

These are only a few of the 2000 projects Progressive has completed over the past 50 years. These projects shaped the company into a leader in the surface treatment machinery industry. Over the years, Progressive's philosophy of helping customers solve problems has created numerous opportunities and opened many new technologies and industries.

From our early days of building blasting and peening systems, these opportunities have allowed us to also become industry leaders in thermal spray coating and waterjet stripping systems. A true testament to Progressive's commitment to building the best machine possible is illustrated by the fact that all of the machines discussed above are still in production today—some have over 30 years of service. That's unheard of in the blasting equipment industry.

From the start, Progressive has focused on gaining a thorough understanding of our customers' requirements, developing the necessary technology to produce process specific solutions, and then providing a lifetime of exceptional support. This is the Progressive brand, and this successful approach will continue for the next 50 years. ●



In 2010, we changed our name to Progressive Surface to emphasize the company's core competencies in the design and manufacture of world-class surface treatment machinery.

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AN INSIDER'S PERSPECTIVE

Kumar Balan | Ervin Industries, USA | kbalan@ervinindustries.com

The Critical Role of Metallic Shot in Achieving Consistent Shot Peening Results

Introduction

The quality of metallic shot plays a critical role in the accuracy and repeatability of shot peening results. Energy transmitted from the shot to the component determines the residual compressive stress, and the fatigue life developed in the component. The two key measures of the value and quality of metallic shot are: Durability (life) and Transmitted Energy (Impact Energy).

The other characteristics such as size, hardness, microstructure, and physical defects including cracks, shrinkage, voids, and chemical analysis, also have a bearing on the effectiveness with which the energy is transmitted.

Process specification for a component to be shot peened will stipulate the shot size, type, and sometimes its hardness. As for the shot quality, the shot peener is completely reliant on the shot manufacturer's self-certification process to ensure its conformance to appropriate SAE or AMS requirements. To validate metallic shot quality, the Ervin Test Lab regularly runs tests of shot samples for the above parameters and evaluates performance using SAE J445.

Compilation of such data through analysis of 37 different samples of non-Ervin manufactured metallic shot in 2016 revealed that over 40% of the samples showed low performance, which was the direct result of specification deficiency in these samples, as required by SAE J827, SAE J444, AMS 2431/1 or AMS 2431/2. Not being able to reliably transmit the intended impact energy defeats the purpose of the process. The information discussed in the paragraphs that follow is intended to provide the reader a procedure to test the two critical parameters—Durability and Transmitted Energy of metallic shot peening media.

Objectives

1. To offer a test procedure for assessing metallic shot durability (to predict life cycle before spherical, peening shot breaks down and is no longer useful for peening)
2. To offer a test for calculating transmitted energy in a test machine using Almen A strip
3. To discuss the effects of microstructure and physical defects on peening results

Methodology – the Ervin Test Machine

The optimum way to test the durability of the shot would be to process it through a production-style blast wheel and study its breakdown characteristics. However, the nature of the process and the inability to precisely capture the shot make that exercise impractical. The Ervin Test Machine was designed to simulate the action of a production blast cleaning or shot peening blast wheel machine, and at the same time, provide a laboratory (and portable) tool to quickly test the performance (durability and transferred energy) of metallic shot.

In the Ervin Test Machine, the centrifugal wheel (commonly referred to as “beater”) is driven at 7,000 RPM by an electric motor to generate a velocity of approximately 200 feet per second. This is within the range of velocity developed in a production machine. Metallic shot introduced into this wheel is impacted against an anvil surface. After impact, the shot falls to the bottom of the rotating anvil recycling assembly which picks it up and returns it to the wheel from where it is repeatedly thrown against the anvil surface. The anvil recycling assembly rotates at 25 RPM resulting in the shot being recycled through the wheel 25 times per minute. This arrangement is used for testing the Durability, and with



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a minor change in set-up, the Transmitted Energy. When testing for Transmitted Energy, the Anvil is replaced with the peening attachment which holds an Almen "A" strip in the impact path of the metallic shot being tested.

Test Procedure (for Durability)

Described for S-550 Amasteel Shot

1. Remove the plug/cork and add an accurately weighed 100 ± 0.1 gram sample of S-550 into the anvil/recycling device. Seal the opening with the plug/cork.
2. Set the counter for 500 cycles.
3. Turn the machine on. The counter will stop the machine after 500 cycles.
4. Empty the shot into the tray provided, ensuring that the contents are removed when the plug is pulled out. Rotate the anvil/recycling device multiple times while steadily rapping the housing with a plastic hammer.
5. Place the sample on an 8" diameter, 40 mesh, 0.0165" opening test sieve and screen the sample for about three minutes. This will remove all the fines from the metallic shot.
6. Weigh the amount of sample remaining on the test sieve and record it as "% Retained".
7. Calculate the Loss, 100% minus weight from (6) above and record the value as "% Loss."
8. Replace lost material with new sample shot until the weight adds up to 100 ±0.1 grams.
9. Repeat steps 1 through 9, regularly adding the % Loss from each 500-pass test run into a new column titled "Accumulative % Loss" until the "Accumulated % Loss" exceeds 100%.
10. Determine the durability, or number of cycles/passes for an exact 100% replacement by interpolation using the following formula:

$$\text{Durability} = \text{Total Passes} - (\text{passes per test run} / \% \text{ last lost}) (\text{accumulative \% loss} - 100)$$

In this example, the durability works out to 3050 cycles or passes of the metallic shot.

Note: The Ervin Test Machine is most effective for testing metallic shot sizes S170 and larger.

The information is presented in Table 1.

Key observations from the data and result above:

- The inference is based on a specific set of process parameters, particularly the shot velocity. The speed was chosen as 7000 RPM to optimize the shot velocity around 200 feet per

Table 1: 100% Life Test

Cumulative Passes	% Remaining	% Loss	Accumulative % Loss
500	91.8	8.2	8.2
1000	86.0	14	22.2
1500	83.3	16.7	38.9
2000	78.2	21.8	60.7
2500	80.6	19.4	80.1
3000	81.8	18.2	98.3
3500	83.1	16.9	115.2

second, to approximate that normally generated by a blast wheel.

- The calculated life cycle of 3050 is an absolute number until compared to metallic shot from an alternate source (competition), but using the same manufactured parameters (size, hardness, etc.).
- Breakdown of the shot in Table 1 demonstrates a uniform and steady pattern throughout its life cycle. The absence of any spikes or radical drops proves the integrity of metallic shot and its natural wear rather than abnormalities that would point towards physical defects such as cracks, shrinkages and voids.
- The steady breakdown also leads us to comment on its microstructure. A highly controlled atomization process is paramount to building a refined and uniform microstructure with minimal voids and other grain imperfections. Additionally, such a breakdown pattern could also mean that the microstructure is free from brittle iron carbides that lead to premature shot fracture.
- The life cycle test provides a good predictability measure as to when the shot will start downsizing due to normal wear and the subsequent potential for erroneous results. These observations need to be understood with the degree of caution that SAE J445–Metallic Shot and Grit Mechanical Testing directs us to, stating that the data from the tests is suitable to check the "uniformity of shot shipments or to determine the relative fatigue life," and not to obtain operating costs. This is because field conditions are different from the test lab. In other words, factors such as machine maintenance, hardness of the component being blasted/peened, metallic shot size, hardness, etc., also have a role to play in shot breakdown.

Test Procedure (for Transmitted Energy)

1. Obtain a 50.0 ±0.1 gram sample of the used metallic shot from the Durability Test conducted earlier.
2. Put this sample in the test machine.
3. Fix an Almen A strip on to the peening attachment.



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The peening attachment matches the test strip holder as specified in SAE J442, with an additional attachment on the back to mount it in the test machine.

4. Peen the Almen strip for 40 cycles (this is assumed to be the point of saturation of the strip) and then measure the arc height.
5. Measure the arc height using an Almen Gage. The resulting value is a measure of the Transmitted Energy.

The two tests described above are identified in SAE J445. For the Durability Test, SAE J445 describes two other techniques: 5.2: Average Life by Measurement of the Area Under the Breakdown Curve and 5.2: Stabilized Loss Method. The Durability Test described here is listed as 5.3: 100% Replacement Method in the specification.

Other Lab Tests

In addition to the above, the metallic shot is subjected to additional tests at the Ervin Lab.

Hardness – This test uses a 1000 gram load.

The test procedure for hardness consists of testing ten different grain samples gathered and positioned in a Bakelite base. These samples are ground to half their diameter so that the center of the grain is tested for its hardness. Based on such a test, the maximum and minimum hardness were 45.5 Rockwell C and 41.9 Rockwell C respectively, for an average hardness of 44.3 HRC. The readings reveal clearly that this is a sample from the standard hardness range of 40 to 51 Rockwell C (SAE J827). In shot peening, the shot hardness is generally the same as or greater than the hardness of the part being peened. This is to ensure that the proper depth and level of residual compressive stress are generated in the part. If not



Hardness Testing – Shot grains are captured in a Bakelite Base and ground to half their diameter. Hardness is tested at the center.

stipulated in the peening specification, the common practice is to use standard hardness shot (40 to 51 Rockwell C – SAE J827 specification for standard hardness). Hard shot breaks down relatively faster and accelerates wear in the interior of the blast machine and wheel parts.

Chemical Analysis – Table 2 below provides the results from Chemical Analysis on the test sample from before.

Table 2: Chemical Analysis

Elements	SAE J827	Amasteel S-550
Carbon	0.80 to 1.20%	0.9
Sulphur	0.050% Max.	0.02
Manganese	0.6 – 1.20%	0.94
Silicon	0.40% Min.	0.93
Phosphorus	0.050% Max.	0.022

Key points from the above test results:

Chemical analysis and subsequent metallurgical adjustments during the melting stage influence the durability of the metallic shot.

- High carbon content results in brittle shot microstructure that contributes to early shot fracture and failure. Low carbon content, on the other hand, will cause the shot to absorb a large portion of the Kinetic Energy, resulting in reduced energy available for shot peening or blast cleaning.
- Sulphur and Phosphorus content should be minimal in the metallic shot. These elements weaken grain boundaries and lead to lower durability and transmitted energy of the metallic shot.
- Manganese content within the specified range is critical in influencing the durability of the shot.
- Silicon in higher percentages also contributes to high durability. Additionally, it also acts as a de-oxidising agent.

Physical Defects

Manufacturing methods commonly employed will result in a certain level of defects and SAE J827 lists the limits for the defects. The detrimental effects caused by these defects are reduced transmitted energy and premature breakdown. The shot sample above was observed under 10X magnification for the following results.

Table 3: Objectionable Defects
(Micro-Examination at 10X – SAE J827)

% Voids	10% Maximum	2.8
% Cracks	15% Maximum	7.0
% Shrinks	10% Maximum	0
% Elongated	5% Maximum	0



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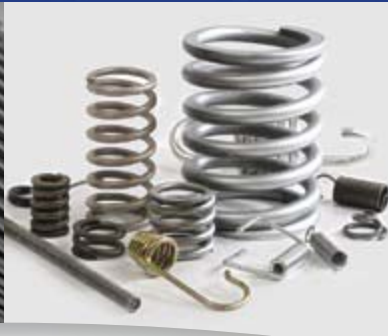
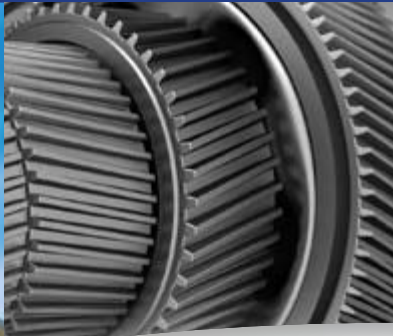


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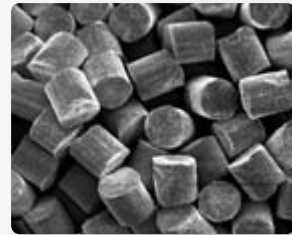
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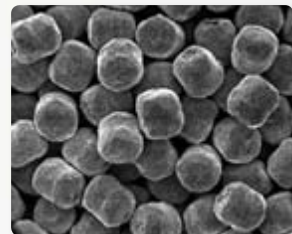


The advantage of Premier Cut Wire Shot

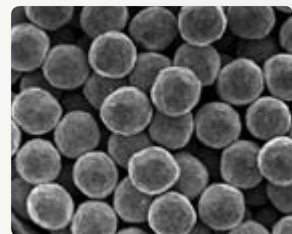
- **Highest Durability** Due to its wrought internal structure with almost no internal defects (cracks, porosity, shrinkage, etc.) the durability of Premier Cut Wire Shot can be many times that of other commonly used peening media
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AN INSIDER'S PERSPECTIVE

Continued

Summary

The ideal metallic shot should be able to transmit the maximum impact energy on to the component being shot peened or blast cleaned. This in turn will provide the most economical cost of operation. Metallic shot with its chemistry within the range specified in J827, consistent hardness, defined microstructure and imperfections within allowable limits will provide optimum peening and cleaning results.

The techniques explained above are aimed at describing a method to test your new metallic shot and ensure that it conforms to required specifications (AMS or SAE) before being put to use.

References

- [1] Ervin Industries Technical Bulletin (Vol No. VIII: Issue No. 6: July 2003, found on ervinindustries.com)
- [2] Ervin Industries Technical Bulletin (September 2003)
- [3] Ervin Industries Lab Test Data
- [4] Ervin Test Machine Technical Data
- [5] SAE J445 Metallic Shot and Grit Mechanical Testing (Rev. Apr. '96)
- [6] SAE J827 High-Carbon Cast-Steel Shot (Rev. Sept. '96)

Acknowledgement

I would like to thank Denny Shearer, Technical Services Manager, Ervin Industries, and Joe McGreal, Vice President Sales and Marketing, Ervin Industries. They helped with the content and review of the article. Their decades of experience in the industry helped validate the information presented here. ●

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Saint-Gobain Launches High-Density Ceramic Peening Shot: Zirshot® HDC

THE CONTINUOUS SEARCH for performance enhancement and energy savings in the use of mechanical components drives many industries to employ harder and stronger metallic alloys, combined with the design of lighter parts and complex shapes.

Shot peening, one of the most efficient surface treatment processes to enhance mechanical strength and reduce weight, has evolved and adapted to these new generations of metallic alloys.

Saint-Gobain ZirPro has developed Zirshot® HDC, a new ceramic shot made from a very tough Zirconia-based material, which combines properties of a high density (6.2 g/cm³ or 386 lb/ft³) together with an extreme degree of hardness (70 HRC or 1180 HV). This new peening media exhibits good roundness, very smooth surface, and narrow size distribution (Figure 1).

With these outstanding characteristics, Zirshot HDC will consistently transfer higher energy levels during each peening impact while improving the surface integrity of the treated parts (Figure 2).

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Figure 1. Zirshot® HDC ZC900 ceramic shots

with the results on harder steel substrates exceeding the performance of the hardest steel cut wire.

Zirshot HDC can comfortably reach the whole range of Almen intensities on the A scale. In addition, Zirshot HDC has high recycling capabilities in both pneumatic nozzle and wheel turbine shot peening equipment.

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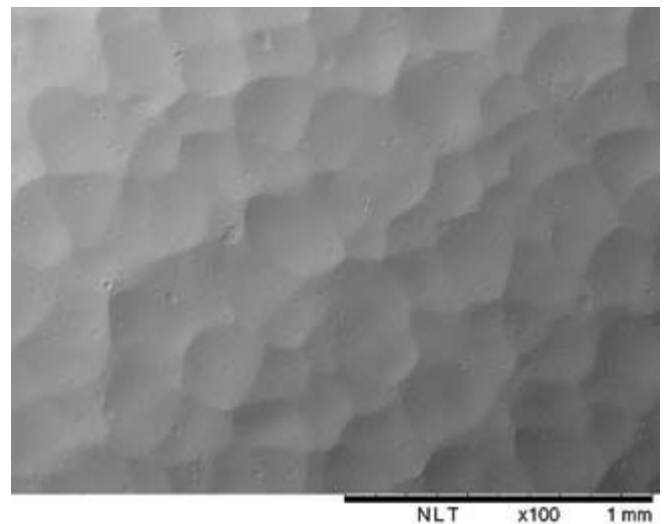


Figure 2. Steel surface peened with Zirshot® HDC



Figure 3. Stress on spring carbon steel peened surface

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Zirshot HDC is manufactured by Saint-Gobain ZirPro in three regular size ranges:

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- ZC900 (900-1100µm)

It is available from the ZirPro sales offices globally and also from ZirPro's authorized distributors.

Saint-Gobain research and development engineers presented a technical study on the Zirshot HDC media behavior in peening processes and their effects on steel substrates at the recent 13th International Conference on Shot Peening (Montreal, September 2017).

Saint-Gobain ZirPro has ongoing developments of Zirshot HDC in the automotive, aerospace and biomedical markets where deep peening intensities, and an improved surface finish are required. Furthermore, Zirshot HDC is currently being tested and is showing enhanced materials parameters of components manufactured by additive manufacturing. Applications could also be foreseen in peen forming with coarse size of Zirshot HDC.

Feel free to contact our sales and marketing offices for further information and for testing the new Zirshot HDC.

- North America: Jeff Girman (jeff.a.girman@saint-gobain.com)
- Asia, Europe and Rest of World: Renaud Hancy (renaud.hancy@saint-gobain.com) ●

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Saint-Gobain ZirPro is the leading manufacturer of ceramic peening and blasting media including the following product ranges:

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The Saint-Gobain Surface Treatment Application Lab

LAI International First to Earn Nadcap Additive Manufacturing Accreditation

THE PERFORMANCE REVIEW INSTITUTE is pleased to announce that LAI International, a leading contract manufacturer of precision-engineered finished parts, components and sub-assemblies for advanced industries, recently earned the first Nadcap Additive Manufacturing Accreditation.

LAI Director of Quality, Joe Beauchemin Jr, stated, "Having Nadcap Welding Additive Manufacturing Certification has improved LAI's sales opportunity and reduced operational cost. PRI provides the infrastructure, documentation, and support to help companies achieve certification."

The Additive Manufacturing checklist developed by the Nadcap Welding Task Group, used to get the Nadcap Accreditation, is based on Subscriber requirements and is specifically for laser and electron beam powder bed metallic components. It is available in eAuditNet via Resources/Documents/Audit Checklists/Welding.

Ian Simpson, Program Manager for Welding at PRI, would like to thank both LAI for their pro-active approach to becoming accredited, as well as the dedicated work by the sub-team led by Dr. Richard Freeman of TWI. Dr. Freeman developed the checklist and ensured its seamless introduction into the Nadcap program.

Any company who is interested in gaining Nadcap Additive Manufacturing Accreditation, or would like further information, should contact:

- Ian Simpson, Program Manager -Welding (isimpson@p-r-i.org tel: +44 1332 869272) or
- Staff Engineer, Gabe Kustra (gkustra@p-r-i.org tel: +1 724 772 8673) for more details.

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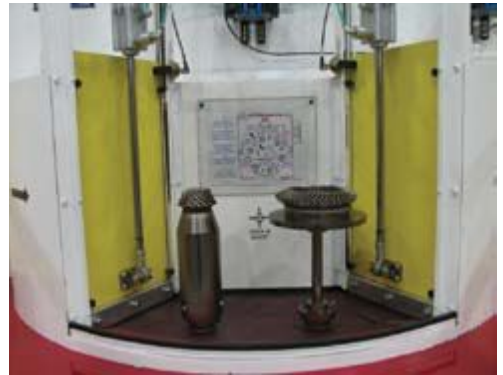


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ACADEMIC STUDY

Dr. David Kirk | Coventry University

Variations on the Almen Technique

INTRODUCTION

First instigated in 1942 with a patent submission, the Almen technique has now provided a reliable and universally accepted method of measuring peening intensity based on the deflection of standard strips when exposed for different times to a shot stream. This article considers various alternatives to and variants of the Almen technique. These alternatives and variants are those developed by the author in his Coventry University Shot Peening Laboratory—set up in order to facilitate studies of shot peening variables. A common thread was to question every aspect of the standard Almen technique. Principal considerations included Materials, Shape and Deflection Monitoring.

MATERIALS

Test Strips

University laboratories have the luxury of not having to be bound by prescribed procedures, including the materials from which standard Almen strips are manufactured. Currently most Almen strips are manufactured from ferritic steels that have been hardened and tempered to a condition associated with that of spring steels. Almen strips are also made from other metals—such as stainless steels and aluminum alloys.

One important question is “Why is hardened and tempered steel normally used as Almen strip material?” We can only speculate as to what was in Almen’s mind when he first established his technique using such material. Perhaps he felt that his test strips should be made from the same material as the springs that had showed fatigue life improvement when blasted. If that was the case it begs the question, “Why should it have to be of the same material and have very similar hardness?” We now know that peening intensity measurements are needed in order to assess the ability of a shot stream to produce a work-hardened, compressively-stressed surface layer. They are not intended to be a form of hardness testing. Nevertheless, most shot-peened components are made from hard metals. It therefore seems logical that test strip materials should also be made from hard metals.

Hardness depends primarily on the melting point of the base metal but also depends on alloying. Hence aluminum is much softer than mild steel but can be alloyed to have twice the hardness of mild steel.

The relationship between component hardness and indent diameter has been established (“Prediction and Control of Indent Diameter”, TSP, Spring, 2004). For that research, experiments were carried out in order to establish the reaction of different materials to a constant shot stream. Strips were manufactured to Almen strip dimensions from readily-available materials—mild steel, pure aluminum, copper and brass. Every material yielded saturation curves that had the same shape. The only difference being that the “10%” arc height decreased with increasing hardness. Indent diameters were found to depend on the “fourth root” of the materials hardness for a constant shot stream. The range of hardness for available strip metals is approximately sixteen to one. It follows that indent diameters will only vary by a factor of about two to one for a given shot stream.

Stability of strip deflection is an important consideration. The surface of peened strips is very heavily cold-worked and is therefore thermodynamically unstable. Raising the temperature of cold-worked metals induces structural changes, classically described as “Recovery, Recrystallization and Grain Growth.” Even at room temperature, the arc height of a peened Almen strip diminishes, if only to a small extent, after peening has been completed. Fig.1 is a schematic representation of the two post-peening temperature-induced phenomena, recovery and recrystallization, which may affect arc height. The third phenomenon, grain growth, only occurs at high temperatures and will not normally affect arc height significantly. The shape of the curves shown in fig.1 is characteristic of body-centered-cubic (b.c.c.) metals such as ferritic steels. Initially there is a small exponential decay

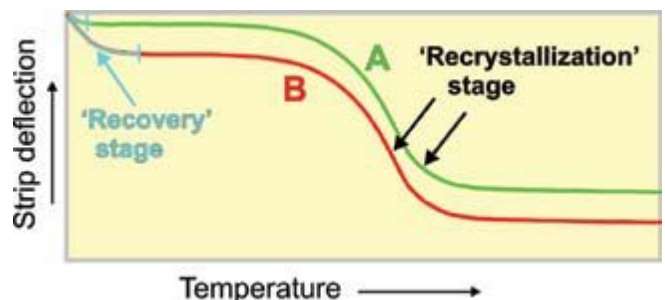


Fig.1. Temperature-induced strip deflection changes for b.c.c. metals.

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(shown in blue). For curve A, recovery contributes only a tiny reduction in arc height. Curve B, on the other hand, indicates a significant reduction of arc height due to recovery.

The standard steel used for Almen strips is ferritic, which is synonymous with it being b.c.c. Experience shows that its behavior is equivalent to that of curve A. In effect, apart from a tiny reduction of arc height immediately after peening, the arc height remains stable unless it is subsequently heated. Tests involving repeated arc height measurements on the same steel strips have shown that their arc heights remained unchanged, even after thirty years, when kept at room temperature.

The shape of curves for heated face-centered-cubic (f.c.c.) materials, such as aluminum and austenitic steels, is different from that for b.c.c. metals. The classic curve is of exponential decay. This predominates throughout the recovery, recrystallization and grain growth stages. Fig.2 illustrates the type of behavior resulting from heating strips to a substantial temperature. Recovery mechanisms occur first, followed by recrystallization and finally grain growth. The rate of strip deflection decay depends upon the temperature.

Standard Almen strips, made from spring steel, have to be heat-treated to achieve required hardness levels. One hazard associated with this heat treatment is decarburization. If decarburization is allowed to occur then there will be a relatively-soft surface layer. Deflection of such strips will be reduced for a given shot stream.

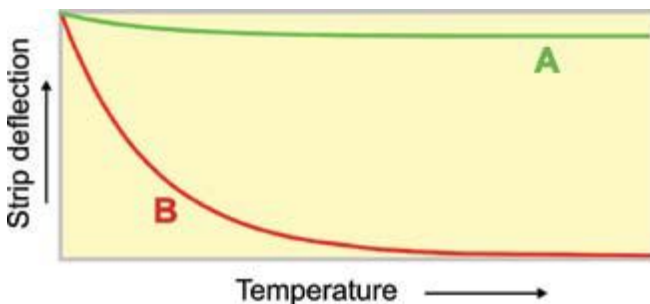


Fig.2. Temperature-induced strip deflection changes for f.c.c. metals.

Curve A in fig.2 is characteristic of peened hard aluminum alloy strips maintained at room temperature. Curve B is characteristic of peened pure aluminum strips. Pure aluminum would therefore be quite unsuitable for peening intensity measurements. Post-peening deflection reduces quickly, even at room temperature.

Component Contamination

The use of alternative strip materials, such as stainless steel and aluminum alloys, is determined by component contamination. Two main effects are involved:

- (1) **Material transfer** and
- (2) **Corrosion cells.**

(1) Material transfer

Three factors combine to promote material transfer both from shot particle to component and vice versa. These are: (a) breakdown of the protective oxide skins of component and shot particle, (b) impact velocity and (c) generation of heat at the shot/component interface.

(a) All components are covered with a very brittle oxide skin. This is shown schematically in fig.3 together with a region AC that is about to be impacted by a shot particle. ABC represents the dent's curved surface. As the shot particle forces its way into the component, the circular area AC is replaced by the dent's curved surface ABC. The dent's curved surface area is larger than the original (prior to indentation) circular area. The following is a specimen calculation that indicates the ratio of areas. This calculation reveals that the curved surface area is some 16% greater than the circular area. Since the ductility of metal oxides is well below 1%, it follows that multiple fracturing must occur. This fracturing is illustrated schematically in fig.3 and pictorially in fig.4 (page 30).

Ratio of circular area and curved indent area for a given dent.

Let us assume that the length AC is 20 (arbitrary units), the depth, h, of the dent is 4. The area, A_c , of a circle is given by $A_c = \pi D^2/4$ - where D = diameter of the circular area. Hence, for this example, $A_c = 100\pi$. The area, A_d , of the dent's curved area (technically called a "spherical cap") is given by $A_d = \pi(D^2/4 + h^2)$. Hence, again for this example, $A_d = \pi(100 + 16)$ or $A_d = 116\pi$. A_d is therefore 16% larger than A_c .

At the instant of dent creation, the shot particle itself will suffer oxide skin breakdown.

(b) Shot particles impact components at a high velocity. Fracture of any brittle material occurs more readily at high velocities than it does at low velocities. A simple demonstration is what happens if a sheet of glass is struck violently with a hammer as compared to a low velocity blow.

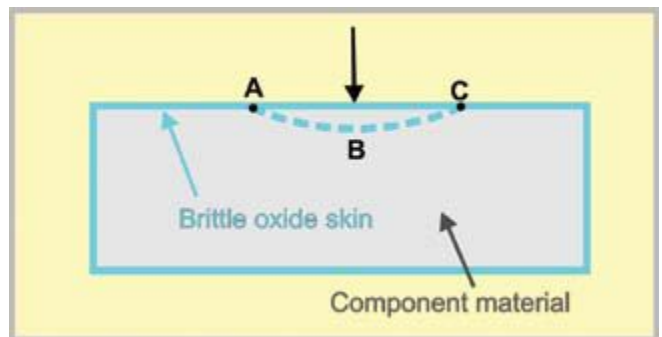


Fig.3. Brittle oxide skin about to be impacted by a shot particle.



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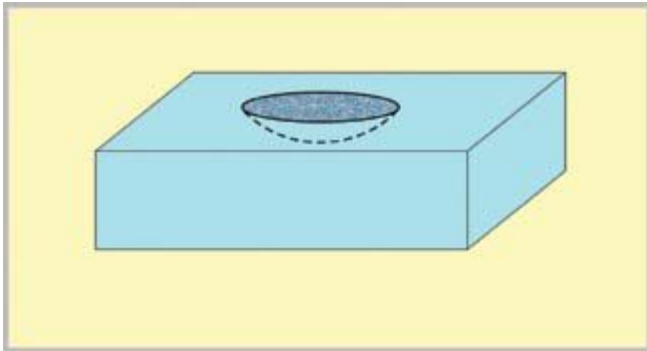


Fig. 4. Pictorial representation of fractured oxide skin at the instant of dent creation.

(c) High temperatures are generated at the particle/component interface. This is due to the work done when forming the dent.

The three factors described combine to generate almost perfect conditions for metal transfer. The first two factors would be sufficient to induce “cold welding,” aka “cold fusion.” Cold welding is a process in which joining takes place without melting being required. The two surfaces are “nascent” (free of any form of surface coating) and are pressed together. In this situation there is no way that the atoms can feel that they belong to two different pieces. Cold-welding conditions are generated, because of oxide fracturing, at huge numbers of places on the dent/shot interface.

Fig. 5 illustrates the cold-welding at a single place where two nascent surfaces of the same metal are pressed together. Two tiny fractions of a shot crystal and of a dent crystal are in contact along a line AB. The structure of the interface, indicated as a dotted line, is identical to that of a grain boundary. There is now no way for the atoms to know that they are in two different pieces of metal. Cold welding therefore becomes inevitable. It should be noted that each

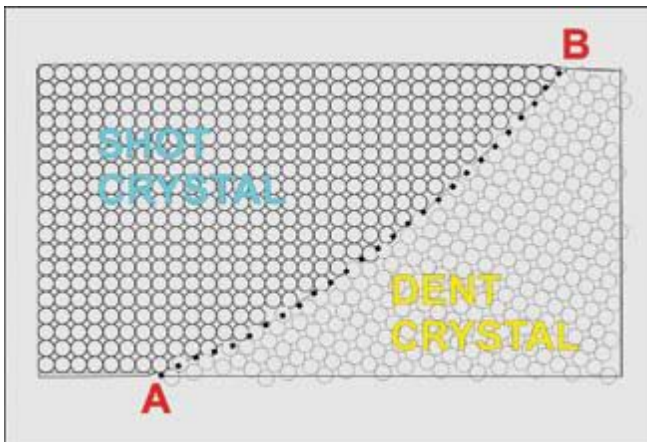


Fig. 5. Interface structure for two identical nascent surfaces in contact.

cold-welded area is minute. However vast numbers of these minute areas are produced as a dent is being produced. Because of relative movement (between the shot particle and the dent) each cold-welded area will be torn apart. That means that material will be transferred—either to the dent surface from the shot particle or from the dent surface to the shot particle.

Material transfer rates will depend on the relative compositions of component and shot. The highest rates will occur if the two are identical. The lowest rates will occur if they are completely different—such as ceramic beads being used topeen steel components. Intermediate rates would occur if, for example, a standard ferritic steel strip holder was used to hold stainless steel Almen strips. Best practice dictates that the strip holder should also be made from stainless steel.

(2) Corrosion cells

Corrosion is the bane of all metallic components and is, of course, an enormous subject in its own right. As a general rule, single-phase materials (such as fully-austenitic stainless steel) are more corrosion-resistant than multi-phase alloys. The individual phases in a multi-phase alloy have different “electrode potentials.” These phases can be ranked in what is called the “electrochemical series.” A phase that is higher in the electrochemical series will act as a cathode and induce anodic reactions in a phase that is lower in the series—hence promoting corrosion. The situation can be likened to the way that a battery operates.

One study of corrosion cell promotion during peening concerned different stainless steel compositions. This study (Kirk, D and Payne N J, “Transformations induced in austenitic stainless steels by shot peening,” ICSP 7, Warsaw, 1999, pp15-22) showed that there was a great difference between the behavior of 304 and 316 grades. For the 304 grade, peening transformed about 50% of the austenite into martensite—hence producing a two-phase structure that reduced corrosion resistance and also magnetized the steel. For the 316 grade, on the other hand, peening did not induce any transformation to martensite. Fig. 6 (page 32) is a schematic representation of the vastly-different behavior. After peening, 304 grade becomes a mixture of interlaced martensite needles (colored red) and untransformed austenite (colored blue). 316 grade, on the other hand, retains its single-phase structure.

One moral for peening intensity measurement equipment is that stainless steel strips and holders should be made from a non-transformable grade such as 316.

SHAPE

Traditionally, peening intensity measurements are carried out using three different thicknesses of rectangular strips. The different thicknesses are needed in order to accommodate the

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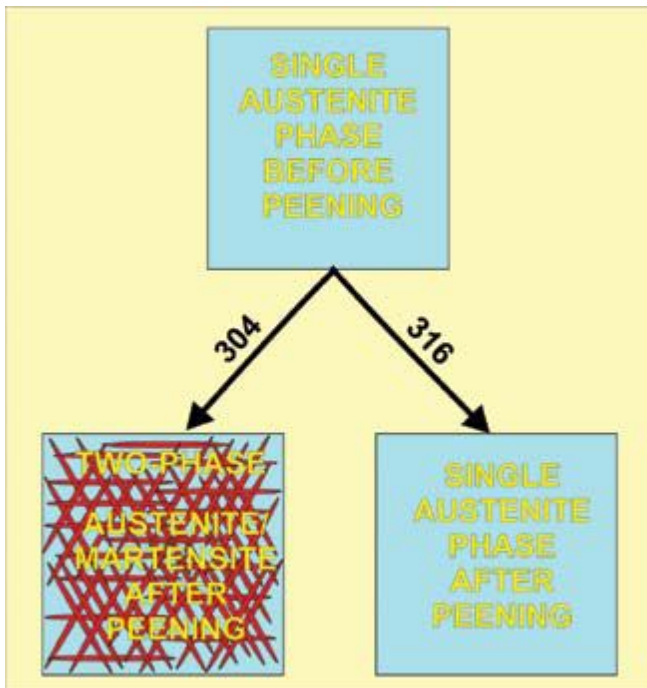


Fig.6. Differing effects of peening on phase structure of 304 and 316 stainless steels.

wide range of peening intensities that are currently employed. Smaller rectangles are manufactured for when intensities have to be measured in confined regions of components.

Circular discs were introduced in 1993 (Kirk, D, "Interactive Shot Peening Control", Proceedings of ICSP5, pp9-14). A linear variable displacement transformer (L.V.D.T.) was used that continuously monitored displacement as shot stream exposure time increased. Fig.7 is a schematic representation of the technique (being fig.4 of the quoted ICSP5 article).

A circular shape of test disc has the advantage that it corresponds to the circular cross-section of most air-blast shot streams.

Fig.8 is a schematic representation of a simplified version of that shown in fig.7. The simplification is to omit the L.V.D.T. This means that the curvature of the discs has to be measured after peening has been carried out—just as happens with the Almen strip technique. The arrangement shown in fig.8 could be employed if deflection was to be monitored using a series of discs, each peened for different times. With this very simple arrangement multiple holders could be jiggered around complex components more easily than when using conventional rectangular strip holders.

A feature of shot-peened rectangular Almen strips is that they adopt two different curvatures. The curvature in the longitudinal direction is different from that in the transverse direction. As an approximation, the longitudinal contribution to deflection is about twelve times that for the transverse contribution. That contrasts with the fact that the length of

an Almen strip is about four times greater than its width. Curvature is parabolic in both directions as opposed to being circular. A detailed discussion of Almen strip curvature was presented in 1999 (Kirk, D. and Hollyoak, R. "Factors affecting Almen Strip Curvature," Proceedings of ICSP7, pp 291-300).

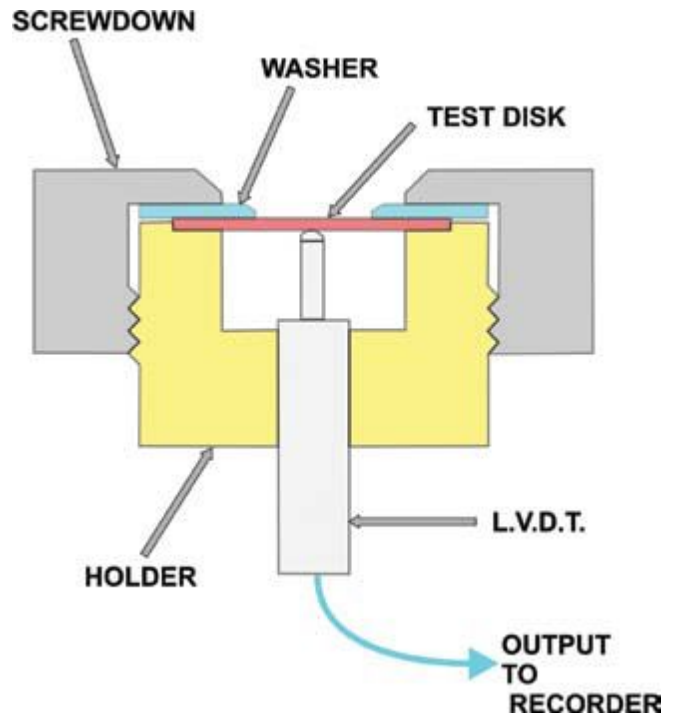


Fig.7. Circular test disc with L.V.T.D. monitoring.

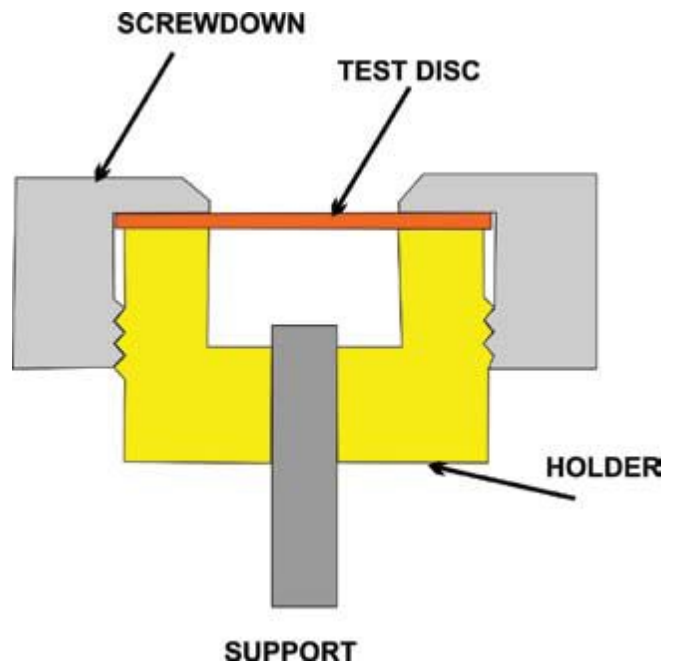


Fig.8. Circular test disc arrangement for intermittent peening.



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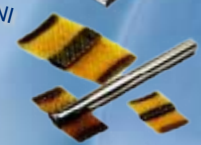
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For a circular test disc, the contribution to deflection will not be affected by direction.

DEFLECTION MONITORING

Peening intensity monitoring has, since 1942, been based on deflections of a set of Almen strips with each strip having been exposed to the shot stream for a different time. So-called “saturation curves” were fitted to the data points. A selected point on the saturation curve was chosen as representing the peening intensity value. This gave rise to terms such as the “10% rule” and the “20% rule.” Over a period approaching three-quarters of a century, there have been no fundamental changes to the technique. Major improvements have, of course, been made to instrumentation and to methods of saturation curve analysis.

One constant factor has been the employment of dial gages to monitor deflection. Analogue gages require an operator to be able to read the gage whereas digital gages display deflection directly. With the relentless march of technology, digital signals are more appropriate as they can now be linked directly to computers for intensity evaluation. A common alternative for accurate displacement measurement is the L.V.D.T. as illustrated in fig.7. J. O. Almen would not have had access to L.V.D.T.’s in 1942. That does not mean that we have to use his original dial-based system.

The use of strain gages in conjunction with interactive displacement monitoring was described at ICSP6 (Kirk, D. “Developments in interactive control of shot peening intensity”, pp 95-106). Although interesting as an academic experiment, strain gages are not a realistic alternative for industrial situations.

There is a fundamental, important, difference between rectangular strips and circular discs in terms of required relative movement. For rectangular strips, the shot stream is generally moved parallel to the major axis of the strip. That is necessary because the shot stream’s cross-section is normally smaller than the major axis length. SAE J443 requires that rectangular strips must have received uniform denting. Previous articles in this series have, however, pointed out that the coverage must vary. Hence denting cannot be precisely uniform. There is no mention of requiring that the axis of the shot stream has to coincide with the major axis of the Almen strip. Inevitably, a slight difference in strip curvature will be induced depending on the difference between the shot stream travel axis and the major axis of the strip.

Fig.9 illustrates axis displacements for a given shot stream. For A, the shot stream travel is co-axial with the major axis of the Almen strip (colored yellow). For B, the shot stream travel is offset from the major axis of the strip. The effect on strip curvature will depend on the diameter of the shot stream, the degree of offset and the variation of shot velocity across the shot stream.

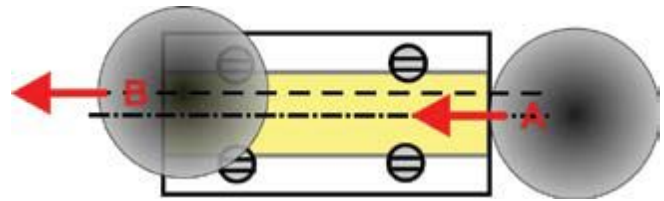


Fig.9. Co-axial and displaced shot stream travel along an Almen strip.

If circular test discs are being employed, there is no need for relative movement of shot stream and disc. For setting-up, an over-sized version of that shown in fig.8 could be employed to confirm axial coincidence of disc and shot stream centers.

CONCLUSIONS

Several variations on the Almen technique have been presented in this article. There is no doubt that the standard technique, based on sets of rectangular strips, is both robust and reliable. That does not mean, however, that there is no place for alternatives. The twin concepts of circular test discs and continuous monitoring do offer advantages in specific situations. Peening intensities can be measured in less than a tenth of the time needed for the conventional Almen technique. Since only one disc is involved, confirmation testing generates a complete saturation curve that can be compared with the original set-up curve. ●

FACTOIDS

The Top Ten Most Dangerous Jobs in the World
We’ve added commentary on the more surprising ones.

10. Truck drivers - *Long hours and massive vehicles put truck drivers on the list*
9. Stunt men/women
8. Sanitation workers - *Heavy materials and toxic or hazardous substances place sanitation workers at risk*
7. Firefighters
6. Miners
5. Loggers - *Falling timber, unpredictable wildlife, and chainsaws are risky enough; in addition, loggers often work in remote locations where help can be slow in coming*
4. Bush pilots - *Rough terrain and hostile weather make bush flying very dangerous*
3. Deep sea fishermen
The #1 most dangerous job in the United States
2. Landmine removers
1. Astronauts - *448 astronauts have gone into space as of April 2016; 34 have died. With a mortality rate of 7.5%, this profession is the most dangerous in the world.*

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Characterization of Residual Stress During the Manufacturing of One-Inch Steel Coil

Student Researchers: Brian Kadowaki, Andrea Love, Garrett Wass, Haojie Xie

Faculty Advisor: David Johnson • Industrial Sponsor: David Mix with United States Steel Corporation

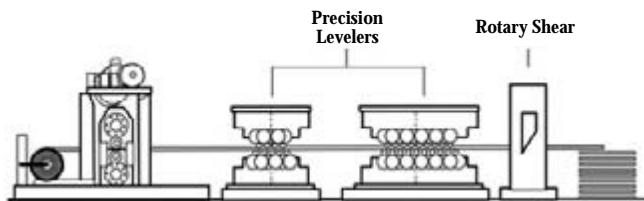
TO CREATE STRUCTURAL COMPONENTS for boom cranes, steel manufacturers need the capability to process one-inch steel coil. Residual stresses present in thick steel coil are due to the larger amounts of constraining material. When the coil is leveled and laser cut into parts, material under residual stress can become unconstrained and warp. Warped steel parts cannot be sold and will damage laser cutting equipment. The manufacturing process was analyzed to locate the cause of residual stresses and investigate residual stress testing methods.

The following is an adaptation of the students' research poster.

Project Background

Grade 50 steel is a high strength low alloy steel. Due to the high yield strength, it is typically used for structural components, trucks, cars, cranes, or roller coasters. Grade 50 steel coils manufactured at U.S. Steel are sent to a company called Steel Warehouse in South Bend, Indiana where they are further processed.

At Steel Warehouse, the coil is sent through a temper mill and then is leveled. After leveling, the now flat steel is sheared into sheets. The crane parts are cut from the sheets with a laser.



Schematic showing an overview of the leveling and tempering process similar to process used at Steel Warehouse.

Goal

The goal of the project is to identify the root causes of the residual stresses manifesting in the Grade 50 1" gauge steel coil and investigate testing to detect warping before laser cutting.

Process Analysis

Thermal relaxation of residual stresses affects the coil after it

has been quenched. The Zener-Wert-Avrami (ZWA) equation estimates a normalized quantity of residual stress remaining after a heat treatment of temperature T_a and duration of time t_a .

$$\frac{\sigma_{T,t}^{RS}}{\sigma_{293K}^{RS}} = \exp\left(-\left(C \exp\left(\frac{\Delta H}{kT_a}\right) t_a\right)^m\right)$$

$$\sum_{i=0hr}^{8hr} \frac{\sigma_{T(i), 1hr}^{RS}}{\sigma_{273K}^{RS}} = 0.0214$$

ΔH = activation energy for stress relaxation*

k = Boltzmann Constant

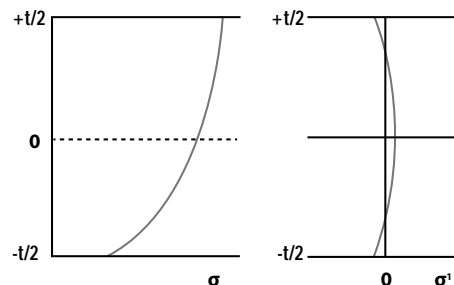
C = material-based constant*

m = process-based constant*

* calculated with experimental values from similar steels

Zener-Wert-Avrami equation with definition of terms. Knowing the coil's initial temperature and cooling rate (T_a), the ZWA equation was used to calculate 2.14% remaining residual stresses after 8 one hour iterations ($t_a=1$ hr). Nikitin, I., & Besel, M. (n.d.). Residual stress relaxation of deep-rolled austenitic steel. Scripta Materialia, 239-242.

As the steel is uncoiled, a reduction in thickness adds a 1-2% strain along the rolling direction during a tempering pass. This process uses superimposed tension to eliminate residual stress. This is done by pulling the coil in tension to eliminate the neutral axis in the plate.



(Left) stress distribution for bending after super-imposed tension. (Right) Residual stress after super-imposed tension.



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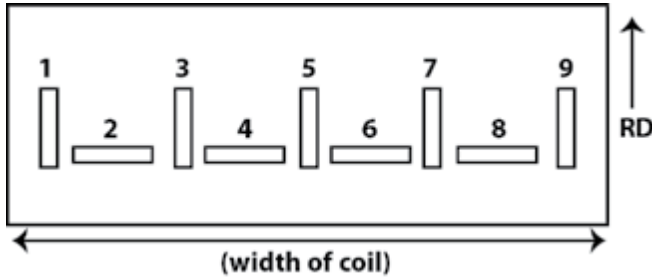
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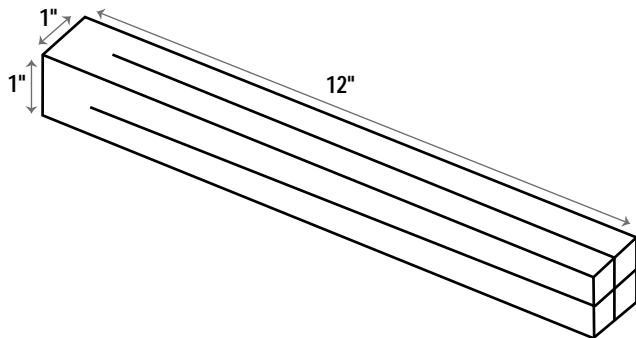
Experimental Procedure

Steel Warehouse has devised a residual stress test called the McNally test. 1" x 1" x 12" samples are cut in both the transverse and rolling directions. The samples labeled with odd numbers are oriented in the rolling direction, and the even labeled samples are oriented in the transverse direction.



View of steel coil showing the position of the cuts used in the McNally Test.

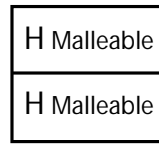
The sample bar is cut through the thickness and width to measure deflection. An observation in deflection signifies a release of residual stresses. Little vertical deflection was observed and most was in the horizontal plane.



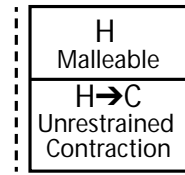
Dimensions of the McNally Test bar. Darker lines signify location of cuts.

Steel Warehouse uses the McNally test's deflection as a means of detecting residual stress rather than measuring it. Experiments were performed in order to use the deflection of the McNally test to calculate residual stress in a sample. First, residual stresses needed to be imparted to test samples in a known amount through a controlled experiment. The selected method involved heating a 1"x1"x12" sample bar in a furnace to a known temperature. When the bar was fully heated, it was removed from the furnace, and one of the 1"x12" faces was placed in a shallow pool of water for a known time. The cooling from this face introduced a thermal gradient in the bar, which imparted residual stress to the sample through means of thermal expansion and contraction. Thermocouples were used to measure the temperature gradient as the bar cooled. When the bar was fully cooled, it was cut as if it were a McNally test bar, parallel to the plane of the cooled surface.

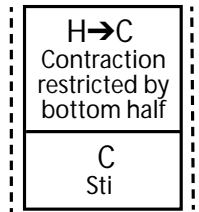
I.



II.



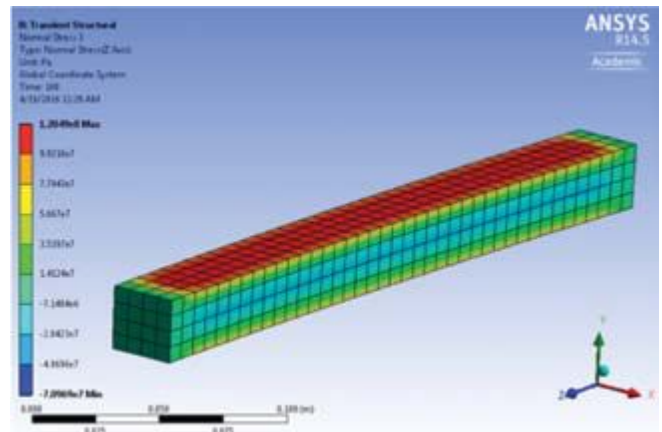
III.



Stages of imparting a material with residual stress by use of a temperature gradient. A sample begins with both sections hot (H). When the bottom section is cooled (C), it undergoes thermal contraction and pulls the malleable hot upper section with it. When the upper section cools later, it contracts and is resisted by the cold stiff bottom section, placing the material into a residual stress state of compression in the lower section and tension in the upper section.

Simulations

Using the ANSYS finite element modeling software, and transient temperature data obtained from the thermocouples, simulations modeling the cooling experiments were performed to obtain residual stress profiles through the sample.



ANSYS simulation of sample bar heated to 500°C and cooled on bottom face constantly at 100°C to induce residual stress.

Results and Discussion

Residual stress was calculated based on the deflection data from Steel Warehouse using the equation below. This equation was derived from the bending moment model.

$$\sigma = \frac{3Etd}{4L^2} \quad [1]$$

= Residual Stress
E = Young Modulus
d = deflection
L = cut length
t = thickness of the testing bar

The data from the McNally Test at Steel Warehouse is analyzed. Tukey's range test is done to check the statistical significance of residual stress at the different positions along



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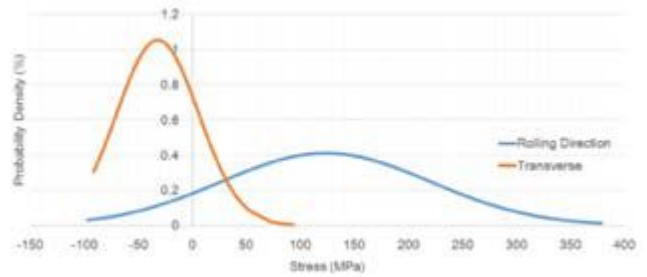
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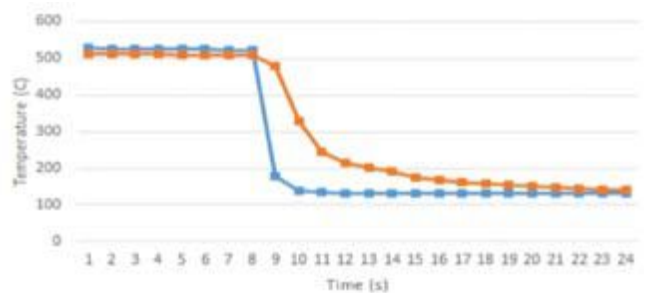
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Normal distribution of residual stress along the rolling (orange) and transverse (blue) direction. Stress in rolling direction is greater than in the transverse direction on average.



Cooling data for sample in one sided cooling test at 600°C.

the both transverse and longitudinal direction. A normal distribution of data is approximated to check stress different along the two directions. Though there is no statistical stress difference of sample bars along the same direction, the stress in transverse is much different from the rolling direction.

TABLE 1. Residual stress amounts were measured by slitting samples in half lengthwise. Equation 1 (page 38) gave the residual stress. Negative values for lengths indicate an inward deflection.

Heating Temp (°C)	Top Deflection (mm)	Bottom Deflection (mm)	t (mm)	E (Pa)	L (mm)	Top Stress (MPa)	Top Stress (psi)	Bottom Stress (MPa)	Heating Temp (°C)
200	0	0	24.71	2×10^{11}	159	0	0	0	0
300	-0.011	-0.0086	26.06			-1.9	-268.4	-1.9	-268.4
400	-0.13	-0.095	25.12			-19.6	-2846.3	-19.6	-2846.3
500	-0.18	-0.14	25.93			29.5	-4273.6	-29.5	-4273.6
600	-0.72	-0.54	26.44			-118.3	-17158.3	-118.3	-17158.3

Recommendations

A large contribution to the residual stresses causing warping can be attributed to the temper pass. The statistical analysis shows that multiple test specimens from the same orientation are not necessary. Therefore, the number of test samples can be reduced to decrease the duration of testing. ●

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Amusement Park Ride Prompts Finishing Process Concept

WALTHER TROWAL developed the new M-TMD drag finisher line for processing work pieces requiring perfect surface finishes. The work pieces, mounted to rotating satellite stations, undergo multiple overlapping, pre-programmed, rotational movements. This rotational variation produces optimum finishing results.

Typical work piece examples from the medical engineering industry are hip and knee implants requiring a high gloss polish. In the aerospace industry, turbine blades and other components must receive a first-class finish with precise edge radiusing and very smooth surfaces. Examples from the automotive industry include the vanes of turbochargers, which must not be nicked or damaged during the finishing process.

Christoph Cruse, General Sales Manager at Walther Trowal, foresees a big demand from those customers. "With our new equipment line, we address precision component manufacturers who want perfect surface finishes, and where any blemishes like scratches could require scrapping a part. We also target manufacturers demanding tolerances of just a few microns. For these work pieces the M-TMD drag finishers with their optimum flow characteristics open entirely new possibilities," he said.

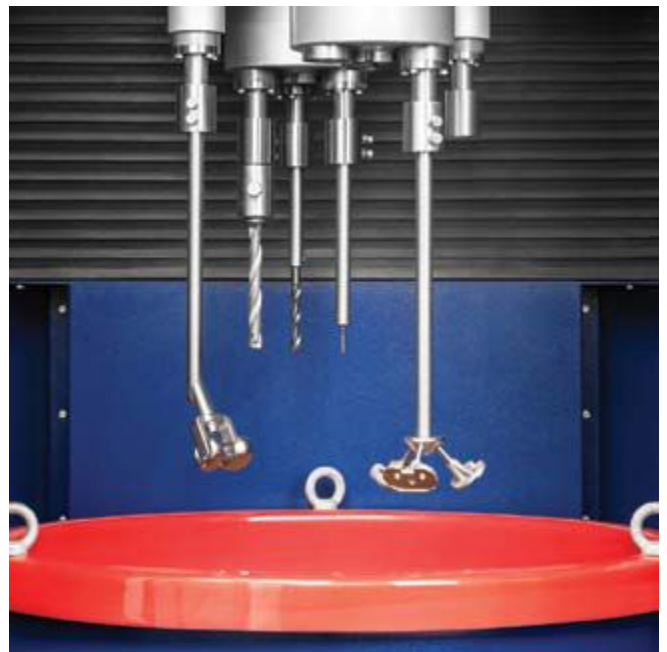
A rotation within the rotation is the functional principle. In standard drag finishers, the work pieces are mounted to rotating work stations and "dragged" through the grinding or polishing media. This movement creates a high processing intensity and produces excellent results on many parts.

The work stations consist of multi-spindle heads with each spindle holding one work piece. In addition to the carousel and work station rotation, each spindle has its own rotational movement. In other words: The spindles move in a circle within two larger circles formed by the carousel and work station rotation. This is similar to the movement of the cabins in "Octopus" rides that can be found in amusement parks.

The drag finisher M-TMD 4 is equipped with four multi-spindle heads (work stations) with each head containing three spindles. Six to 18 work pieces can be processed at the same time. The independently adjustable rotational speed and rotational direction of the spindle heads and spindles creates a wide range of different movement patterns. In addition, the spindle heads can be tilted in different angles. This allows adjusting the flow characteristics to the specific shape of the



The cabins in "Octopus" rides that can be found at any amusement park inspired the movement of the spindles in the new M-TMD drag finisher line.



The multi-spindle heads allow up to 18 parts. Different parts were mounted onto one spindle head in this photo.

INDUSTRY NEWS

various work pieces. Multi-stage processing programs can be easily implemented with the PLC controller.

The work bowl is vibrating for the optimum mixing of the grinding or polishing media during the final processing. This guarantees a high degree of process consistency. The media fines and undersize media, along with the metal fines from the work pieces, are continuously discharged from the machine. This is another contribution towards process stability and consistency.

The new Trowal machines can be operated in wet as well as dry processing mode. For surface grinding and smoothing, as well as for certain polishing operations, compounds and water are used. In the case of targeted edge radiusing with tolerances of a few micron, for example, hard metal drill bits and milling heads, a dry process with special grinding granulate is utilized. Dry processing with organic polishing media and paste is also suitable for high gloss polishing.

Multiple finishing steps, from pre-grinding all the way to the final polishing stage, takes in one single machine without the need to remove and remount the work pieces to the work stations: One work bowl filled with a certain finishing media can be easily and quickly removed with a pallet truck and replaced with a bowl containing another media.

The first unit of the new machine generation has been installed in the Walther Trowal test lab in Haan/Germany. It is available for processing trials with customer work pieces allowing the customers to prove their finishing process before making an investment decision. This ensures that the customer specifications can be fully met. Once the trials have yielded a viable process, the work piece range and quantity is analyzed to determine machine type and size, media and compound type, process water treatment system and drying method. For more information, contact Meik Seidler at +49 2129.571-204 or m.seidler@walther-trowal.de.



Work bowls containing different media types can be easily and quickly exchanged with a pallet truck.










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Pangborn Group Selects New President

ROGER STONECIPHER is the new president of the Pangborn Group, according to an announcement made by the company earlier this year.

As President, Stonecipher will have responsibility for the company's operating units worldwide. He will report directly to Doug Basler, Chairman of United Generations, LLC, the family-owned holding company of The Pangborn Group.

Stonecipher, 52, is a 29-year veteran of the manufacturing industry. He ran various global divisions of Tyco Electronics over a 21-year career, and went on to become CEO of two other companies. Roger was most recently Executive Vice President of Zeus Industrial Products, Inc., a family-owned global supplier of industrial fluoropolymers, located in Orangeburg, South Carolina.

"Roger is an accomplished leader with a successful track record of running global manufacturing organizations," said Doug Basler, Chairman of UG, LLC. "He brings a great mix of leadership, financial know-how, operations and product management experience, as well as, sales and marketing talent to his new position at the Pangborn Group. Roger has the unique experience of running both a family-owned business, as well as a publicly-traded business, and understands there can be differences. Roger is also very personable and we feel is a great fit for our family culture."

"I couldn't be more excited about joining the Pangborn Group," said Stonecipher. "Not many companies have been around since 1873. Obviously, they have been doing something right, by providing customers with reliable and innovative surface preparation solutions globally. I'm honored and grateful to Doug and the United Generations team for this opportunity to lead this exceptional group of talented professionals. I look forward to continuing the tradition of taking care of our customers in each of our regions, while driving one global Pangborn team."

About the Pangborn Group

The Pangborn Group designs, manufactures and services shot blast and surface preparation machines and related products for a range of industries, including foundry and forge, metalworking and descaling, automotive and heavy truck, ship and rail, defense and energy.

The company has led the way in all aspects of the surface preparation industry with unique designs, heavy-duty applications, and best-in-class service and support.

For more information about the Pangborn Group, please visit www.pangborngroup.com. ●



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