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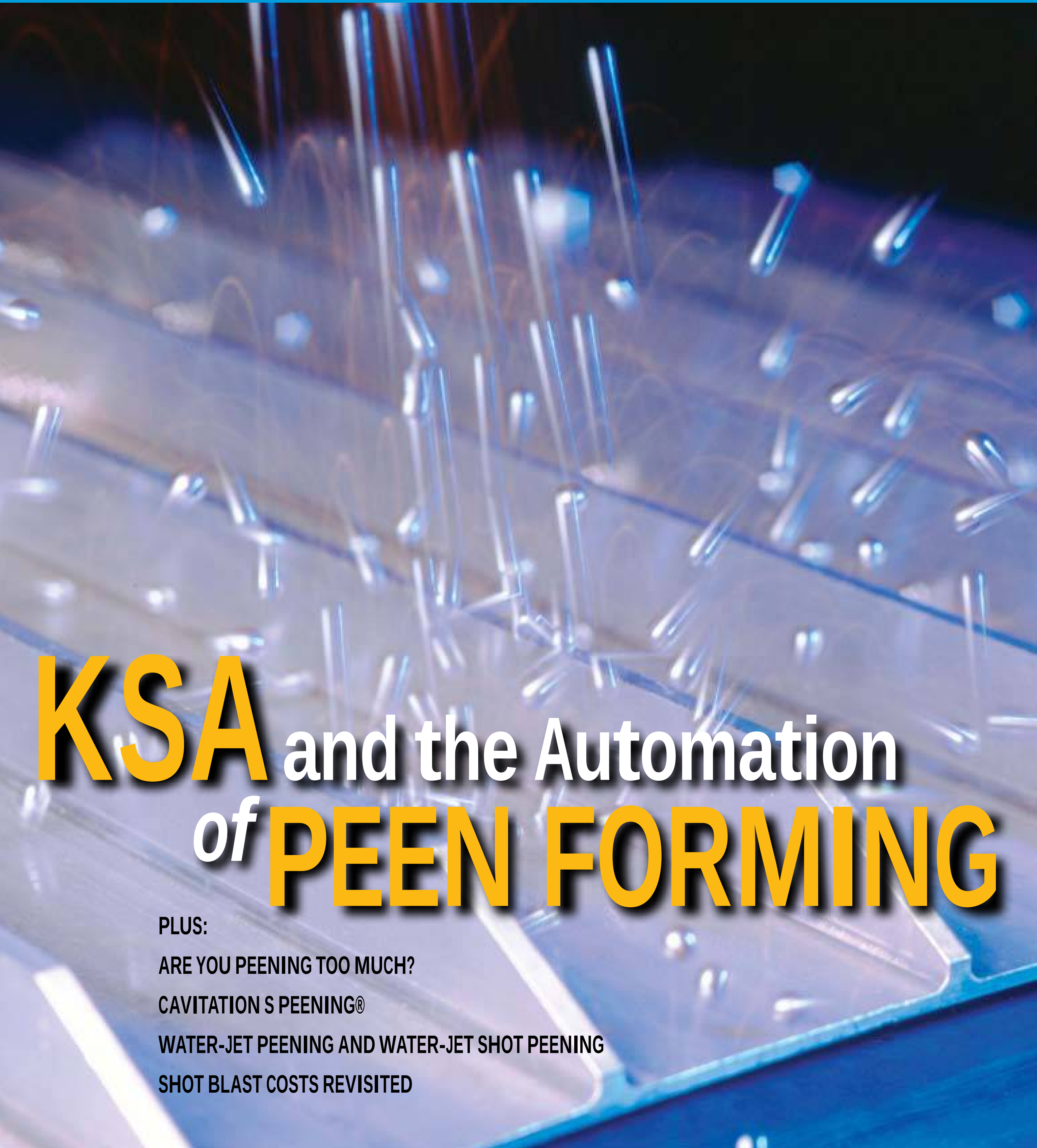
The Shot Peener

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



KSA and the Automation of PEEN FORMING

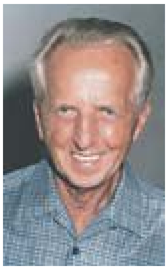
PLUS:

ARE YOU PEENING TOO MUCH?

CAVITATION S PEENING®

WATER-JET PEENING AND WATER-JET SHOT PEENING

SHOT BLAST COSTS REVISITED



Industry News

THE SHOT PEENER

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

Exploring Special Applications

THE SHOT PEENER is covering an important resource in the shot peener's toolbox: **water**. The unique benefits of water are put to good use in Cavitation Peening, Water-Jet Peening and Water-Jet Shot Peening. Two experts in these fields are sharing their knowledge with us in *The Shot Peener.* We're also covering Automated Peen Forming and many more topics of value.

JACK CHAMPAIGNE

Cavitation S Peening®
Hitoshi Soyama, a Professor at Tohoku University in Japan, gave a presentation on Cavitation Peening at the last SAE Surface Enhancement Committee and Aerospace Materials Engineering Committee meeting. This is a fascinating technique that imparts a deep compressive stress by injecting high pressure water streams in water. I was so impressed with Professor Soyama's research that I asked him to share his work with us. See page 16 for a thorough explanation of the process and its benefits.

Water-Jet Peening and Water-Jet Shot Peening
Dr. David Kirk writes in the opening of his article: "Water-jet peening and water-jet shot peening have the common feature of employing a jet of water. There are, however, important differences between the two processes." Dr. Kirk then proceeds with thorough and easy-to-understand research that explains the differences. See page 22 to see why Dr. Kirk's articles are so popular.

Another Special Application: Automated Peening Forming
Shot peen forming isn't used to increase fatigue strength—it takes advantage of the transfer of kinetic energy from the shot media to the component to generate material flow in all directions. This material flow and the residual stresses induced by peen forming create a permanent curvature of the component. Peen forming is frequently used in the aerospace industry to form large panels such as wing skins and fuselage shells.

KSA Kugelstrahlzentrum Aachen GmbH is a leader in peening forming and the company first automated its re-shaping process successfully at Airbus in 2003. More recently, KSA applied its Automated Peen Re-shaping (APR) to a wide range of complex structural components for a leading European manufacturer of aircraft parts. Dr. Carolyn Kenny with KSA is the author of "Shaping Parts with Shot Peening Forming" on page 6.

Even the Basics Deserve Special Attention
As our readers know, we think every aspect of shot peening (and blast cleaning) deserve attention. That's why we're especially appreciative of Dr. John Cammett's article on coverage and Erwan Henry's review of shot blasting costs and his "sure recipe to reduce your costs."

We hope you enjoy the magazine. Please email me with comments or suggestions for subjects you would like covered in *The Shot Peener*. (jack.champaigne@electronics-inc.com)

THE SHOT PEENER

Editor
Jack Champaigne

Associate Editor
Kathy Levy

Publisher
Electronics Inc.

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Dr. Carolyn Kenny | Executive Assistant | KSA Kugelstrahlzentrum Aachen GmbH

Shaping Parts with Shot Peen Forming

AS IS WELL KNOWN to *The Shot Peener* readers, shot peening is widely used in the aerospace and automotive industries as a process for improving fatigue resistance. The compressive residual stresses induced in the cross-section of the component and the hardening of the surface layer of the material strengthens its resistance to cracks or corrosion.

Shot peen forming can be regarded as a specialized application of shot peening. Rather than focusing on increased fatigue strength, shot peen forming makes use of the fact that the transfer of kinetic energy from the shot media to the component generates material flow in all directions. From a certain peening intensity onwards, this material flow and the residual stresses induced by peen forming result in a permanent curvature of the component due to the balance of forces and movements induced in the part. The objective of shot peen forming is to control this change and to form the component into a previously defined curvature.

If only a small percentage of the component's cross-section is "plastified" by the shot media, the material flow and residual stresses result in a convex curvature. If the cross-section is plastified as far as the centre, the result is merely a stretching of the part. The part then "grows" without any curvature. If the kinetic energy of the shot is increased to such an extent that the part is plastified throughout its cross-section, the result is a concave curvature.

Intensity, peening time and pre-stressing are the three most significant control values of peen forming. Further important peening parameters include shot type, size and velocity and, of course, shot coverage. The properties of the component to be peened obviously also play a significant role. These include factors such as material hardness and thickness, thickened edges with transitions, the presence or absence of integral stringers and residual stresses induced in the part by machining.

Successful peen forming requires extensive knowledge of the interaction of all these variables as well as expertise on material flow and behaviour. Too great a shot velocity, for example, can result in irreparable damage to the piece. Peening which does not take sufficient account of the variations in the growth and stretching of the metal due to various thicknesses can induce non-correctable waves or bulges in the component. Because principles of both plasticity and elasticity play a role in determining how the part will change shape, shot peen forming is particularly difficult to predict and control.

Generally, peen forming is carried out on a manual or semi-automated basis by skilled technicians whose experience and know-how enables them to predict the growth factor of the component in question. In the case of new parts, a small number of attempts at achieving the required result may be

Peen forming of a tank bulkhead segment for Ariane 5.

KSA's peen forming processes are fully automated.

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necessary before an accurate prediction of the component's behaviour can be made and the peen forming process can be "frozen."

Peen forming is frequently used in the aerospace industry to form large panels such as wing skins and fuselage shells. While the complexity of the process means that it is extremely difficult to automate, this is not impossible. In fact, KSA Kugelstrahlzentrum Aachen GmbH of Germany succeeded in introducing Automated Peen Forming (APF) for parts for the Ariane 5 space launcher more than two decades ago, including spherical tank bulkhead segments as well as cylindrical and conical panels. More recently, KSA successfully used APF to peen form elliptical panels and even orthogrid structures. (In an orthogrid panel, the stringers run at right angles to each other, making these panels a huge challenge to peen form as the stiffeners resist the material flow in both directions.)

Thousands of parts have been produced for Ariane to date using this fully automated, "frozen" closed-loop process and KSA expects to continue to implement this successful peen forming technology in ambitious launcher programmes in the future.

Shot Peen Re-Shaping

The correction of distortions which have occurred due to residual stresses induced in the material during an earlier process such as milling or welding is a further application of peen forming. This corrective process is often described as shot peen straightening or rectification. A combination of relaxation peening and high-precision peen forming is required to "re-shape" the distorted part and to bring it to within its defined tolerance range. With increasingly strict specifications in aircraft manufacturing and the introduction of new, more complex designs and materials, this process has become more relevant than ever.

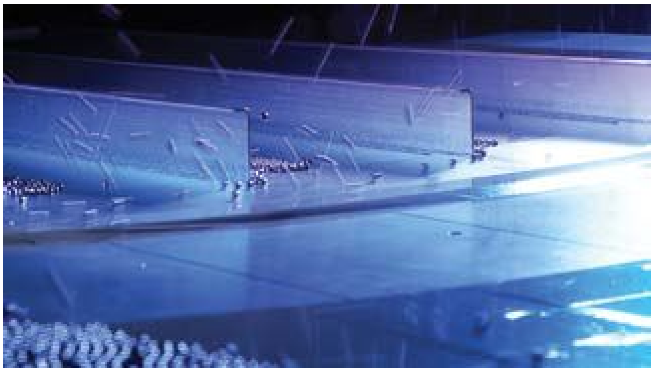
As in all peen forming, the process involves the application of both plasticity and elasticity principles and is therefore particularly challenging. KSA first automated its re-shaping process successfully at Airbus in 2003 with the introduction of an integrated on-site machine for re-shaping laser-beam-welded fuselage shells for a wide range of aircraft. A key customer requirement was to eliminate all manual intervention from peen forming and to implement it as a state-of-the-art process. As the focus was on achieving a previously defined final curvature in a fully automated controlled process, the term "re-shaping" rather than straightening or rectification was used.

More recently, KSA has applied its Automated Peen Re-shaping (APR) to a wide range of complex structural components for a leading European manufacturer of aircraft parts. These include ribs, spars, beams and frames. In each case, an individual peening "recipe" has been developed for the part in question and the corresponding software written. The initial investment in process development has had a disproportionately high pay-off in terms of reduced throughput times, excellent results and process reliability. A further advantage is that the APR software generates the required compliance documentation for the components automatically. Thousands of components have now been re-shaped automatically by KSA in accordance with the quality standard QSF-A. This is proof that APR is an excellent alternative to manual rectification.

Future Potential

Process automation is especially valuable where large numbers of components of the same geometry need to be formed. Repeatability, reliability and consistently high quality then become absolutely essential. While fully automated peen forming is not widely used in the aerospace industry today, there is obviously huge potential here; for example, in the peen forming of wing panels. Considering the constant drive to reduce costs and to use resources as efficiently as possible in today's competitive manufacturing environment, more widespread application of this fully automated industrialized process would surely be a useful development.

Automated peen re-shaping of a fueslage shell.



KSA creates individual peen forming "recipes." The recipes and software can be developed off-line if required and subsequently transferred to the customer's site for series production.

John Cammett | Consultant, Nadcap Auditor, EI Shot Peening Training Lead Instructor

Are You Peening Too Much?

INTRODUCTION

The title of this article does not refer to the amount of peening business you are doing nor does it represent inquiry into how many parts you are peening by way of manufacturing or repair. Rather, the purpose of this article is to consider the subject of peening coverage and to consider how much coverage should be employed when peening is being done for the most common legitimate purposes including fatigue life and fatigue strength enhancement, stress corrosion resistance, and weight reduction as a result of strength enhancement achieved. It is recognized that peening nearly always conveys some benefit. One should recognize, however, that the amount of the benefit may well be determined by how the peening is performed. In addition to coverage, this likely will include considerations for intensity and for media selection and maintenance. Only the matter of coverage is treated in this article, leaving plenty of room for others to investigate other factors and parameters. The author's argument for taking up the subject of coverage is the probability that this factor represents the greatest opportunity for improving the peening process.

If you decide to read on, please do so with the understanding that it will not be possible for the author to give you recipes for peening or even to state what you must do in given circumstances. The author's thesis herein is that, in terms of coverage, generally too much peening is being done with resulting detriment to cost, equipment wear and tear, cycle time and even to part quality and durability. But the arguments come later in the article. For now, suffice to say that the author intends to briefly review principles of coverage, to consider the importance of attaining correct coverage and to present arguments and data for generally reducing coverage. The author is not so naïve as to expect that the result of this article will find many individuals or organizations ready to put concepts advanced herein into practice. Indeed if you are a peening source, you must follow specifications and directives of your customers including producing required coverage values. If you are a prime or a part manufacturer, then altering coverage requirements may require part requalification and this may be a significant financial barrier. Not the least of requirements is that considerable experimentation may be required to allow changing coverage requirements. If, at least, this article causes a few of you to consider the benefits of reduction in peening coverage and perhaps even to take some action, then the author will be gratified accordingly. If some of you at least will agree that this article has validity, then the author will likewise be pleased.

COVERAGE – SOME BASIC CONCEPTS AND TERMINOLOGY

This is a digression from the main thrust of this article, but is included for two purposes:

- provide background to readers not intimately familiar with the concept of peening coverage
- attempt to get all readers "on the same page"

First and foremost, in this article the use of the term coverage always implies uniformity, meaning that the impact sites are uniformly and randomly distributed over the peened surface area. Shown in Figure 1 are two examples of peening coverage, 1 (a) partial coverage and 1(b) complete coverage.[1] Coverage up to 100% is defined as the percentage of area exhibiting impact dents as a percentage of the total area being considered. Per SAE J2277 full (also "complete") coverage is defined as 98-100% coverage. Coverage is considered as complete at 98% because of the difficulty in resolving small non-impacted areas and the subjectivity of coverage inspection by the usual method per SAE J2277 of optically aided observation at 10-30X. Partial coverage thereby is any coverage value less than 98%. Rationale for the acceptability of allowing at least some un-impacted areas will be presented later in this article. Clearly, if one is attempting to achieve full coverage, more peening exposure will be required to make the partially covered surface resemble the fully covered surface in Figure 1. It is very important to realize is that coverage is a time-dependent quantity. It increases with exposure time. Very often peening specifications or directives call for coverage at 150%, 200% or other value greater than 100%. Coverage greater than 100% is defined as that which results from peening at a multiple of the time required to achieve full coverage: 1.5x for 150%, 2.0x for 200% and so forth. One cannot visually inspect for coverage greater than 100% because the surface appearance does not detectably change at greater than 100% coverage. Thus, we cannot truly ascertain

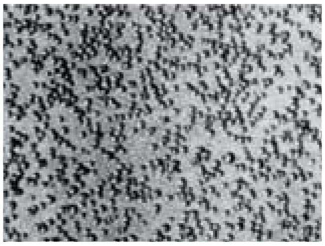


Figure 1a. Partial Coverage

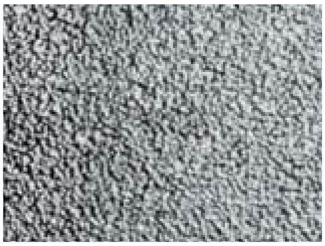


Figure 1b. Complete Coverage

the coverage associated with 1(b) unless we have determined it by observation and know that we did not exceed 100%.

Figure 2 is an exemplary graphic display, called a coverage curve, representing the progression of coverage with time of exposure in the peening process. It is determined by exposing an article or articles to peening under given parameters for various times and then determining coverage values associated with each time by observation. Let it suffice to say that no information for a coverage curve representing peening of a part or sample comes from any observations of Almen strips. Indeed, one should have no quantitative concern for Almen strip coverage except to note that it is uniform.

Referring back to Figure 2, the Y-axis is % coverage as determined by observation of the peened surface at various times and, indeed, this is the only valid means for determining coverage. Any attempt to relate coverage to exposure times or saturation time is invalid unless, perhaps, the part material is the same at the same hardness as the Almen strip which is cold-rolled SAE 1070 steel heat treated to 44-50 HRC hardness (45-48 HRC for premium strips, all the better). Again referring to Figure 2, note that the coverage initially increases relatively rapidly with exposure time and then more slowly as time progresses. In this example, it took two minutes to achieve 86% coverage and then another two minutes to achieve the additional 12% to attain full (98%) coverage.

In other words, the rate of coverage slowed as time of exposure increased though the amount of coverage continued to increase albeit quite slowly as 98% was approached. The basic reason for this is that the peening impacts occur uniformly with time (assuming constant media flow rate); however, they occur randomly over the peened surface such that some impact sites are repeatedly struck until at least 98% have been struck once.

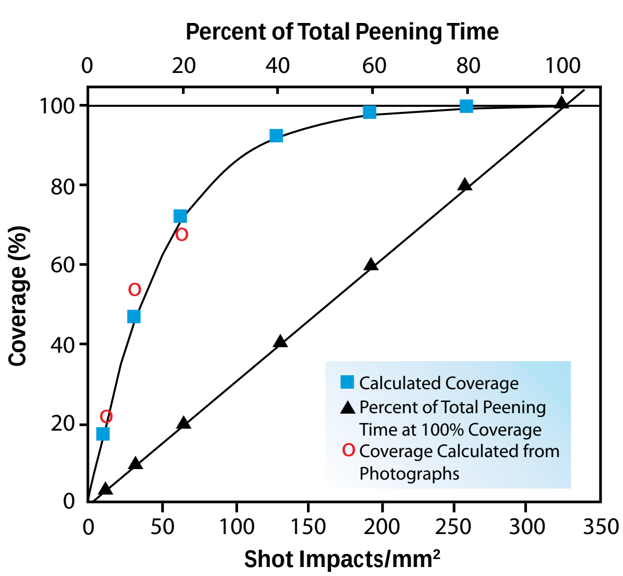


Figure 2. Exemplary Coverage Curve

AMOUNT OF COVERAGE MATTERS

The author has heard verbal expressions to the effect that coverage does not really matter so long as there is enough. It is doubtful that any of the individuals expressing such a view have a real basis for it or have ever tested it. Certainly, not much on the subject appears in the literature. Exceptions are offered here by way of Figures 3, 4 and 5. Figure 3 is a series of crack growth curves obtained after peening to different amounts of coverage. As can be seen, specimen life increased with increasing coverage from 0%, to full coverage. Unfortunately, data for peening to greater than 100% coverage were not developed or presented. Figure 4 from a 1981 paper by Horwath shows fatigue strength in 1070 steel at 45-48 HRC as a function of a parameter that includes peening time and number of impacts[1]. Though not directly in terms of coverage, this parameter implies it. Note that fatigue strength first increases with coverage, reaches a peak and then falls off

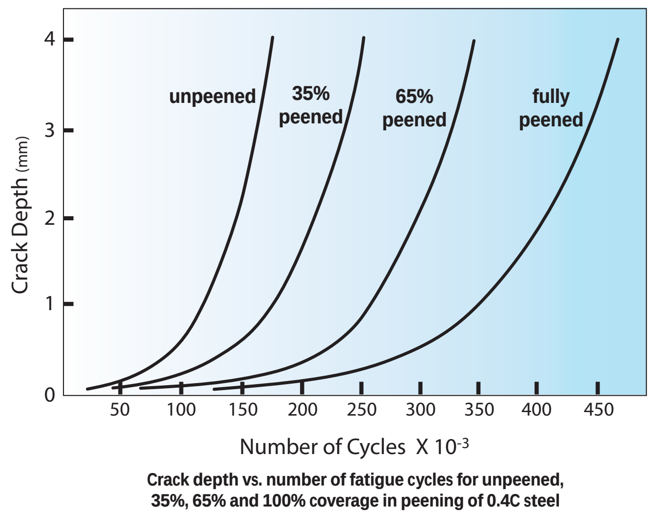


Figure 3. Crack Growth Curves Related to Coverage

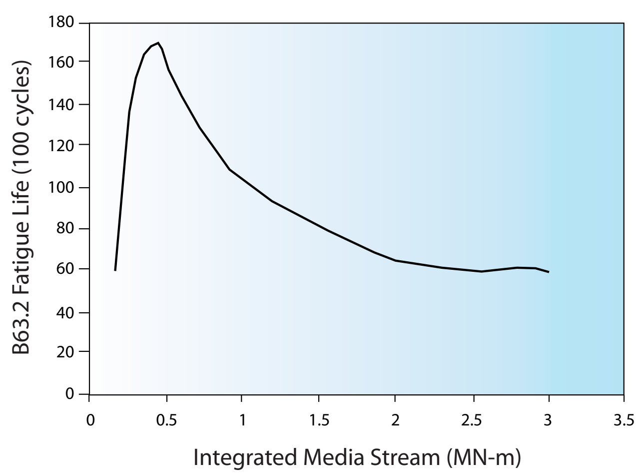


Figure 4. Fatigue Strength Related to Integrated Media Stream Energy Parameter that Relates to Coverage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- Miscellaneous Items
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- Almen Gage
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- Almen Strips
Empty Weight of 21 lbs. (9.5 Kg) Fully Loaded Weight of 27 lbs. (12.3 Kg)
Emergency Off Button
Small and Comfortable Handpiece Grinder
ON/OFF Button
Grinder Cord of 25 ft. (7.7m)
USB Memory Key Slot to Record Process Parameters
Locking Military Type Connectors
Large 5.7 in. (145mm) QVGA Color Display with Robust Touch Screen Interface
Integrated Saturation Curve Solver Software
Flapspeed PRO

as peening coverage increases further. Consideration of these data overall strongly supports a thesis that coverage matters. Unfortunately it does not directly indicate what is an optimum coverage level. Having considered such information, in 2002 the author and Prevey performed a coverage study on AISI 4340 steel, 49 HRC and published results in the ICSP 8.[2] This study revealed that the optimum coverage level for peening at 9A intensity was about 80%. Indeed fatigue results presented in Figure 5 revealed that the full benefit of peening was realized at 80% coverage and that coverage at greater than 100% resulted in decreased fatigue strength.

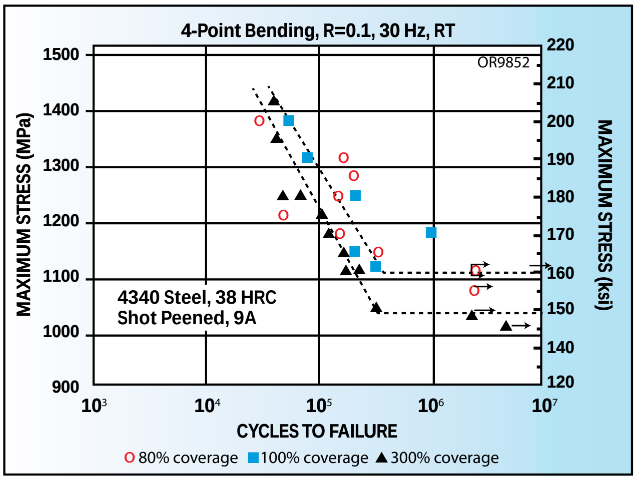

Figure 5. Fatigue Strength as Related to Coverage (80% and 100% upper curve, 300% lower curve)

The author is not advocating performing peening to less than full coverage because of issues regarding subjectivity of peening coverage determination as well as possible peening control. Similar results in later work on Inconel alloy 718 were much the same. The results of these studies, however, do present a compelling case that peening coverage does matter and that peening coverage should not exceed full coverage. Coverage by a few percent less than 98% probably would not present a problem.

So what is it about coverage in excess of full coverage that results in reduction of fatigue strength? The logical and experimental evidence point to the fact that peening creates surface defects such as folds and laps caused by overlapping of peening dents, as well as micro-cracks in some instances. The population of such defects increases as coverage increases and the defects produced are the initiation sites for fatigue cracks. Fatigue cracks emanating from such defects in overpeened (>200%) AISI 5160 spring steel are shown in Figure 6.

REDUCE PEENING COVERAGE

All things considered, there is opportunity to reduce peening coverage, hence time. Results from the Cammett–Prevey 2002 study can be displayed on a timeline as in Figure 7. The lesser time to achieve 80% and 100% coverage as compared to peening to multiples of 100% coverage should be obvious even to a casual observer. Logically limiting peening coverage has potential for economic benefits that may accrue…reduced process cycle time, less wear and tear on equipment, increase in part quality and durability. Peen lean!

SUMMARY

Returning to the subject of this article, are you peening too much? In terms of coverage, the answer is most probably yes. Is this a good thing? Most probably no. The author has presented a case for reducing coverage in peening. This can save time, reduce wear and tear on equipment and media, also reduce cost and improve part quality—all at the same time. Why would you not want to have all these benefits? If you are a part owner or design authority, the ball is in your court whereby you can succeed at this if you invest in an effort to make it happen.

Figure 6. Fatigue Crack Emanating from Micro-Lap Surface Defect in AISI 5160 Spring Steel

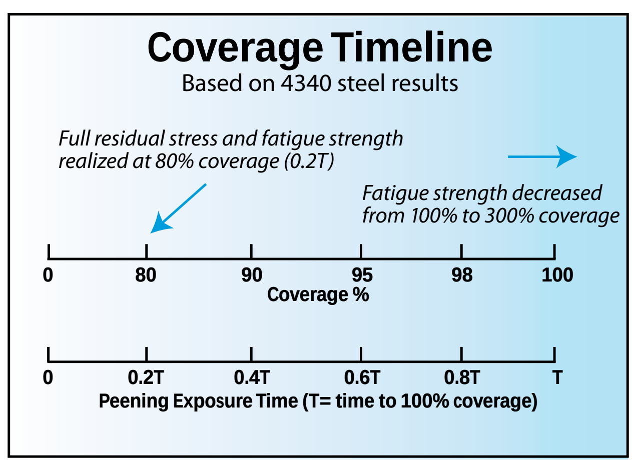

Figure 7. Timeline Illustrations of Coverage Development in an Alloy Steel

REFERENCE

1. Horwath, *Effect of Shot Peening Variables on Bending Fatigue*, Proc. ICSP1, 1981
2. Prevey & Cammett, *Effect of Shot Peening Coverage on Residual Stress, Cold Work and Fatigue in a Ni-Cr-Mo Low Alloy Steel*, Proc. ICSP8, 2002

ACADEMIC STUDY

Professor Hitoshi Soyama | Tohoku University | soyama@mm.mech.tohoku.ac.jp

Cavitation S Peening®

"I, along with staff members at Tohoku University and Babcock-Hitachi K.K., began developing a peening method for mitigating Stress Corrosion Cracking (SCC) in nuclear power plants about 25 years ago. We found that water-jet peening could mitigate SCC, and the cavitation impacts peened a surface. I got my PhD in cavitation erosion so I understood the complicated mechanisms of cavitation impacts. I then began to research 'cavitation peening' and received a trademark for a method that I named Cavitation S Peening®.

Cavitation peening has many advantages: Its treated surfaces are smooth compared to conventional shot peened surfaces and there are no sparks during the process as there are no solid collisions. The strain speed during the process is very high because shock waves when the cavitation bubble collapses are used. The cost is very inexpensive compared with the laser shock process.

Cavitation peening can be applied in the automobile industries and chemical plants. Although we can peen hard materials in the same way as shot peening, I think soft materials such as aluminum alloy and magnesium alloy are better suited for this peening process. An additional benefit to using cavitation peening in chemical plants is that the water supply that is part of the fire-extinguishing system can be used for cavitation peening.

Unfortunately, many researchers and engineers do not understand the difference between cavitation peening and water-jet peening. Cavitating jet can treat a much wider area than normal water jet and when the cavitation is optimized, the impact intensity of cavitating jet is also bigger than that of normal water jet.

I am pleased to share some of my research on cavitation peening with the readers of The Shot Peener magazine. If you are interested in reading more of my research on Cavitation S Peening®, please send an email to soyama@mm.mech.tohoku.ac.jp."

—Professor Hitoshi Soyama
Tohoku University, Japan
Department of Nanomechanics, School of Engineering

CAVITATION S PEENING® is a peening method that uses cavitation impacts to improve fatigue strength and/or to introduce compressive residual stress. The peening method using cavitation impact is called "cavitation shotless peening (CSP)", as shots are not required (see Fig. 1). In the case of cavitation shotless peening, cavitation is generated by cavitating jet.

Cavitation is a phase change phenomena from liquid-phase to gas-phase. It is similar to boiling, but with cavitation the liquid-phase becomes gas-phase by decrease of static pressure until saturated vapor pressure due to increase of flow velocity (see Fig. 2). When the static pressure is increased by decrease of the flow velocity, the cavitation bubble is collapsed. When the cavitation bubble collapses, a part of the bubble is deformed and a micro-jet is produced (see Fig. 3). As the speed of the micro-jet is about 1,500 m/s, the micro-jet produces plastic deformation pit on the solid surface. After the cavitation bubble shrinks, the cavitation bubble rebounds. At the rebound, a shock wave is produced. The shock wave also produces plastic deformation (see Fig. 3 on page 18).

Cavitating jet is a jet with cavitation bubbles produced by injecting a high-speed water jet into normal water jet. (See Fig. 4 on page 18.)

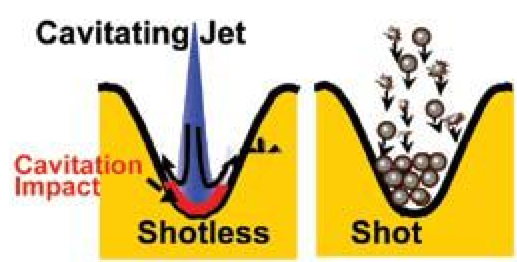

Figure 1. Shotless Peening and Shot Peening

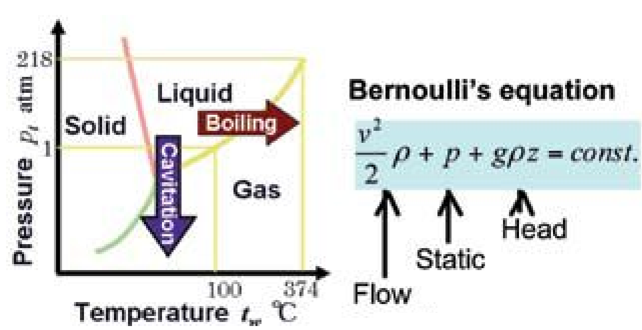

Figure 2. Phase diagram of water and Bernoulli's equation

The cavitation bubbles take place in the low pressure region of vortex core in the shear layer around the jet. The vortex cavitations combine and a big cavitation cloud is produced. When the cavitation cloud hits the surface, cavitation impacts are produced when the bubble collapses. Soyama successfully produced cavitating jet in air by injecting a high-speed water jet into a low-speed water jet.

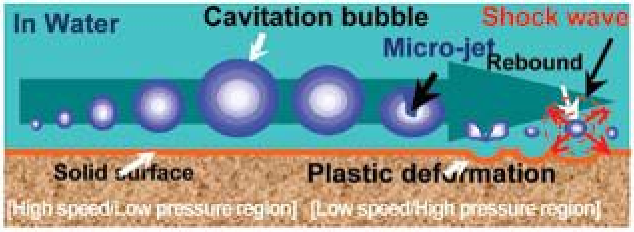

Figure 3. Schematic diagram of cavitation bubble

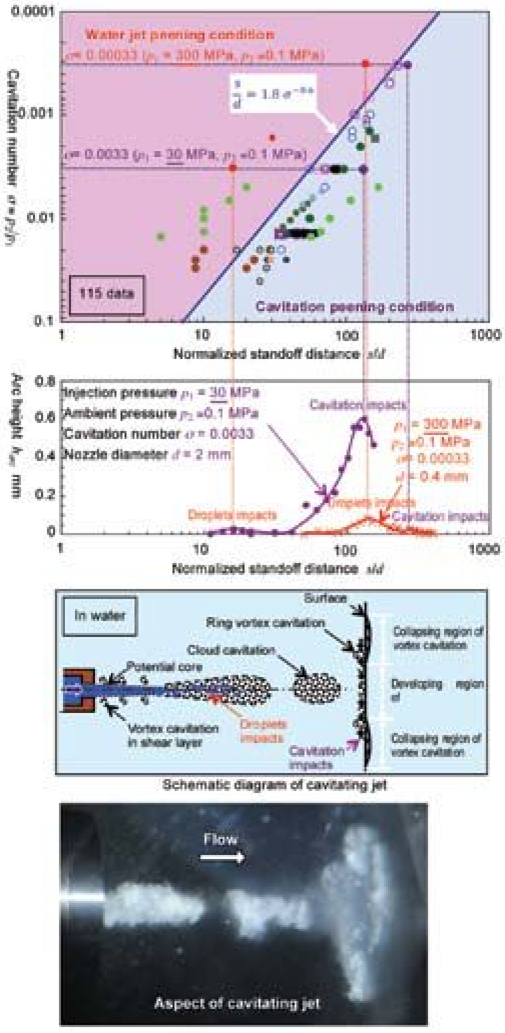

Figure 4. Schematic diagram and photo of cavitating jet

Improvement of Fatigue Strength

Cavitation S Peening® improves the fatigue strength of gears made of carburized chromium molybdenum steel SCM420H[1]. It also enhances the fatigue strength of carburized chromium molybdenum SCM420[2] and SCM415[3], aluminum alloy AC4CH-T6[4], Duralumin, magnesium alloy, stainless steel, silicon manganese steel and other materials. See Fig. 5 - 7.

Figure 5. Improvement of fatigue strength of gear demonstrated using a power circulating type gear tester (Carburized SCM420H)[1]

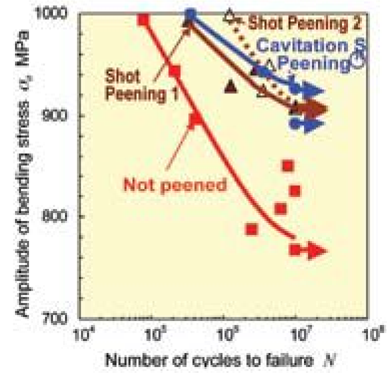

Figure 6. S-N curve of rotating bending fatigue test (Carburized SCM420)[2]

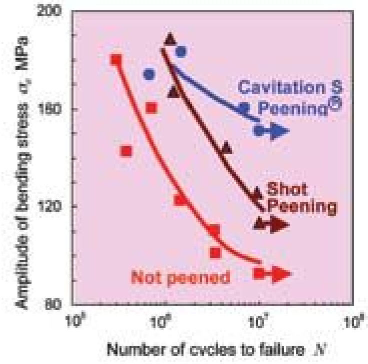

Figure 7. S-N curve of rotating bending fatigue test (AC4CH-T6)[3]

1. H.Soyama and Y.Sekine, "Sustainable Surface Modification Using Cavitation Impact for Enhancing Fatigue Strength Demonstrated by a Power Circulating-Type Gear Tester," International Journal of Sustainable Engineering, Vol. 3, No. 1, 2010, pp. 25 - 32.
2. H. Soyama, "Improvement of Fatigue Strength of Metallic Materials by Cavitation Shotless Peening," Metal Finishing News, Vol. 7, March issue, 2006, pp. 48 - 50.
3. H.Soyama, K.Sasaki, K.Saito and M.Saka, "Cavitation Shotless Peening for Improvement of Fatigue Strength of Metallic Materials," Transaction of Society of Automotive Engineers of Japan, Vol. 34, No. 1, 2003, pp. 101 - 106.

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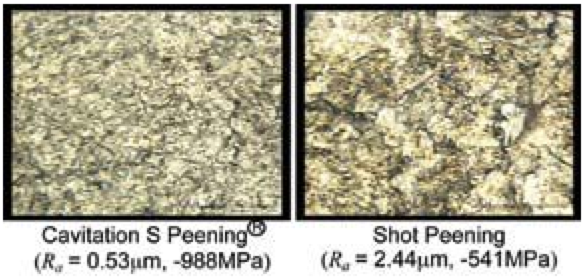


Figure 8. Peened surface and residual stress (Ti-6Al-4V)[4]

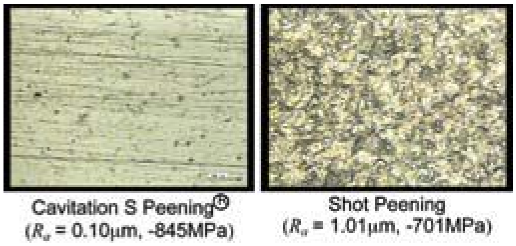


Figure 9. Peened surface and residual stress (SKD61)[5]

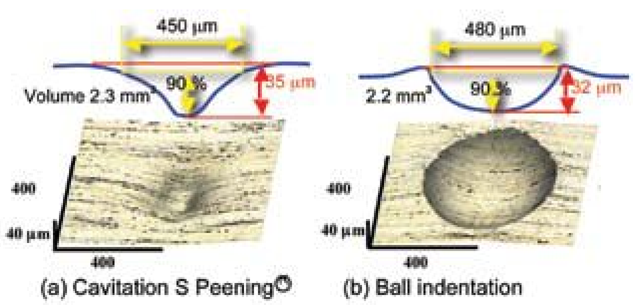
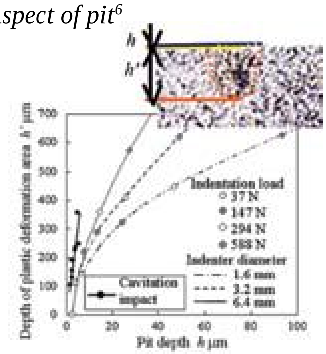


Figure 10. Aspect of pit[6]

Figure 11. Depth and plastic deformation area[7]



4. H.Soyama, D.O.Macodiyo and S.Mall, "Compressive Residual Stress into Titanium Alloy Using Cavitation Shotless Peening Method," Tribology Letters, Vol. 17, No. 3, 2004, pp. 501 - 504.
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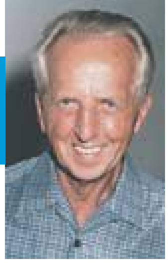

ACADEMIC STUDY
Dr. David Kirk | Coventry University

Water-Jet Peening and Water-Jet Shot Peening

INTRODUCTION
Water-jet peening and water-jet shot peening have the common feature of employing a jet of water. There are, however, important differences between the two processes. Water-jet peening has to impose a direct pressure high enough to generate surface plastic deformation. Water-jet shot peening, on the other hand, uses entrained high-velocity shot particles to generate the required surface plastic deformation. Figs.1 and 2 illustrate the essential differences between the corresponding impacting streams.

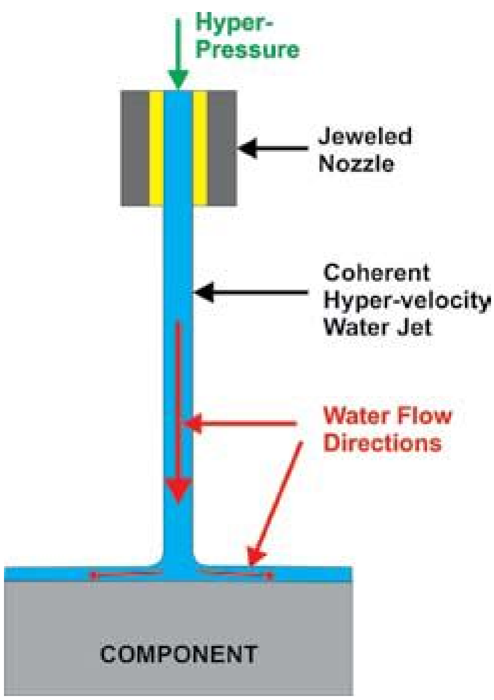

Figure 1. Schematic representation of Water-jet Peening

With water-jet peening, the nozzle shown is jeweled in order to provide adequate wear resistance. Every attempt is made to preserve 'coherence' of the jet stream, i.e., to prevent divergence.

With water-jet shot peening, shot is added to a much lower-velocity stream. Shot particles are accelerated by the water-jet, impact the surface and rebound.

The two processes are treated separately in this article but use common methods for estimating factors such as pressure, force and power.

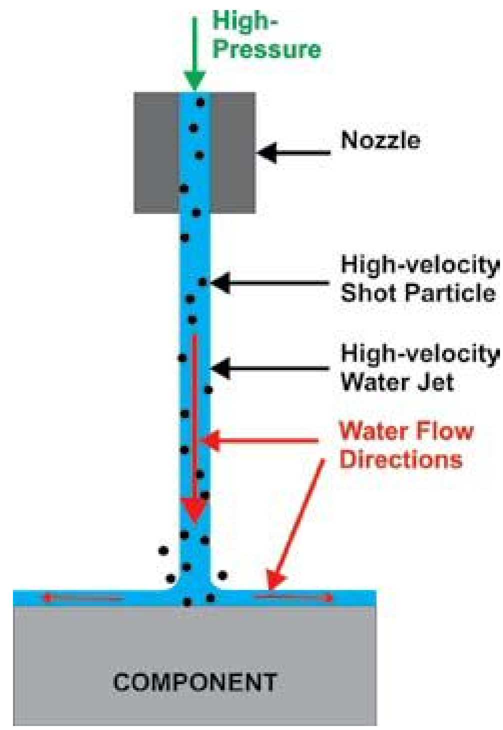

Figure 2. Schematic representation of Water-jet Shot Peening

WATER-JET PEENING
The essential requirement with water-jet peening is that the jet must exert a pressure greater than the compressive yield strength of the component material. Enormous pressure has to be applied to the water as it enters the nozzle. If the water stream diverges then its velocity drops. Water, being a liquid, is incompressible. That means that it behaves differently from an air jet.

Velocity of Water Jet
The velocity of a water jet, **V**, can be estimated using the following formula:

$$\mathbf{V = 44.721{*}P^{0.5}} \quad (1)$$

Continued on Page 26

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Where **V** is water-jet velocity in m/s and **P** is the pressure applied behind the nozzle, in MPa.

As an example: If the applied pressure was 500MPa then substitution into equation (1) gives that **V** = 1000 m/s.

Equation (1) when using Imperial units becomes:

$$\mathbf{V = 377.56{*}P^{0.5}} \quad (2)$$

Where V is water-jet velocity in ft/s and **P** is the pressure applied behind the nozzle, in kpsi.

Equations (1) and (2) are simplified forms of the classic fluid mechanics equation that $v = 0.98(2{*}P/\rho)^{0.5}$ where ρ is the density of water (1000 kg/m³ for equation (1) and P is in Pascals).

Equation (1) has been plotted in fig.3 for a range of applied pressures. A logarithmic scale has been used for pressure because of the huge range that is involved. Water-jet velocities can be arbitrarily divided into "Low", "High" and "Hyper". It is hyper velocity that is applicable to water-jet peening.

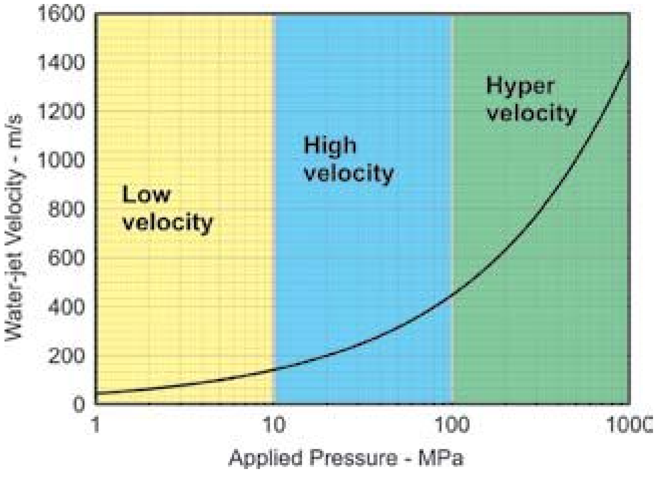

Figure 3. Effect of Applied Pressure on Water-jet velocity

Pressure Applied on a Component by a Water-jet

The pressure made on contact with a component, $\mathbf{P_w}$, is the key factor in water-jet peening. This pressure can easily be estimated knowing the density of water and the jet's velocity on impact. The following equation is central to water-jet peening:

$$\mathbf{P_w = \rho_w{*}v_w^2} \quad (3)$$

Where $\mathbf{P_w}$, in Pa, is the pressure exerted by a water-jet impacting at 90˚, $\mathbf{\rho_w}$ is the water density, in kg/m³, and $\mathbf{v_w}$ is the velocity, in m/s, of the water-jet on impact.

In words: **the water-jet impact pressure is the density of water multiplied by the square of the jet's velocity.**

Water-jet peening relies on being able to exert a pressure greater than the component's yield strength in compression. According to metalworking theory, the yield strength in compression is 1.155 times the yield strength in tension. For water-jet peening the density of water is fixed at 1000 kg/m³. Equation (3) therefore simplifies to become:

$$\mathbf{P_w = 1000{*}v_w^2} \quad (4)$$

Air, at atmospheric pressure, has a density of 1.225kgm⁻³. That means that a water-jet will exert about 800 times the pressure that would be exerted by an air jet that had the same velocity. The key to understanding water-jet pressure is that it is proportional to the square of the jet's velocity. Fig.4 plots the impact pressure of a water-jet against the jet's velocity. Material yield strength is plotted on the same scale.

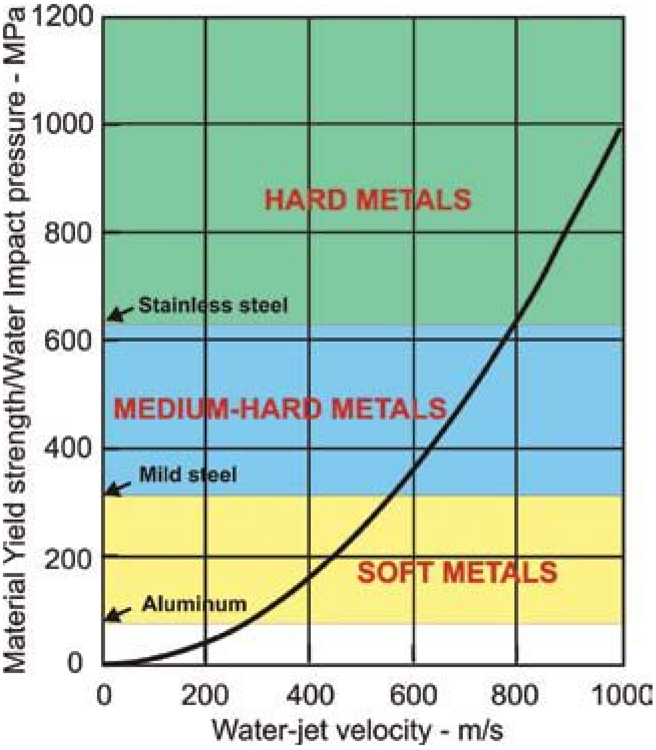

Figure 4. Effect of water-jet velocity on Impacting Pressure and Material Yield Strength

The water-jet velocity must generate enough impacting pressure to exceed the material's yield strength. In fig.4 materials have been divided, arbitrarily, into three groups. The softest material normally peened is aluminum which would require a minimum of about 300 m/s of water-jet velocity. At the top of the "Soft Metals" range mild steel would require nearly 600 m/s. Stainless steel, at the top of the "Medium-hard" group, would require a water-jet velocity of at least 800 m/s. Harder materials (than stainless steel) would require even greater water-jet velocities.

A curiosity of fluid mechanics is that the impacting pressure of a coherent water-jet is approximately twice the pressure applied behind the nozzle.

The foregoing account assumes that the water-jet neither diverges nor converges after it leaves the nozzle. Unlike air, water has 'surface tension'. Surface tension forces tend to maintain and minimize the surface area of water – either as drops or as a stream. Hence a water-jet stream tries to maintain its shape. Jet design and jet materials play an important part in ensuring that the water-jet stream does not diverge significantly. Imagine, however, that a water-jet stream doubled its diameter between nozzle and impact on a component. This would reduce the impact pressure by a factor of four (the cross-sectional area having been increased by a factor of four).

Water-jet Power

A high-velocity water-jet stream represents an enormous amount of power. This can be estimated using an equation presented in an earlier article in this series (Summer 2013):

$$JP = ½\,\rho^*v^{2*}A \qquad (5)$$

Where **JP** is Jet-stream power, **ρ** is water density, **v** is water-jet velocity and **A** is the cross-sectional area of the water-jet as it leaves the nozzle.

As an example: a water-jet travelling at 1000 m/s and having a cross-section of 10 mm^2 represents a power of 5,000 kilowatts.

Water-jet Energy

Water-jets have a kinetic energy, $½mv^2$, where m is mass and v is velocity. The energy can readily be estimated before it impacts a solid object.

Example: Consider the situation illustrated in fig.5. A 10 cms length of jet that has a cross-sectional area of 0.1 cm^2 will have a volume of precisely 1 cc. Water has a density of 1 g/cc so that this length of jet will have a mass of 1 g. If the jet velocity is 1000 m/s then the kinetic energy of the length being considered will be $½*1*1000{,}000\ g.m^2/s^2$ or $500\ kg.m^2/s^2$. Now $1\ kg.m^2/s^2$ = 1 J (Joule) and 1 calorie = 4.186 J. Therefore, $500\ kg.m^2/s^2$ = 500 J = 120 calories.

Water-jet Energy Absorption

When a water-jet impacts a component there must be a change in the distribution of its energy. Forward momentum is lost completely and the direction of the jet changes by 90˚ - on hitting a flat plate, see fig.1. Some energy remains in the water flowing sideways, i.e. parallel to the component's surface.

If it assumed that most of the kinetic energy becomes thermal energy then the contacting water-jet can become hot – even boil. There are reports in the literature of water-jets creating clouds of steam.

Example: Assume that in the previous example the water temperature before impact was 10˚C and that 10 of the 120 calories were retained as sideways momentum. 90 calories would be needed to heat the water from 10˚C to its boiling point of 100˚C. That leaves 20 calories that could be used in steam generation.

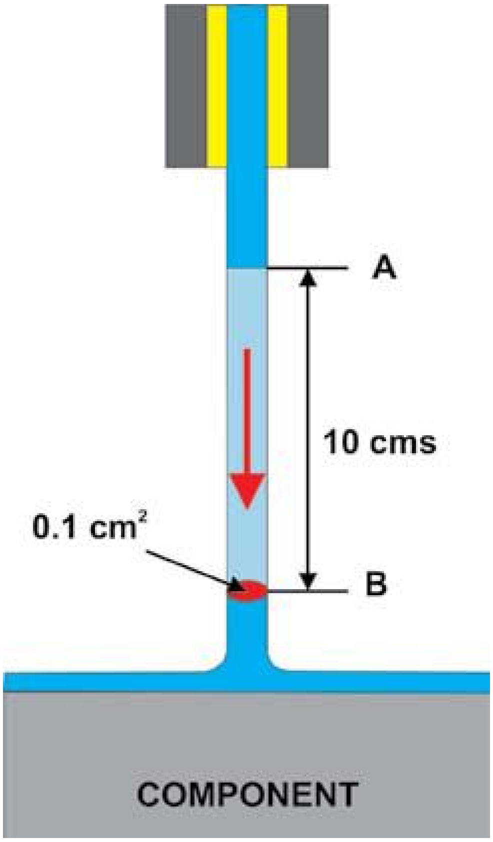

Figure 5. Imaginary length of a water-jet

There are theoretical grounds for believing that the conversion of kinetic water-jet energy to thermal energy is not uniform. The rate of momentum change will be largest on the axis of the jet stream. It can, therefore, be supposed that a much greater proportion of the kinetic energy is turned into heat on that axis. Fig.6 is a schematic representation of the possible energy transfer mechanisms.

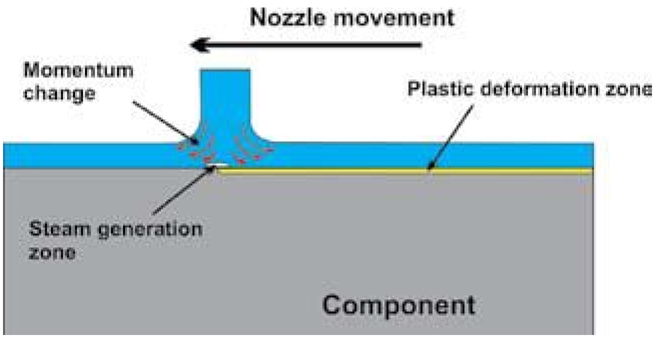

Figure 6. Schematic representation of energy transfer mechanisms during water-jet peening

A minute amount of energy will be consumed in blasting-away fractured surface oxide.

WATER-JET SHOT PEENING

The basic features of water-jet shot peening were illustrated in fig.2. Essentially, high-velocity water is used to accelerate shot particles to a high enough velocity for them to cause surface plastic deformation. Water, being so much denser than air, readily accelerates the shot particles.

Velocity of Water-jet

The required velocity of the water-jet is now much lower than that needed for water-jet peening. It is the entrained shot particles that generate surface plastic deformation – forming familiar dents in the surface. If the water-jet component does not diverge then its velocity is constant. That is because water is incompressible – unlike air, where compression by 10 atmospheres reduces a given volume by a factor of ten and increases its density tenfold.

Velocity of Entrained Shot Particles

A previous article in this series (Winter 2007) presented the relevant theory and equations for calculating the shot velocity that is induced by fluid acceleration. The only significant difference (between water-jet shot peening and air-blast shot peening) is the density of the accelerating fluid. Water has a density of 1000 kgs/m^3 which is very much higher than that of compressed air. At 10 atmospheres compression, air has a density of 12 kgs/m^3.

The velocity, $\mathbf{V_S}$, achieved by the entrained shot particles depends on several factors:

(1) **Velocity of water-jet, V_J**.

(2) **Drag coefficient, C_D**. This is a dimensionless quantity equal to 0.5 for a sphere.

(3) **Cross-sectional area of shot particle, A**.

(4) **Density of water, ρ_W**.

(5) **Density of shot particle, ρ_S**.

(6) **Distance over which the particle is being accelerated, s**, and

(7) **Relative velocity of water-jet and shot particle, $(V_J - V_S)$**.

As mentioned previously, the relevant equation for estimating the shot velocity has already been derived and presented. Table 1 shows how an Excel spreadsheet can be employed to carry out the relevant calculations. In the example shown, it is assumed that a water-jet pressure of 12 MPa is applied with steel shot acceleration taking place over a length of 100 mm. The water-jet velocity is estimated using equation (1) of this article. "Boost efficiency" is the ratio of shot velocity to water-jet velocity – expressed as a percentage. For this example the shot is travelling at over 90% of the water velocity.

In Table 1 a term "X-Factor" is used. This is the term that contains the factors listed previously. Hence, the X-Factor is given by:

$$\mathbf{X = (1.5*B2*B3*B4*B7/(B5 + B6))^{\wedge 0.5}} \qquad (6)$$

The significance of **X** is that the ratio of shot velocity to water-jet velocity, $\mathbf{V_S/V_J}$, is given by:

$$\mathbf{V_S/V_J = X/(1 + X)} \qquad (7)$$

For the example given, **X** is 10.7 so that $\mathbf{V_S/V_J}$ = 10.7/11.7 which equals 0.915. Expressed as a percentage that is 91.5% and is equal to the 'boost efficiency'. It should be noted that the larger the "X-Factor" the larger is the boost efficiency of the water-jet stream. Boost efficiency is plotted in fig.7 against the "X-Factor", **X**.

Table 1. Excel Spreadsheet Estimation of Shot Velocity induced by a Fluid Stream.

A	B	C	D
1	**Parameter**	**Value**	**Units**
2	Cd	0.5	-
3	Water Pressure	12.0	MPa
4	Water Density	1000	kgm^{-3}
5	Shot Density	7860	kgm^{-3}
6	Shot Diameter	1	mm
7	Length	100	mm
8	Water Velocity	155	ms^{-1}
9	**Shot Velocity**	**141.7**	$\mathbf{ms^{-1}}$

11	**Boost Efficiency**	**91.5**	**%**
12	**X-Factor**	**10.7**	**-**

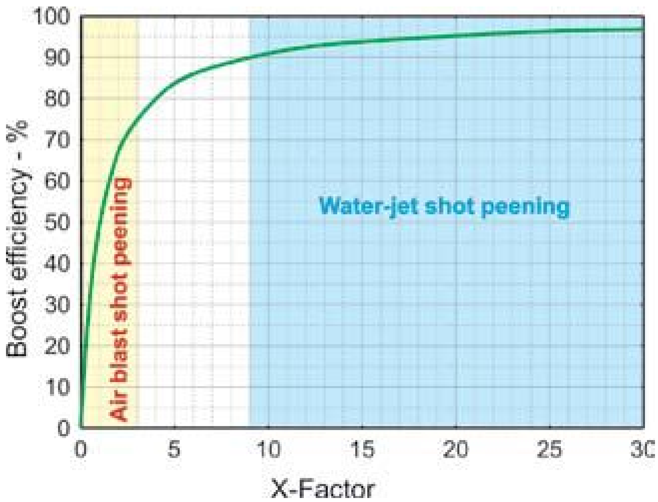

Figure 7. Effect of X-Factor on Boost Efficiency of Air-blast and Water-jet Shot Peening

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The shape of the curve in fig.7 is that of a "rational function". This is also the shape of the France-specified peening intensity curve. The figure illustrates the key differences between water-jet shot peening and air-blast shot peening. With air-blast shot peening the X-Factor is, necessarily, small so that the boost efficiency is correspondingly small. The maximum air velocity at the nozzle is also restricted by the speed of sound in air (about 340 m/s). With water-jets the limiting speed of sound is some 4.3 times greater (at about 1500 m/s).

Entrained Shot Speed Variability

With water-jet shot peening, the boost efficiency is almost constant – being above 90%. The X-Factor for air-blast shot peening is, by contrast, on a steep slope. This might lead to a conclusion that the entrained shot speed will be much more variable with air-blast shot peening than it is with water-jet shot peening. That would be correct if (and it is a big if) the cross-sectional area of the water-jet stream remained constant.

If, for example, the cross-sectional area of a water-jet doubled (due to divergence) then the velocity of the jet must be halved. With such a reduction in water velocity this would rapidly slow down the entrained shot particles. This rapidity of velocity reduction is the reverse of a water-jet stream's ability to accelerate slower moving shot particles. Air, being much less efficient than water as an accelerator/decelerator, will have a much lower effect on shot speed variability after leaving the nozzle.

DISCUSSION

The analysis presented in this article is complementary to two previous TSP articles that were devoted to air-blast and wheel-blast shot peening velocities. With the aid of Excel spreadsheets it is possible to estimate, quantitatively, the relative effects of factors such as applied pressure, power requirements, velocity boost efficiency and shot characteristics. For example it is easily shown that air-blast shot peening struggles to achieve high velocities with large-diameter shot. By contrast, water-jet shot peening can easily induce high shot velocities for large-diameter shot. Power and energy requirements are of major concern, particularly with water-jet peening.

Pure water-jet peening requires hyper-velocity jet streams in order to be able to induce the surface plastic deformation needed generate surface compressive residual stress. No shot is involved, so that dimpling of the component's surface is avoided. The greater the yield strength of the component's material the more difficult it will be to induce plastic deformation.

Water-jet shot peening has the advantage of being able to generate very high shot velocities even with large shot particles. This could be advantageous for peen-forming operations. As with pure water-jet peening there is the problem of recycling.

The equations that have been presented depend on basic principles of fluid mechanics. Some simplifying assumptions have, however, been made. It follows that calculations based on the equations will not be 100% accurate. It is believed, however, that their accuracy is good enough to allow both quantitative analysis of different variables and comparison of different processes. The Excel spreadsheets for the several peening processes are available from the author via shotpeener@btinternet.com—they do not contain macros.

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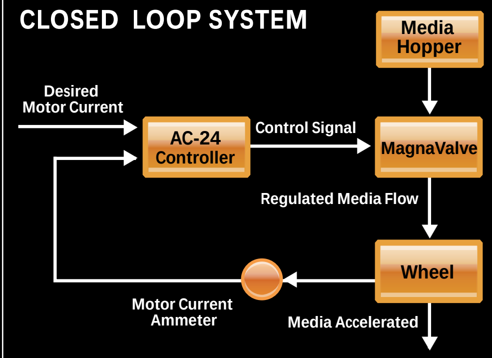

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BLAST CLEANING ANALYSIS

Erwan Henry | erwan.henry@yahoo.com

Shot Blast Costs Revisited

"We're gonna cut your shot-blasting costs"
This is an attractive sales pitch from media suppliers and equipment manufacturers. It raises the interest of industrial customers who struggle to keep afloat in the tremendously competitive pressure of the global economy. The purpose of this article is to analyze the sales pitch from a realistic and practical point of view.

We will first clarify what a cost-cutting offer means and we will list the costs associated with a blasting process. We will review the impact of the individual costs on total blasting costs, compare the cost-cutting potential of abrasives compared to equipment and then reach a pragmatic conclusion.

What Does "Cutting Costs" Mean?
The objective of any supplier engaged in "shot-blasting cost cutting" is to justify its offer, maintain or penetrate the account, or defend its price level.

A supplier's cost-reduction method begins with the gathering of current expenses, defining and implementing an improvement plan, documenting costs again, and providing the method and the materials to operate at this optimum. The following items are generally tracked:

- Abrasives consumption (price x volume),
- Energy (wheel or compressed air and dust extraction),
- Direct labour,
- Wear parts,
- Maintenance (labour),
- Waste disposal,
- Poor quality, and
- Depreciation of the equipment

This list is typical of an accounting-based approach, but does it reflect how a production department works? Does it take into account the costs that change the most from changes in the blasting parameters?

Not All Costs Are Proportional
Abrasives consumption is clearly a direct cost factor because the number of cycles and transmitted energy of a media affects consumption. It is generally estimated that abrasives represent roughly 30% of the total blasting costs.

Energy is also proportional with the blasting duration, varying between 20% and 25% of the cost.

The cost of **Direct labour** isn't as easy to compute. In the vast majority of finishing departments and shot-blasting plants, labour is a fixed cost. Shortening blasting time by a few seconds will never cut labour time as the machine operators are not waiting in front of the machines until the cycle is done.

Unless the whole production process is overhauled, changes in shot-blasting parameters are unlikely to cut labour costs.

Wear parts represents 15 to 25% of the costs, but their consumption is a subject of debate. If the separator of the shot-blasting machine is properly set, the consumption should be reasonable. Checking the separator, tuning its settings and keeping it properly adjusted is a basic maintenance objective. But this is independent from variations in media. Furthermore, in reality it is difficult to indisputably relate wear part consumption to the choice of abrasives. Faster cleaning means higher energy transmission and/or abrasiveness. In the cases of low-hardness grit versus shot, or high-carbon versus low-carbon shot, slightly faster cleaning is compensated indeed by slightly less abrasion. The combined variation is negligible and this parameter should be dropped in a serious comparison.

Most cost-cutting proposals say they will reduce **Maintenance (labour)**. The reasoning is that less wear parts consumption means less maintenance work, which is untrue. I suggest that additional maintenance effort is necessary to cut costs. The checking and tuning up of the machine parameters more frequently is needed to keep a shot-blasting operation at peak performance.

Waste disposal. Contaminants, dust, and discharged particles must be properly disposed of. Dust and discharged particles (separated magnetically from contaminants) should be recycled and can be sold. Properly tuning up the machine and separating recyclable material from contaminants does improve costs. But this is the task of maintenance and does not depend on X or Y abrasive supply.

Poor quality. Blasting a batch for the second time is a nightmare for any production manager. This is one of the reasons why a vast majority of operations shot-blast too long. Variations are in the nature of all industrial processes, including abrasives production. While staying within specifications, one batch of media may over-perform, and another one may be less effective. As a consequence, the blasting time is set to accommodate the poorer performing batches.

It's easy for a task force, assigned by an abrasives supplier, to shorten the blasting duration to its minimum while ensuring all parameters are tightly preserved. But when the task force leaves, maintaining such optimized and ideal industrial conditions is not realistic. Operating on the very limits of the capability of a process is risky and may sooner or later generate poor quality product.

The **depreciation of the equipment** is annualized and unless the productivity of the production line or the machine

increases tremendously, the variation between abrasives is unlikely to make a real difference.

What Are the Benefits of a Cost-Cutting Project?

Make no mistake, cutting costs is mandatory in the global economy and a cost-killing exercise is healthy and should take place on a regular basis.

The first benefit is the "Hawthorne Effect." This is where a minor change (including the mere observation and measurement) triggers an improvement. The second advantage is that reviewing cost components, tracking bad work practices, benchmarking, updating standards and setting goals can only have a positive effect.

What Questions Should Be Asked?

- Is the calculation of the cost improvement solidly documented and in line with the reality of the operation?
- Is the achieved improvement sustainable, in particular the blasting time, after the supplier's task force goes away?
- What is the counterpart—the compensation or reward—for this cutting costs assistance?

The Impact of Abrasives

It's accepted that costs go down when productivity goes up. Shorter operating time, less consumption and energy usage, higher processing speed and less fixed costs per part cut costs. Period.

How can abrasive X perform better than abrasive Y in an industrial shot-blasting operation? (X and Y belonging to the same quality league.)

The life and transmitted energy of abrasives of the same quality show little variation in industrial operation. Comparisons, made with a testing machine, are a useful lab benchmark but do not reflect the real blasting machine operation with generally higher projection speed, rebounds, and, at the end of the day, an unknown number of cycles. In other words, after all parameters have been tuned up and optimized, the differences between X or Y abrasives is unlikely to significantly reduce the cost of blasting.

Let's Take An Example:

The price of abrasives X is 10% higher than abrasives Y, but abrasives X shows a better efficiency (life and energy transmission) in the machine by 10%.

- A 10% higher price of abrasives, which is 30% of the total blasting cost, means 3% higher total blasting cost (10% x 30%).
- A 10% higher effectiveness of the abrasives will make the consumption drop by 10%. This higher effectiveness reduces by 10% the abrasives consumption which is 30% of the total cost, means 3% lower total blasting cost (10% x 30%).

As stated before, Energy is proportional to blasting duration, varying between 20% and 25% of the cost. The energy is then tilting the total blasting cost in favor of abrasive X: shorter blasting means less energy consumption, which is perfectly proportional. As Energy = 20% of the total blasting cost, the 10% reduction of the blasting time means a gain of 2% in the TOTAL blasting cost (20% x 10% = 2% of the total blasting cost). We expect that the spare parts consumption will not vary, nor the direct labour and the depreciation.

In this example, the cost advantage is a meager 2%. If the abrasives are the same price, the total blasting cost advantage would be 5% (2% for energy and 3% for faster blasting, hence less consumption).

Now if we take a step back and look with common sense at the reality of the shot-blasting operation, it is unlikely that two abrasives of the same quality league would show such difference inside the blasting machine. The 10% difference observed and measured by a lab technician and conveyed by a salesman does not mean this happens inside the machine. In the real life of sustained industrial operations, abrasives of the same quality typically do not show variation of consumption and efficiency combined over 5%.

What is the difference between two abrasives of the same quality league and at the same price, with one cleaning faster by 5%? Answer: 5% of energy costs and of consumption = 5% X (20% + 30%) = 2.5% of the total blasting costs. In other words, such difference in industrial performance can justify a price gap of 8.3% in pricing (2.5% divided by 30%).

So, unless the quality levels show huge differences, the room to lower the total blasting costs between abrasives of the same quality league ranges around 2% or 3%. This potential cost advantage makes room for a higher price between 5% and 10% per ton to break even. This cost-killing exercise is indeed healthy but its outcome remains modest in properly run operations.

Having said that, the value of the technical advice, the constructive customer-supplier relationship and a sufficient supply of media at all times are valuable components in the commercial offer and deserve a price difference reward and should legitimately drive the choice of a supplier.

What Can Shot-Blasting Machines Achieve?

It is clear that the speed of blasting is a key factor of productivity and has a direct impact on cutting costs (less fixed and variable costs per part). This is precisely what the new machines achieve: higher output and enhanced productivity along with more control, especially in maintaining and recycling the operating mix. The new generation of turbines cut maintenance costs even more because of the fast and secure changing of their blades.

The rule of thumb is that replacing a 10-year old machine will decrease your abrasives consumption by 20%, a 15-year old machine by 30%, etc. At the same time, your productivity will surge, depending on your operation. Replacing an old machine with a new machine is a sure path to cutting your blasting costs by 10% or more, which will pay for your investment.

Conclusion

A shot-blasting cost-cutting process is a healthy and profitable exercise. Any help from a supplier or an outside specialist should be welcomed and compensated. It is unlikely that two abrasives of the same quality league will make much difference in your shot-blasting costs. Investing in new shot-blasting machines, which are more productive and efficient, is the sure recipe to reduce your costs.


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Indiana Gear Engineer Wins $75,000 for Google Glass Application

JOEL NEIDIG, an engineer at Indiana Gear (a division of ITAMCO), has been awarded a $75,000 prize for his research project titled "Expanding Manufacturing's Vision: MTConnect® and Google Glass."

Mr. Neidig's winning project was his contribution to the MTConnect Challenge 2. The National Center for Defense Manufacturing and Machining, the Office of the Secretary of Defense, Defense-wide Manufacturing Science and Technology, the Association for Manufacturing Technology and the U.S. Army Benét Labs sponsored the contest. Participants were asked to develop innovative and unique software applications using the MTConnect standard that could be easily adopted by manufacturing enterprises, especially lower-tier producers. MTConnect is an open, royalty-free set of communication standards intended to foster greater interoperability and information sharing between manufacturing equipment, devices, and software applications.

Mr. Neidig coupled MTConnect functionality with Google Glass — a camera, touchpad, microphone, email and Internet connection built into a spectacle frame. Mr. Neidig's application, called the MTConnect Glassware app, will reveal a view of the manufacturing process that has never been seen before. The app user will be liberated from laptops and hand-held smart devices and be able to travel the entire shop floor, gathering and sharing machine data provided by MTConnect, and accessing the Internet for more information.

"We're using the MTConnect Glassware app on our shop floor at Indiana Gear and have received inquires from companies that want a customized solution. We plan to use the prize money to develop the next generation of the app which will be available in safety glasses," said Mr. Neidig.

The award-winning product benefits every department in a manufacturing facility, from the shop floor to the management suite. Getting and sharing information will be as intuitive and non-threatening as using a smartphone or playing a video game, but glasses do not distract from a task like handheld devices. For example, a new machine operator watches YouTube training videos while at the machine, supplementing his training program. A machine operator sends an email to the maintenance staff as soon as he sees a problem. The CEO travels the shop floor, getting accurate real-time machine data and comparing it to the company's accounting, quality control, sales and engineering data. Project managers evaluate workflow and machine readiness before scheduling future work. They will access 100% accurate data and share information with their customers to ensure smooth delivery between vendors. The maintenance staff becomes even more astute at monitoring machines and they respond quicker to problems while developing stronger preventative maintenance programs. With Google Glass, they can "see" instruction manuals overlaid on the equipment when installing or repairing machinery. The sales staff provides guided Google Glass tours, impressing prospects with the capabilities of the facility and helping them visualize the final product.

Google "MTConnect Glassware app" at www.youtube.com for a demonstration.

About ITAMCO

Since 1955, ITAMCO has provided open gearing and precision machining services to many heavy-duty industries including mining, off-highway vehicles, marine, and aviation. Learn more about ITAMCO at www.itamco.com or call (574) 936-2112.

Joel Neidig uses the MTConnect Glassware app on the shop floor at Indiana Gear.


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NanoSteel Introduces EverShot™

- **Ferrous micro peening alloy designed to impart exceptional compressive stresses while minimizing dimensional distortions**
- **Ideal for parts with high hardness, small size, complex geometries or small radii**
- **Lasts up to 70x longer than ceramic and 9x longer than other high hardness ferrous micro shots**

THE NANOSTEEL® COMPANY, a leader in nano-structured steel materials design, today announced the introduction of its proprietary EverShot™ ferrous micro peening alloy. The new material combines high hardness with a low breakage rate which allows the shot peening of parts to precision specifications. The exceptional durability of the EverShot™ peening media dramatically increases operational efficiencies leading to higher throughput and lower processing costs.

"Compared to both ceramic and ferrous microshot media, EverShot™ enables the shot peening of parts to tighter dimensional requirements at significantly improved uptimes." said Harald Lemke, NanoSteel's vice president and general manager of powder metallurgy. "The media is ideal for the shot peening of small parts and parts with small radii or complex geometries such as gears, springs and threads."

In a customer test conducted by NanoSteel's development partner Superior Shot Peening in Houston, the EverShot™ media with an average shot particle size of 83 microns (0.0033 inches) generated intensities equal to CW14 steel cut wire shot while providing a more uniform level of compression.

"NanoSteel's micro shot is extremely durable and generates the most uniform level of sub-surface compressive stresses that I've seen from any media other than ultrasonic shot peening," said Dan Spinner, Superior Shot Peening's director of technology. "The high hardness of the NanoSteel ferrous micro shot results in a deeper impact than existing ferrous micro shots without additional workhardening."

Competitive benchmarking shows that an EverShot™ cut lasted up to 70x longer than ceramic and 9x longer than other high-hardness ferrous micro shot. This substantially higher durability provides more consistent surface quality and improved uptime from less frequent material replacement while lowering process waste.

NanoSteel is the world leader in proprietary nano-structured steel material designs. Over its eleven-year history, NanoSteel has created progressive generations of iron-based alloys from surface coatings to foils to powder metals and sheet steel. For the oil and gas, mining and power industries, NanoSteel has successfully introduced commercial applications of metallic coatings to prolong service lifetime in the most extreme industrial environments. NanoSteel has achieved a significant breakthrough in the development of nano-structured sheet steel with exceptional strength and ductility for the automotive industry. NanoSteel is a privately held company funded by lead shareholders EnerTech and Fairhaven Capital. For more information, visit www.nanosteelco.com or follow them on Twitter @NanoSteelCo.

Wheelabrator Celebrates One Million Safety Hours

Wheelabrator Group reached a major milestone during the first quarter of 2014 with 1,000,000 hours without a lost time incident. Over 200 Wheelabrator employees and guest marked this special event during a safety luncheon at their LaGrange facility, March 13th. Featured speakers included Robert E. Joyce, President & CEO of Norican Group (parent company of Wheelabrator and DISA); Poul Erik Arre, Director of HS&E, Norican Group from Denmark; Pierre Tanguay, VP Supply Chain, Wheelabrator Group; Judith Carr, Member of Chairman's Board Georgia State Board Workers Compensation; Jim Thornton, Mayor City of LaGrange; Kathleen Parsloe, CPCU, ARM Senior VP Marsh USA, Inc. and others.

On March 13, 2014 an American Flag flew over the Washington D.C. Capitol in recognition of the 1,000,000 work hours for Wheelabrator. This flag was sent to Wheelabrator with a certificate in recognition for the 1,000,000 work hours without a lost time incident; and will be displayed in the LaGrange, Georgia Wheelabrator lobby.

Martin Magill, Senior Vice President; Pierre Tanguay, VP Supply Chain; and Angelyn Gill, Health Safety and Environmental Coordinator raise the flag at Wheelabrator, LaGrange, Georgia that was flown in Washington, D.C. in honor of one million work hours without a lost time incident for Wheelabrator.

Wheelabrator is the world's leading surface preparation company, offering a complete range of equipment, services and parts. Leading companies in the foundry, automotive, aerospace, energy, marine, rail, construction and many other industries have used Wheelabrator Group's products and services to improve productivity and profitability for over 100 years. With active customers in nearly 100 countries, Wheelabrator manufactures a full range of wheel-type shot blast machines, mass finishing equipment dedicated to the demands of the industry, and automated airblast solutions. Technically advanced and designed for ease of maintenance, Wheelabrator Group machines range from standard versions to fully customized and integrated systems. Wheelabrator Plus professionals will inspect your current blasting equipment and conduct a thorough assessment that includes reviewing the latest modernization options to determine if any productivity, cost savings, safety or environmental improvements could be realized as a result of upgrading to newer technology.

Wheelabrator, a global provider of surface preparation and finishing solutions, works closely with customers to deliver the best solutions, service and support worldwide.

Innovative Robotic Solution: Fully Automatic Vibratory Finishing

ONE OF OUR CUSTOMERS has been using vibratory finishing for the deburring and polishing of delicate precision aluminum components for many years. However, until now the components had to be protected against nicking during the finishing process requiring time-consuming and expensive manual labor. This challenge was solved by the installation of an innovative, fully automatic cleaning, deburring and polishing system which allows the finishing of around 30 different work pieces without the parts ever touching each other during the process. For this challenging application Rösler not only developed the material handling concept but, with the High-Frequency-Finishing (HFF) system, also a completely new vibratory finishing method.

Fully Automatic Operation

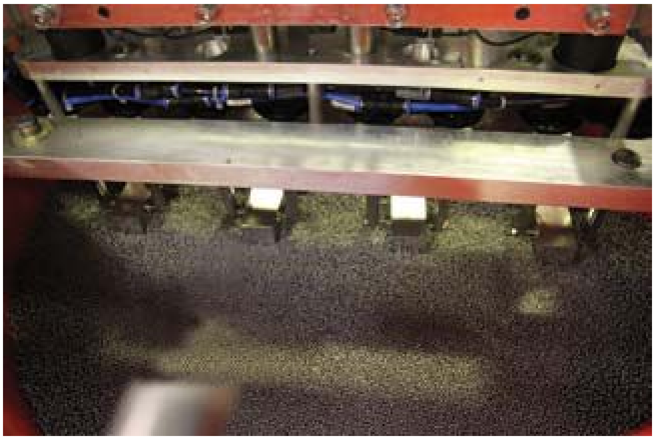
At the center of this ground-breaking fully automatic system is a robot equipped with a gripper that vibrates at very high frequencies during the HFF process. Different grippers are utilized to accommodate the various work piece shapes and sizes. After the machining operation the parts are placed on a conveyor belt in an exactly defined position. Once they arrive at the finishing system the robot picks up four parts at a time. In a first step – degreasing and cleaning – the robot dips the parts into a cleaning tank. This is followed by the HFF vibratory finishing process including a rinsing and blow off phase. Finally, the robot places the aluminum components back on the conveyor belt for transport to the next manufacturing operation.

High-Frequency-Finishing (HFF), a newly developed vibratory finishing process produces excellent and absolutely repeatable deburring and polishing results in very short cycle times.

HFF – Excellent and Repeatable Finishing Results in Short Cycle Times

During the HFF process the robot gently dips the high frequency vibratory gripper with the 4 mounted work pieces into the work bowl filled with spherical stainless steel media. The gripper vibration with 3000 RPM and the movement of the steel media induced by the vibratory drive of the mass finishing machine produce an intensive and homogeneous media flow around the work pieces. Furthermore, during the finishing process the robot can take the work pieces out of the work bowl to turn them at a defined angle and dip them back into the media mass. These two independent media movements, in combination with the compound and media precisely adapted to this process, yield excellent and absolutely repeatable deburring and polishing results in very short cycle times.

Depending on size and shape of the respective work pieces, the complete operation, including picking the parts up and placing them back on the conveyor belt, lasts between 180 and 300 seconds.



The robot picks up four work pieces at a time from the conveyor belt and runs them through the process steps, degreasing, HFF, rinsing and blow off.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