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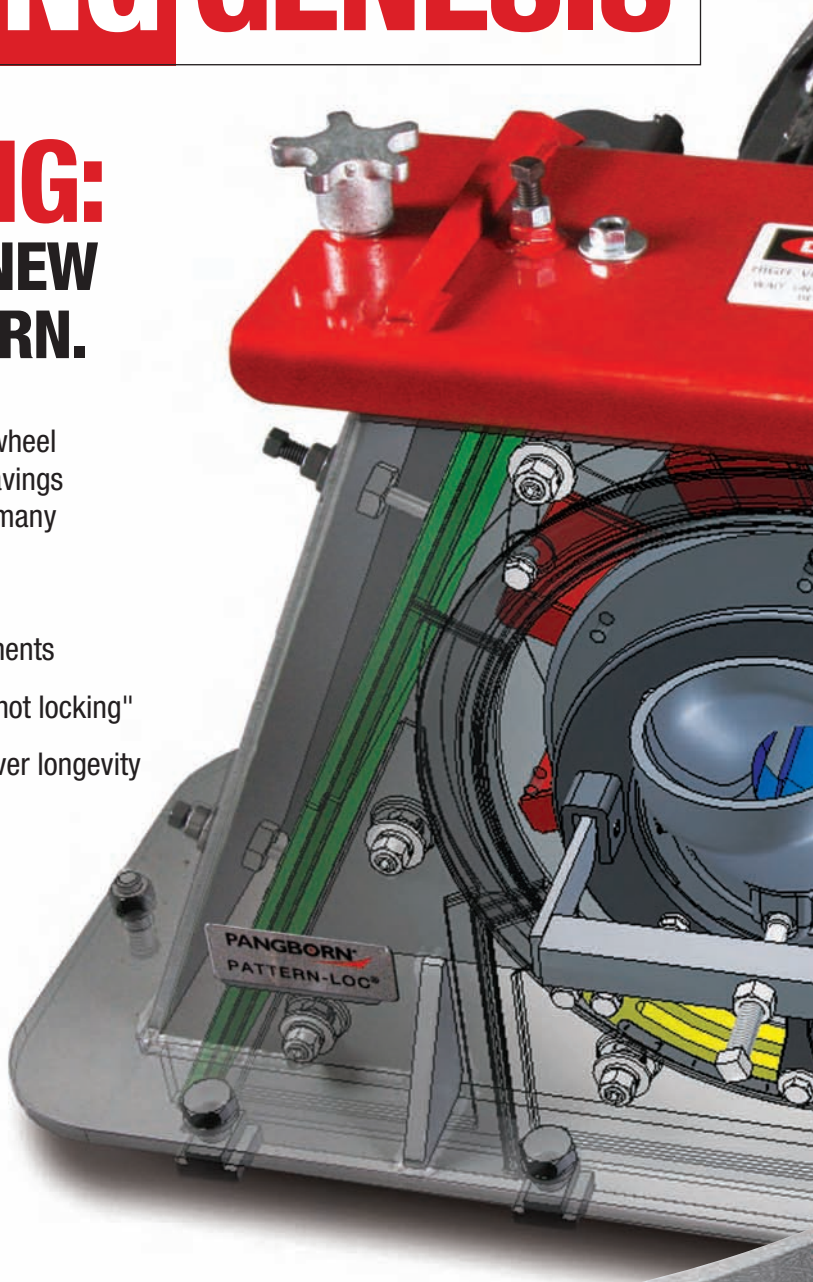

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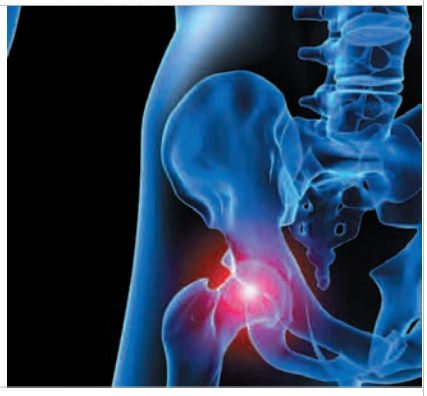
Volume 23, Issue 3 **Summer 2009**

The Shot Peener

Dedicated to sharing information and expanding markets for shot peening and blast cleaning industries



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Articles

Gaging the Wind

How strong is the wind energy market?

A record-breaking number of attendees and exhibitors were taking measure of the wind energy industry at the WINDPOWER 2009 Conference and Exhibition in Chicago in May. WINDPOWER 2009 was the world's largest wind energy conference and it hosted 1,280 exhibitors and over 23,000 attendees from 48 U.S. states and 46 foreign nations. The exhibition hall exceeded 290,400 square feet—more square footage than the 2008 and 2007 WINDPOWER shows combined. "The size and breadth of this show are a clear indicator that the wind energy industry is a hub of business activity even in this hesitant economy," said American Wind Energy Association (AWEA) Chief Executive Officer Denise Bode. Some of the highlights of the conference included:

- Siemens announced it will open a wind turbine nacelle manufacturing facility in Hutchinson, Kansas. Investment in manufacturing facilities in the U.S. has accelerated over the past two years, with over 55 wind turbine and wind turbine component manufacturing facilities announced, added or expanded in 24 states in 2008.
- Five Governors (Chet Culver of Iowa, Jim Doyle of Wisconsin, Jennifer Granholm of Michigan, Pat Quinn of Illinois, and Ted Strickland of Ohio) addressed the conference. The Governors of Kansas and Pennsylvania were also present. States and their offices of economic development are competing to attract wind turbine supply chain companies and create good jobs. At least 19 state or regional economic development offices exhibited at WINDPOWER 2009.
- Secretary of the Interior Ken Salazar, Energy Secretary Steven Chu (via a taped speech) and Federal Energy Regulatory Commission Chairman Jon Wellinghoff also addressed the conference. Secretary Salazar pointed to new rules for offshore wind farms that open the way for the U.S. to become a leader in offshore wind power.

Exhibitors from metal finishing industries included Clemco, Engineered Abrasives, Metal Improvement Company, Rösler Metal Finishing USA and Wheelabrator Group. Some are pioneers in the wind energy business, some are new to the market and some are seeking business to supplement smaller work orders from the shaky U.S. automotive industry.

Ed Richerme

Engineered Abrasives

Engineered Abrasives received good leads from WINDPOWER 2009 and is already quoting a machine for a wind turbine supplier. "We just shipped a machine for the mining industry that would be perfect for peening wind turbine gears," said Richerme. "We're one of the leading shot peening machine suppliers to automotive power train companies and we apply the same advanced technology and years of experience to shot peening machines for wind turbine transmission gears."

Patti Roman and Hernan Azocar

Clemco

Clemco has been serving wind energy customers in Europe for decades, and with the U.S. growth in wind power, Clemco has recently sold blast room and media recovery systems to several turbine blade and wind tower manufacturers. Clemco exhibited to bring their experience in

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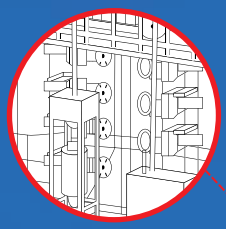

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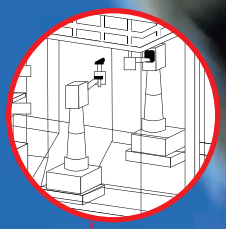

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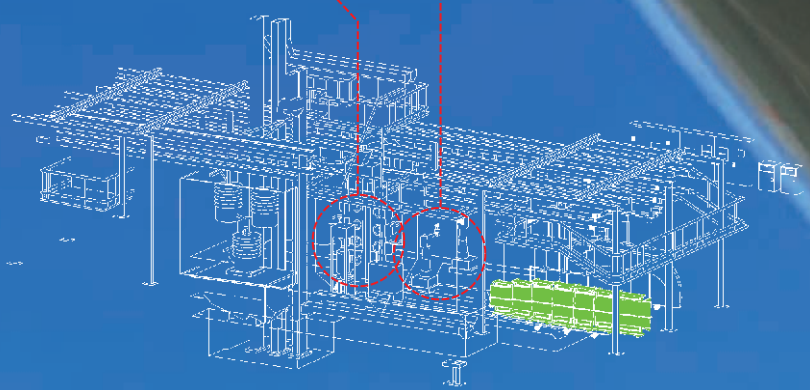

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blasting, media recovery, and shot peening to wind industry customers. According to Patti Roman, Vice President, Marketing, "With the economy in a slump, and traditional markets in turmoil, companies are drawn to this one bright spot—alternative energy—wind in particular. It was evident that this show attracted both exhibitors and attendees because no one wants to miss this boat. There were about 20,000 visitors, some of whom waited in line three hours to gain admittance. That speaks volumes about the event's atmosphere."

Graham Smith, Macon Jones, Pam Akin, Nick Szczechowski

Wheelabrator Group

Wheelabrator Group has a strong foothold in a variety of wind energy businesses—from wind tower OEMs to automotive suppliers transitioning into the wind industry. "Wind energy has been our growth opportunity especially during this current economic downturn. When the economy recovers, Wheelabrator Group is globally positioned to grow with the future demands of the wind energy sector," said Pam Akin, Wheelabrator Marketing Manager, North America.

Metal Improvement Company

"It was a good show for us," stated Mark Renius, Director of Sales, North America for Metal Improvement Company (MIC). "We met with customers and prospects, a good variety." MIC is aggressively pursuing the power generation industry. They marketed shot peening at the show as a way to prevent component failures and enable greater loads to be applied on critical design features in wind turbine shafts and gears. MIC also promoted their engineered coatings that provide corrosion resistance and wear protection. In addition, MIC offers on-site processing worldwide which is ideally suited to needs of the wind industry.

Germany has already proven that a renewable energy industry can bolster an economy. Home of Mercedes-Benz and Volkswagen, Germany will have a larger green sector than automotive industry by 2020, according to a recent study by Roland Berger Strategy Consultants in Munich. In the late 1990s, Germany's government pushed through major changes to their energy and recycling policies. The mandate for the creation of a number of incentives to drive environmentally friendly industrial development and alternative energy are maturing now: Germany has created 250,000 new jobs in renewable energy, including nearly 50,000 wind-power jobs in the last five years alone. Almost half of all the wind turbines worldwide are today produced in Germany.

While America is unwilling to commit to renewable energy with the same resolve as Germany, the U.S. is becoming more receptive to green legislation. Barack Obama promised a green policy during his presidential campaign and The American Recovery and Reinvestment Act of 2009 was passed by the United States Congress and signed into law by President Obama in February 2009. The stimulus plan allocates enough capital over the next three years to eventually double domestic renewable energy capacity. In addition, the passing of a Renewable Electricity Standard (RES) into law is being debated by the U.S. Congress this summer. According to a poll released by the American Wind Energy Association (AWEA), over 75% of Americans support a RES. The initial RES would require that 25% of the nation's electricity be generated from renewable energy by 2025. However, at the time this article was written, significantly lower renewable targets are being discussed in Congress and the bill could pass in a greatly diluted form.

Even if the U.S. federal government doesn't pass a strong RES, individual states can set their own standards and pursue renewable energy. Michigan, the epicenter of the U.S. automotive industry meltdown and subsequent job loss, has set a RES of 10% of the state's energy to come from renewable sources by 2015. The industrial behemoth that created work for hundreds of thousands of companies throughout the world is welcoming innovative, green companies. "Michigan's political and business leaders assert that Michigan's manufacturing prowess, its vast wind, fresh water and farm resources, and its location at the center of the Great Lakes shipping lanes will enable it to compete in a range of clean energy industries. The Department of Energy last year identified Michigan as one of the prime locations in the country for building and using wind turbines to generate electricity," writes journalist Keith Schneider in his article, *Michigan's Sun, Wind Sprout New Clean Energy Jobs Sector*. Close to 700 Michigan manufacturers now do wind industry work. Many of them were, or

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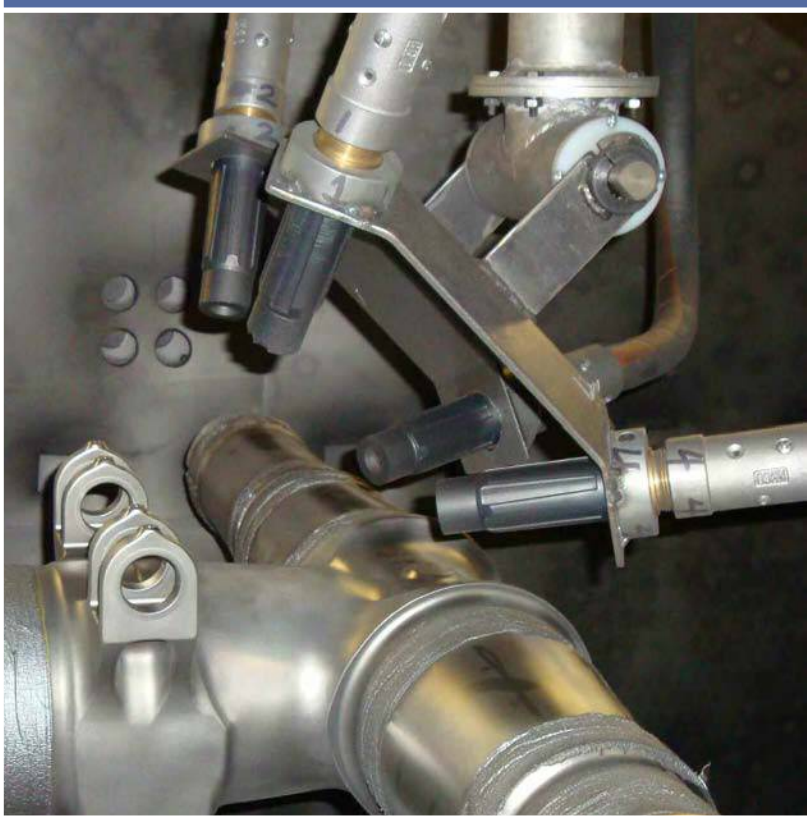

Shown right: Wheelabrator Model® LGA-08 Landing Gear System, picture courtesy of Hawker Pacific Aerospace

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still are, auto-industry suppliers. Changing over from automotive to wind industry work isn't difficult. Even though the parts are much larger, the process of making them is very much the same.

As the wind industry grows and matures in the U.S., it will need Maintenance, Repair and Overhaul (MRO) services. Research and Markets, an international research and market data firm, presents interesting statistics in its report titled "Growth Opportunities in Wind Maintenance, Repair and Overhaul Service Market 2008-2013":

- Gearbox, generators and wind blades constitute 90% of all MRO costs
- The key MRO markets will be in the U.S. and China
- The MRO market will grow 24% in the U.S. and China (14% in Europe)
- As the market matures and demand for MRO services outstrips supply, the research company sees a strong shift to third-party contracting by OEMs and the growth of independent service providers

So what is the wind gage telling us? Nimble and aggressive shot peening and blast cleaning OEMs and job shops can expect their pipelines to fill with wind energy-related work. It's not going to be as easy to get and it's not going to be as plentiful as automotive work was in the past. Companies like Clemco, Engineered Abrasives, Metal Improvement Company, Rösler and Wheelabrator Group are first in line to service a green economy. These companies all joined AWEA—they had to be members to exhibit at WINDPOWER 2009—and the benefits of membership are inside knowledge and a networking track with qualified prospects that are serious about looking for new equipment and technologies. Visit www.awea.org to learn more about the organization. Review the Upcoming Events list to see if these events can benefit you. (Studies show that the cost per sale generated through a trade show or event is almost half as much and takes about a third of the time as a sale generated any other way.)

The U.S. wind energy industry is dependent to a large degree on national policy and it wasn't immune to the recession's cruel blow. Yet there are enough indications that it's a growth industry, it creates business for the metal finishing market, and it's work that you can feel good about.

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We know about white collar, blue collar and even pink collar jobs, but our most exciting job sector may be the new green collar workforce. Green collar jobs aren't high-tech jobs that require a college education. Van Jones, author of *The Green Collar Economy*, describes green collar jobs as "blue-collar employment that has been upgraded to better respect the environment." Shot peening and blast cleaning operators working on wind turbine components can be proud to call themselves green collar craftsman.

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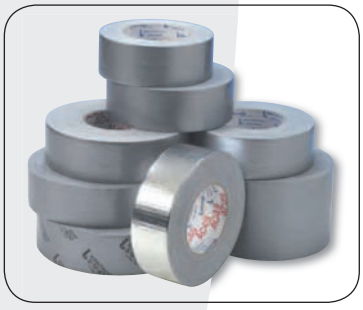

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Shot Peening: A Powerful Surface Coating Tool for Biomedical Implants

by Dr. Donncha Haverty and Dr. Brendan Kennedy of HKPB Scientific Ltd., Ireland

Dr. Haverty and Dr. Kennedy are graduates of the University of Limerick (UL), Ireland. They have established a spin-out biotechnology company from UL focused on solving the urgent bio-active coatings problems encountered in the medical devices industry today. Their patent-pending technology is a modified shot peening-based technology called Temperature Moderated – Collision Mediated Coating (TM – CMC) that allows for the coating of medical devices with thermally sensitive therapeutic agents in an one-step process.

Shot peening is widely used in the automotive and aerospace industries to reduce fatigue failure. However, shot peening and grit blasting have also been adapted to embed or coat materials onto metal surfaces and offer benefits to the biotechnology field. Three classes of modified shot peening and grit blasting techniques have been employed to this end:

- abrasive blasting or shot-peening processes utilizing a single type of solid particle comprised of a single phase
- abrasive blasting or shot-peening processes utilizing a single type of solid particle comprised of multiple phases
- abrasive blasting or shot-peening processes utilizing multiple types of solid particles, the solid particles themselves comprised of a single phase

Examples of the first class of coating technique are found in patents filed by Kuo[1] and by Arola and McCain[2]. In such processes, the single phase solid particle is carried to the substrate surface at high velocity in a gas or liquid stream. On impact, shattered pieces of the particulate embed in the metal surface. Such processes have been used to embed ceramic materials as the particles must have the appropriate properties of brittleness, hardness, size and mass to embed in the surface when projected at velocities achievable in ordinary blasting or shot peening equipment. The mechanics of the process restrict it to the embedment of particles at random in the surface and a coherent coating on the surface cannot be achieved by this means.

The multiple-phase solid particles in the second class of coating technique typically comprise a hard and soft phase, the harder phase embedding the softer phase into the metal surface. In the Rocatek™ bonding system developed by 3M, pre-roughened metal substrates are bombarded with composite particles of a hard core of alumina and a thin outer laminar layer of softer amorphous silica. On impact, the interface between the outer silica and the core alumina is broken and the energy dissipated fuses the silica to the surface of the substrate. Other examples are to be found in the work of Müller and Berger[3] and Bru-Maginez et al.[4]

The third class of coating technique, known in its earliest incarnation as peen plating, was developed in the 1970s and 1980s by a team of scientists working for the National Aeronautics and Space Administration (NASA) on the thermal, wear and corrosion properties of metals used in the aerospace industry. The earliest peen-plating patent by Babecki and Haehner[5] describes a process where a stream of fine aluminum and/or copper powder (the coating) is impacted onto a metal surface by the simultaneous peening action of a stream of glass bead shot. Subsequently the peen plating process was optimised and extended to coating with other fine metallic powders[6] and non-metals[7]. Fig. 1 is an illustration of one configuration of the peen plating process taken from Babecki and Haehner's patent.

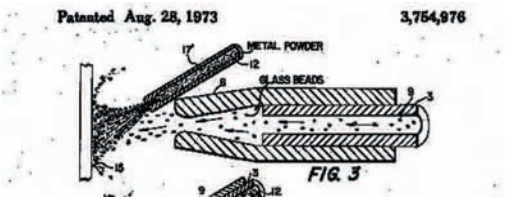

Fig. 1: An illustration from the peen plating patent of Babecki and Haehner

The peen plating process was further developed for coating metallic substrates with solid-state lubricants such as molybdenum disulphide. SURFGUARD was successfully commercialised by Techniblast Co. under licence from NASA[8] and the equipment used in the SURFGUARD process was patented by R. Spears[9]. Subsequent to the invention of the peen plating process, many variants on the theme of using the action of particle collisions to adhere materials to the surface of metals have been developed for a wide range of applications including the addition of biocompatible ceramics to the surface of biomedical implants[10, 11].

It has been recently established that high temperatures are induced in substrates during collision processes such as shot peening[12-14]. It is estimated that between 70% and 90% of the incident kinetic energy transferred to the substrate is converted to heat in the uppermost layers. In light of this, it is not surprising that whether used in the aerospace, biomedical or other industrial sectors, previous shot peening-based coating processes, such as developed by NASA, have been limited to the coating of metal substrates with fine ceramic or metallic powders primarily because these coating materials can withstand the heat generated during the collisions accompanying shot peening and because these materials are readily available in fine particulate form.

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Temperature Moderated – Collision Mediated Coating (TM – CMC)[15] was developed to circumvent the limitations of previous coating techniques and enable the coating of substrates with thermally sensitive materials, such as therapeutic agents or polymers.
The process involves atomising a liquid-based precursor coating composition to form an aerosol which is directed to the surface of the substrate in conjunction with a stream of shot particles. The collision energy released by the impacting shot mediates the transformation of the precursor composition into a well-adhered coating in a one-step process without the requirement for complex curing agents or subsequent heat treatments.

The results of initial proof of concept experiments are shown below. Fig. 2 shows the antibiotic release assay with bacterial kill zones around titanium stubs coated with hydroxyapatite and the antibiotic gentamicin using the TM – CMC process (the different sizes of the kill zones are the result of differing concentrations of gentamicin in the coatings). The stubs were ultrasonically cleaned after coating and incubated for 36 hours at 37˚C (98.6˚F) in bacterial cultures of *E. Coli*. The kill zones, where no bacteria have grown, are the result of gentamicin eluting from the coating on the titanium stub into the broth on which the bacteria grow. The antibiotic remains active through the process in all three titanium stubs.

Fig. 2: Antibiotic Release Assay for three titanium stubs coated with hydroxyapatite and gentamicin using the TM – CMC process.

An example of a polymer coating applied by TM – CMC is in Fig. 3 where a Focused Ion Beam Image of a milled section of a Teflon coating on a titanium stub is shown. The precursor composition was a dispersion of 200 nm Teflon particles in n-hexane solvent and it is clear that the morphology of the starting precursor composition is manifest in the adhered layer wherein the coating being formed by the compaction of the liquid-dispersed particles of nanometer dimensions contains pores of similar size.

This early work demonstrated that the range of materials that can be coated by TM-CMC is not restricted to inorganic solids but, under appropriate operating conditions, the technique may be used to incorporate thermally sensitive materials into coatings. We believe that this novel, patent-pending coating technique has the capacity to solve many of the urgent problems facing bioactive coatings in the medical device arena such as the problem of late stent thrombosis encountered with the Drug Eluting Stent.

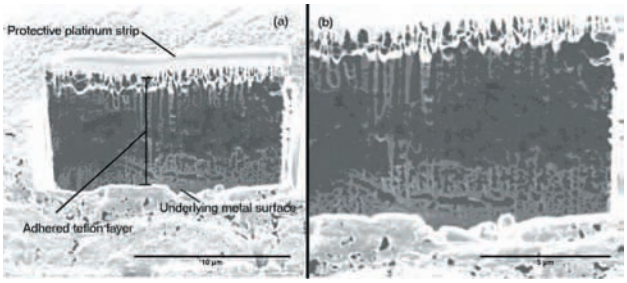

Fig. 3: A Focused Ion Beam of a titanium stub coated with Teflon

Mechanistically, while the energy released on collision of the shot with the surface is necessary to transform the precursor composition into a coating, unchecked the consequential temperature rise that would result would be detrimental to the inclusion of thermally sensitive components. The key to incorporating thermally sensitive components is moderating this heat. This is achieved through the liquid element of the aerosol, which absorbs part of the heat generated and protects the thermally sensitive components, and where necessary, the underlying substrate. Precise control of the atomisation and composition of the liquid-based precursor appears critical to the process: insufficient liquid and the temperature moderating effect is absent while excessive liquid prevents the formation of a coating.

Using a liquid medium also extends the range of materials that can be coated beyond particles. Many potentially advantageous coating compositions are not available in particulate form. For example, nano-particles are generally supplied as colloidal suspensions to prevent agglomeration and/or to protect chemical functionality with which they may be augmented. In addition, the process may readily extend to the precursor gels, sols and resins of a wide range of polymers and ceramics without the requirement for complex chemical coupling or curing treatments, circumventing the biocompatibility problems that such components present in coating methodologies currently employed in the biomedical sector.

Furthermore, TM – CMC is easily implemented in a manufacturing environment, combining two widely used and readily automated equipment platforms, atomisation and shot peening, in a new way. The company's current efforts are directed towards exercising the necessary control over the process to ensure reproducibility and quality.

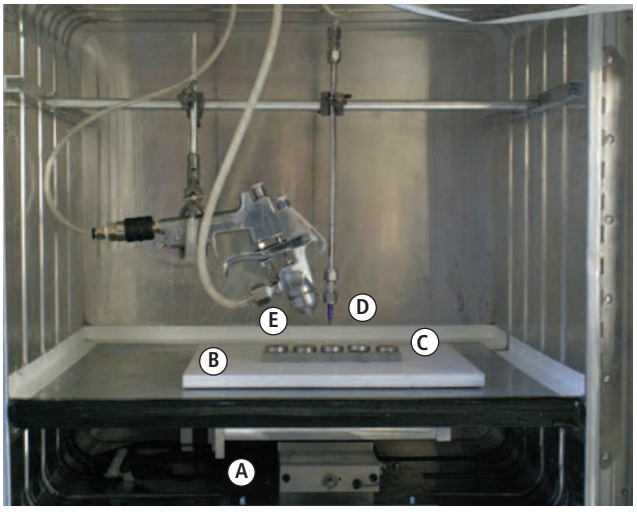

Fig. 4: The TM – CMC automated test rig

Fig. 4 shows an automated rig developed by HKPB Scientific for generating reproducible samples for physical, chemical and biological testing. The rig consists of an upper and lower chamber that are isolated from each other. An XY positioning table (A) located in the lower chamber is used to accurately move and position the sample platform (B) and the test samples (C) below the shot peening nozzle (D) and the two fluid atomiser (E). The shot peening nozzle and the two fluid atomiser are positioned so that the streams of shot and atomised coating precursor are directed to the same spot on the samples so that a coating is formed according to the mechanisms described earlier. HKPB Scientific uses aluminum oxide

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Dr. Haverty and Dr. Kennedy anticipate that the ability to control the density and energy with which the primary collision particles (shot) strike the surface in conjunction with the choice of solvent provides enormous scope for TM-CMC as a coating process. HKPB Scientific is targeting three key applications:

Hard Tissue Implants
TM – CMC has the potential to solve the two major problems encountered in the arena of hard-tissue implants: aseptic implant loosening and infection.

Drug Eluting Stents
TM – CMC has the potential to offer improvements in the area of cardiovascular drug delivery by reducing the incidence of post-operative complications and improving the stent's drug delivery.

Pacemakers and Defibrillators
Based on Centre for Disease Control (CDC) research (Klevens et al., 2007), Hospital Acquired Infections (HAI) are responsible for 5% of surgical failures of pacemakers and defibrillators. Pacemakers have been identified as a medical device that would benefit from antimicrobial coatings but currently no effective methodology exists to coat pacemakers with suitable anti-microbial formulations. TM - CMC allows for the low temperature deposition of coatings comprising a range of biocompatible materials, which may be augmented with antibiotics.

Further details on the TM – CMC process can be accessed on the HKPB Scientific website at www.hkpbscientific.com. HKPB Scientific is actively seeking partners with an expertise in automated shot peening, atomisation and related CNC and encourages those who are interested to contact us through our website.

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Shot Peening Reduces Costs for Oil Companies

TRC Rod Services of Oklahoma is shot peening oil well sucker rods to reduce costs and prevent downtime for domestic oil companies. Sucker rods are one of the most critical elements in a working oil well, connecting the pump jack at the surface of the well to a down-hole pump. The twenty-five foot steel rods are joined by threaded couplings. The pump jack rotates and forces the rod string up and down, in turn driving the down-hole pump.

The constant movement and weight on the rod string generates enormous residual stresses in the sucker rods. Those stresses often lead to costly breaks in rods. A sucker rod's life span affects an operation's profitability in two ways:

1) Sucker rods are expensive as they are made from alloyed steel.

2) Failure of one of the rods can damage other rods in the string and force the shutdown of the well to retrieve and repair the rods.

TRC Rod Services are specialists in helping major and independent oil and gas companies extend the life of their sucker rods through TRC's inspection and reconditioning services. "Sucker rod failures have the potential of costing our customers millions of dollars each year," said Don Heck, President of TRC Rod Services of Oklahoma. "At the heart of our reconditioning service is shot peening, which gives new life to used rods by greatly reducing residual stress. Our services prevent costly failures at a fraction of the cost of purchasing a new string of rods," Heck elaborated.

TRC company was formed in 1996 by a group of veterans in the sucker rod business that included Bob Payne—the originator of the sucker rod reconditioning process. "Shot peening is the most valuable and cost-effective process for sucker rod owners," Payne explained. "When we formed TRC, the industry had moved away from shot peening to cleaning the rods with shot blasting due to a lack of knowledge about the peening process and a desire to cut costs. We believed that we were uniquely positioned to bring the process back to the industry because of our prior experience in shot peening rods. And we knew that oil companies would jump on the opportunity to get new life out of their sucker rods through our reconditioning process," Payne went on.

Payne's prediction was accurate. TRC built a loyal customer base that appreciates the value of shot peening. Soon TRC's rod processing plant in Oklahoma City was operating at full capacity and needed more space. In February 2009, they opened a state-of-the-art facility situated on thirteen acres.

TRC's new sucker rod plant was based on the design of a rod plant built in 2007 by TRC's sister company, TRC Rod Services of Texas in Midland, Texas. Heck explained, "Before this plant was built, without question the most advanced sucker rod plant in the industry was the TRC Texas plant. We took their plant layout and design and improved it even further. Bar none, there are no other sucker rod plants in the country that can be compared to TRC's plants in Oklahoma City and Midland."

TRC Rod Services of Oklahoma's new facility

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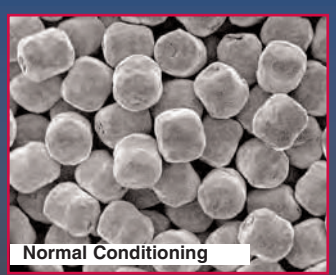
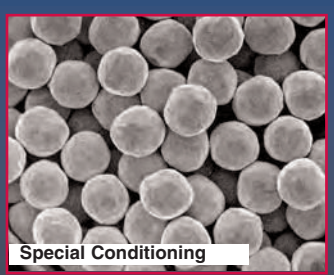
- **Lower Dust Generation -** Highest durability equals lowest dust levels.
- **Lower Surface Contamination -** Cut Wire Shot doesn't have an Iron Oxide coating or leave Iron Oxide residue - parts are cleaner and brighter.
- **Improved Part Life -** Parts exhibit higher and more consistent life than those peened with equivalent size and hardness cast steel shot.
- **Substantial Cost Savings -** The increase in useful life of Premier Cut Wire Shot results in savings in media consumption and reclamation, dust removal and containment, surface contamination and equipment maintenance.


As-cut


Normal Conditioning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A sucker rod is fed into the Wheelabrator shot peen machine

A shot peen machine is one of the most important pieces of equipment in the new facility. TRC corroborated with the engineers at the Wheelabrator Group that had installed a shot peening machine in the Texas plant. TRC worked closely with Wheelabrator to design a new machine capable of effectively shot peening rods at a rate of seventy-five feet per minute and that could be placed in line with TRC's other inspection and reconditioning processes.

"The Wheelabrator Group proved to be just what the doctor ordered," joked Heck. "We pooled our years of experience in shot peening rods with their state-of-art equipment to develop a unique piece of equipment that effectively shot peens our customers' rods at a rate that doesn't slow down our operation."

The shot peening process relieves the residual stresses built up in the sucker rods from down-hole use and it provides the same benefits attained by shot peening aircraft and automobile parts—increased strength and durability. Shot peening also helps prevents corrosion of sucker rods when they are in oil wells by putting the outer layer of the rods into compression. In addition, the anchor pattern created by shot peening enables a corrosion inhibitor, applied during the reconditioning step, to adhere better. The inhibitor prevents corrosion during storage and in-use.

TRC is still the only company in the industry that shot peens sucker rods. Perhaps that's why TRC is also the only company that provides a written warranty on used sucker rods that is equal to the warranty on new rods. "I believe that we are the only company able to offer a warranty on sucker rods run through our plant because we are the only company that shot peens the rods. This gives us the confidence that our reconditioned rods will not fail," explained Heck.

Asked why TRC's competitors don't shot peen, Heck explained, "True shot peening is not a process that is easily implemented. The equipment is expensive, but the biggest hurdle is the learning curve associated with implementing the correct shot peening procedures. You can't just go out and buy a shot peen machine and start shot peening or you would do more harm to the rods than good. It takes years of experience and dedication to know how to effectively shot peen rods, and know-how is what TRC is all about." ●

Contact Information
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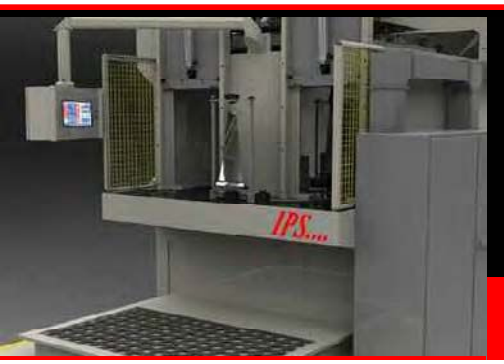

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Back to Basics: Sizing Hoses and Nozzles

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Call Herb Tobben at 636-239-8172 or submit your request online at www.clemcoindustries.com Herb Tobben is Sample Processing Manager for the ZERO and AEROLYTE brands of Clemco Industries Corp., Washington, Missouri. He is a speaker at the EI Shot Peening Workshops.

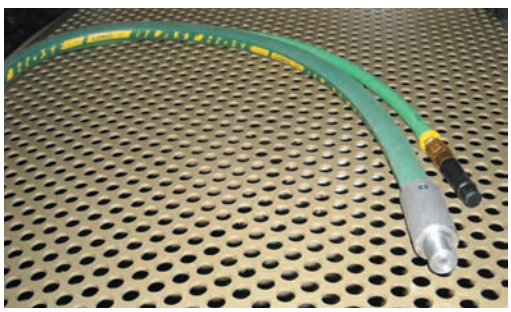
These uncertain economic times stop us in our tracks and encourage us to reconsider how we do things. We take the opportunity to examine our procedures and question our decisions so that we can find ways to make improvements. In a previous article, I wrote about how to select the right media for your application. In this article, I am offering more food for thought, this time about taking care to select and use the right size air supply hose, blast hose, and nozzle. Ultimately, all the choices you make impact system performance, productivity and efficiency. In good times, few people worry about being wasteful. We're in too much of a hurry getting product out the door and making money! Now that times are tougher, we're all inclined to think more about doing things properly to save money and time and to ensure we turn a profit.

To begin, a blast system needs to be designed for maximum performance. Next, it must be cared for to keep it performing as designed throughout its life, which for a blast system can be many decades. Proper maintenance will ensure it continues to provide optimum service for its intended purpose.

Properly sized components are carefully combined during system design. Making sure those components continue to be used through the life cycle of the product is critical. Replacing parts with the same sizes as originally specified is key to keeping the system operating at peak performance.

People frequently ask about the importance of hose size and its impact on their operation. Here are a few questions to ask yourself to raise your awareness of the important variables to consider:

- What is the application: blast cleaning or shot peening?



- At what pressure will the blasting or peening be done?
- What size and type of nozzle will do the job?
- What type of media is needed: angular or round?
- Where will the cabinet system be located and is there enough space available for proper hose arrangement?

Blast Cleaning vs Shot Peening

For blast cleaning or deburring operations, angular media are most often used and are frequently used with a rich media-to-air mix. Such a combination calls for a hose to nozzle size ratio of three or four to one. For example, a 1/4-inch nozzle calls for a 3/4-inch to 1-inch inside-diameter hose. It is the ID of the nozzle which determines air volume demand. When the recommended ratio is disregarded and the nozzle orifice is larger than recommended, premature hose wear occurs. The hose wears more quickly than it should because a larger orifice permits more media (more particles) to race through the hose, abrading the surface of the inner tube along the way. With hose and nozzle similar in size, the hose will wear much more rapidly.

In shot peening applications, round media are used in a leaner media-to-air mix, compared with blast cleaning. In these applications, the suggested hose to nozzle ratio is two or three to one. The smaller ID hose keeps velocity high, preventing excess media from accumulating in the hose and preventing surging in the flow.

Blasting or Peening Pressure

Pressure affects velocity. When using a small nozzle (No. 3 and smaller) at low pressure (20 to 40 psi), the ratio of nozzle orifice to hose ID may be further reduced to two to one. This tighter ratio keeps media moving, preventing the media from falling out of suspension in the blast hose. Media falling out of suspension causes media accumulation and surging. With higher blasting pressure (50 to 100 psi), and higher velocity, media remains suspended in the air and more easily maintains a constant flow.

Nozzle Type and Size

Your application will guide nozzle selection.

Continued on page 24

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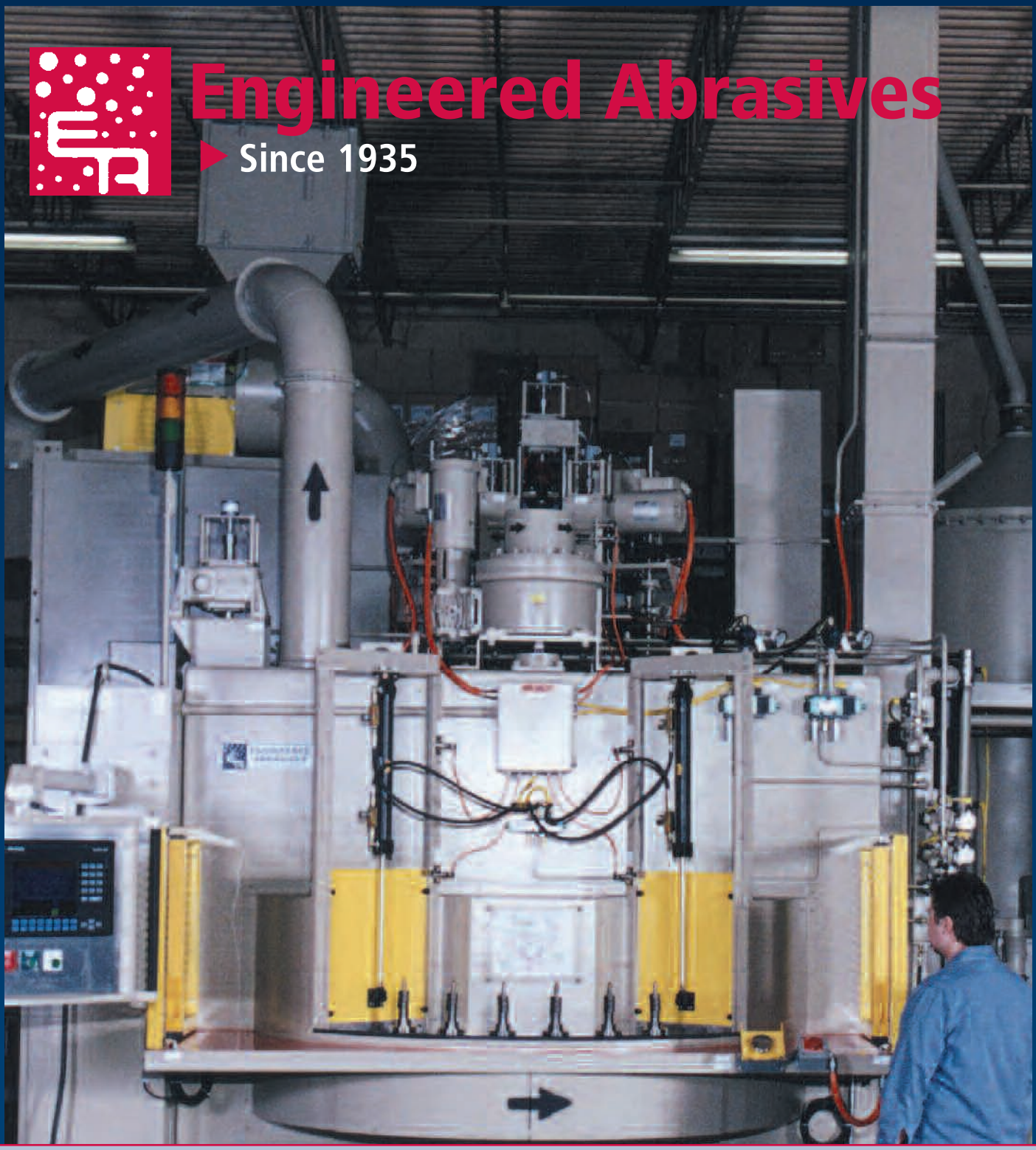

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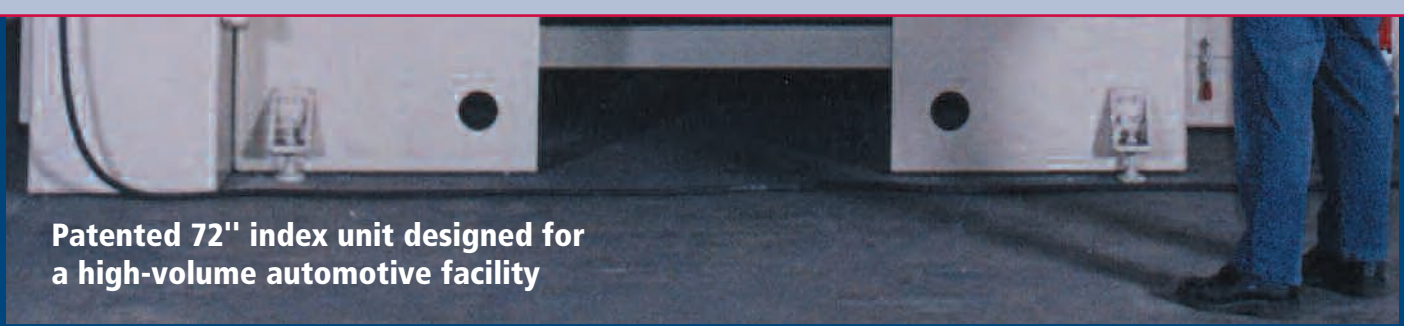

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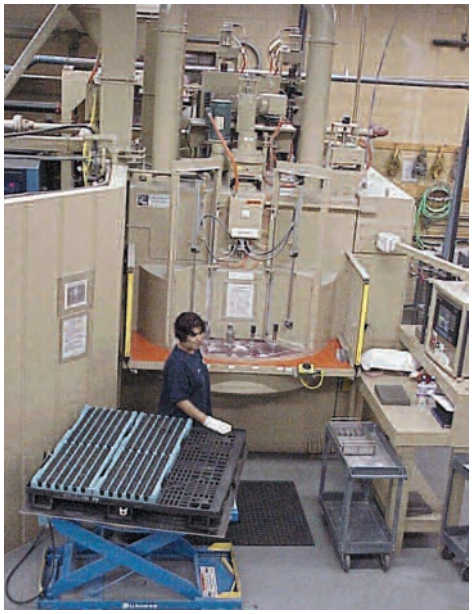

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For example, blasting into a restricted area will call for a straight-bore nozzle with or without an extension for adequate coverage. Blasting in a blind hole may call for a side-angle nozzle with a deflector tip. The nozzle orifice size will depend upon the size of the hole, ensuring there's adequate space available for blasting and evacuating media.

More accessible and exposed surfaces can be blasted with a venturi nozzle which produces a larger blast pattern and maximizes surface coverage. Blast nozzle liner material should be matched to the media to be used. Harder media calls for harder, more durable nozzle liner material. Typically, tungsten carbide is suitable with glass bead, but boron carbide is needed for more aggressive media such as aluminum oxide and silicon carbide.

Air Supply Line

A sufficiently large air supply line maximizes air delivery to the system in the required volume. Volume and pressure are equally important. Adequate air volume (cubic feet per minute, cfm) at a given pressure (pounds per square inch, psi) ensures that the blast system will perform for your purpose. Sufficiently large means as large as or larger than the blast system plumbing. The size and type of plumbing also affect the system's performance. To avoid pressure loss through the system, the plumbing in a pressure-blast system must be sized to maintain the volume of air provided to it and on through the blast hose and finally through the nozzle. Nozzle performance depends on adequate air volume and pressure to accelerate the blast media and shape the blast pattern. The size and configuration of the components are important each step of the way.

Type of Media

In shot peening applications, spherical media in a lean media-to-air mix do not normally cause rapid hose wear compared with blast cleaning applications. Spherical media do not abrade the surface as angular particles will. In a leaner mix, round particles will glide through the hose minimizing abrasion. In these applications, what's most important is consistent flow. Shot peening intensity issues develop when flow is inconsistent causing intensities to drift.

System Location

Many times so much emphasis is placed on the application that little or no attention is paid to the available space for the equipment in the shop. A critical consideration for optimal performance is minimizing the number of bends in the hoses and keeping any necessary bends in sweeping rather than tight arcs. Regardless of the application, hoses will wear prematurely where media comes into constant contact with the hose at each bend. Too many bends will reduce velocity and negatively affect blast pressure at the nozzle. In peening applications, hose bends can cause media to fall out of suspension and also cause inconsistent peening intensity.

Conclusion

Paying attention to the principles of air movement through a blast system will ensure a properly performing one. Creating a maintenance checklist and making sure the list is consulted for servicing will pay dividends in an easy-to-use, reliable and dependable blasting or peening system. If you need help, I'm only a phone call away (636-239-8172). ●

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Non-Uniformity of Shot Peening Coverage

Dr. David Kirk is a regular contributor to The Shot Peener. Since his retirement, Dr. Kirk has been an Honorary Research Fellow at Coventry University, U.K. and is now Visiting Professor in Materials, Faculty of Engineering and Computing at Coventry University.

INTRODUCTION

It would be very desirable if shot-peened components could have a uniform coverage of indentations. Unfortunately this is impossible to achieve. As a shot stream passes over a component's surface it induces non-uniform coverage. This is due to the variation of the indent ratio, Ar, that the stream imposes. Coverage is the effect that is caused by a particular indent ratio.

Indent ratio, **Ar**, is the ratio of total area of indents to target area. If 100mm^2 of indents are imposed on a component target area of 100mm^2, the **Ar** ratio is **1·0** but only induces a coverage of **63%**. With 400mm^2 of indents imposed on a target area of 100mm^2 the ratio is **4·0** which induces a coverage of **98%**.

Indent ratio, **Ar**, is the product of three factors, **peening time**, **t**, **average area of the indentations**, **a**, **and indenting rate**, **n**. Hence:

Ar = t * a * n

All of the three coverage controlling factors (**t**, **a** and **n**) vary everywhere on a peened component's surface.

Coverage – defined as the percentage of surface area indented at least once – is a beguiling parameter. That is for two reasons. Firstly, for peened components, it normally varies by only a few percent and secondly it often appears not to vary at all! Indent ratio, **Ar**, on the other hand is an effective control parameter. For example, doubling the peening time will double the indent ratio.

This article aims to show how indent ratio must vary with position on a peened component's surface. The variation of indent ratio is then translated into corresponding variations of coverage. Indent ratio variation is primarily due to the geometrical interaction between a shot stream and a component's surface. Ways of homogenizing indent ratio (and therefore coverage) are suggested.

SHOT STREAM INTERACTION WITH FLAT SURFACE

The simplest peening geometry is that of a right circular cone shot stream moving across a flat plate component. Fig.1(a) is a pictorial representation of the coverage produced by passing a shot stream of diameter, **d**, in a straight line, **B** to **A**, across a flat plate. Coverage is most intense on the center-line because that is where the indent ratio, **Ar**, is highest. Fig.1(b) is a schematic representation of the variation of the three factors contributing to **Ar**.

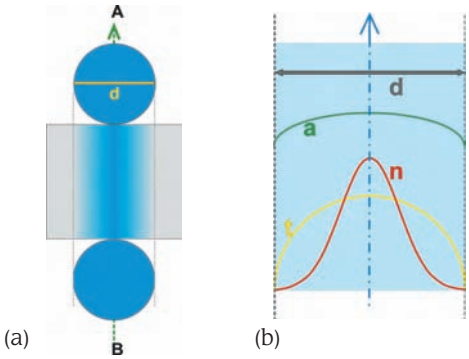

*Fig.1. Variation of (a) coverage across a shot-peened trace and (b) factors contributing to indent ratio, **Ar**.*

t is the amount of time that the shot stream is in contact with any particular spot on the component. For a circular-section shot stream that time varies precisely as a semi-circle.

n is the number of indents being produced per unit area per unit time. This is known to vary as an approximate 'normal distribution''.

The average area, **a**, of the indentations will be lower at the edges of the indented region than at its center. That is mainly because the shot particles at the surface of the shot stream cone travel more slowly than those at its center.

INTERACTION OF INDENT PARAMETER VARIATIONS

Indent ratio, **Ar**, is the product of the three contributory parameters t, a and n. Using fig.1(b) as a model indicates that the product varies as does a 'normal distribution' – albeit with 'lopped-off tails':

$$Ar = Ar_{max} * [\exp(-(x-50)^2/400)] \quad (1)$$

where Ar_{max} is the maximum value of **Ar**, **x** is the position of **Ar** across the trace in % and **50** is the center of the normal distribution.

Fig.2 shows the 'normal' distribution predicted by equation (1) when $\mathbf{Ar_{max} = 4}$. The inclusion of the coverage levels illustrates the considerable difference between indent ratio variation and coverage variation.

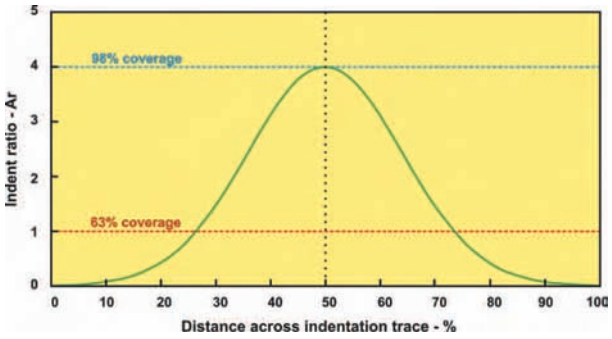

Fig.2 Model of indent ratio variation across an indent trace when Ar_{max} is 4·0

RELATIONSHIP BETWEEN INDENT RATIO AND COVERAGE

The known relationship between coverage, **C**, and indent ratio, **Ar**, is that:

$$\mathbf{C\% = 100[1 - exp(- Ar)]} \quad (2)$$

Substituting the value of **Ar** from equation (1) into equation (2) gives that:

$$\mathbf{C\% = 100[1 - exp\{-Ar_{max}*(exp(-(x-50)^2/400))\}]} \quad (3)$$

Equation (3) allows us to estimate the variation of coverage across shot peening traces and is plotted as fig.3 for different values of $\mathbf{Ar_{max}}$. Here a first pass, 1, has $\mathbf{Ar_{max}}$ = 1 with a maximum coverage on the centre-line of 63%. This first pass gives a coverage that varies widely across the peened trace. Subsequent equal passes, 2 to 7, impose increasingly uniform coverage about the centerline.

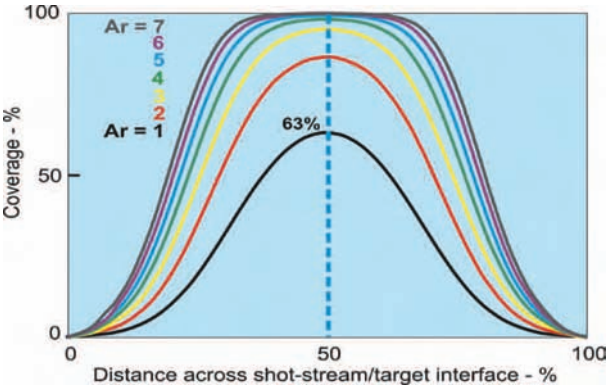

*Fig.3 Effect of maximum indent ratio, **Ar**, on coverage variation across the interface between a uniform conical shot stream and a flat target.*

An indent ratio, **Ar**, of 4 imposes a maximum coverage of 98%. It follows that a larger indent ratio would be needed to achieve "full coverage" (98%) over a reasonable fraction of the stream/target interface. Fig.4 contrasts the variations of indent ratio and coverage when $\mathbf{Ar_{max} = 6}$.

The variations of coverage shown in figs.1(a) and 4 are substantial. They reflect what happens in practice. Passing a conical shot stream over a flat plate component is analogous to trying to paint a wall using a round paint brush – coverage variation is then all too obvious. As with

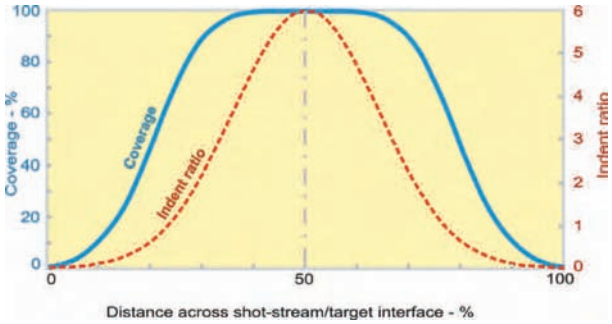

*Fig.4 Variation of Coverage, **C**, and Indent ratio, **Ar**, across a peened trace when $\mathbf{Ar_{max} = 6}$.*

the analogy, a more uniform coverage is achieved by using a series of overlapping parallel strokes/passes.

OVERLAPPING SHOT STREAM PASSES

Components are normally peened by using several passes which involve overlapping. There must be some degree of overlapping in order to avoid having completely unpeened areas. It is the degree of overlapping that is important. Fig.5 represents three degrees of overlap – 50, 60 and 70%. When dealing with this problem it must be noted that only **Ar** values are mathematically additive. We cannot simply add coverage values.

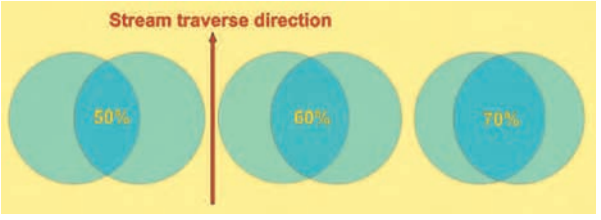

Fig.5 Model of parallel shot streams overlapping by 50, 60 and 70% of their diameters.

Fig.6 is a pictorial representation of the variation in coverage, caused by overlapping of parallel passes. The 'stripe effect' can only be observed on peened components when low coverage values have been applied. That is because we cannot normally distinguish between a 'high degree of coverage' and a 'very high degree of coverage.' If, however, the **Ar** ratio varies between say 1 and 2, then coverage varies from about 63% to 86% - which is normally detectable.

Fig.6 Representation of variation of coverage for overlapping parallel passes.

Quantification of coverage variation due to overlapping requires the application of equation (3). The following is an example that illustrates how such an application can be carried out.

Example: Effect of Parallel Pass Separation on Coverage Variation When a Nominal "100% Coverage" is Specified. Parallel passes will have normal distributions that have different centers. Equation (3) can be modified to accommodate these different centers:

$$\mathbf{Ar} = \mathbf{Ar}_{max}*[\exp(-(x-d)2/400)] \quad (4)$$

where **d** is the position of the pass center - as a % of shot stream width.

The first pass will have a **d**-value of **50**. A **d**-value of **150** for the second pass would be too large - the passes would touch rather than overlap. As a first guess we can assume an overlap of 50%. Hence we have a **d**-value of 100 for the second pass, 150 for the third parallel pass and so on. The combined **Ar** values with $\mathbf{Ar}_{max} = 5$ are then:

$$\mathbf{Ar} = 5\ [\exp(-(x-50)^2/400) + \exp(-(x-100)^2/400) + \exp(-(x-150)^2/400) + \ldots] \quad (5)$$

Substituting the value of **Ar** from equation (5) into equation (3) and then plotting gives the coverage variation shown in fig.7. The coverage varies in a cyclical manner from a maximum of 99% to a minimum of 87%. Repeating the exercise with a greater overlap, 60%, gives the result (also shown in fig.7) that coverage now varies from 99% to 97%. This might, or might not, be regarded as satisfying an overall "100% coverage requirement." Increasing the overlap to 70% certainly satisfies the requirement - the coverage minimum exceeds 99%. It is significant that the 'Coverage period' of the cyclical fluctuation of coverage is equal to the separation of the parallel stream centers.

It may be concluded that an overlap of between 60 and 70% is required to satisfy the specification.

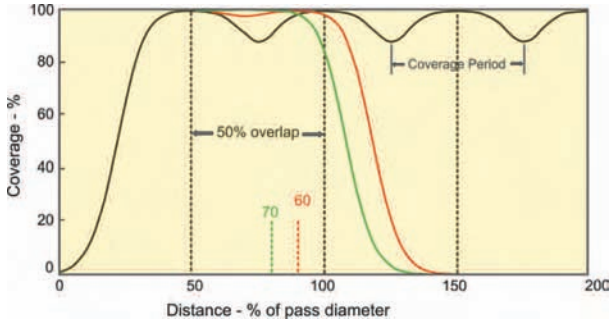

Fig.7 Effect of degree of overlap on coverage induced by parallel passes.

MULTIPLE INDENTATION, INDENT RATIO AND COVERAGE VARIATION

The greater the indent ratio the greater are both the coverage and the degree of multiple indentation. Fig.8 indicates the effects on multiple indentation of applying two different indent ratios – 4 and 8 – inducing coverages of 98.2 and 99.97% respectively (both being above "Full coverage" of 98%). The average number of indentations has doubled with doubling of the indent ratio. More significant, however, is that a significant percentage of the surface suffers at least 14 indentations when **Ar** equals 8.

Indent ratio and coverage both vary when overlapping shot stream passes are applied. Harmful indent ratios may occur due to either repetition or overlapping of shot stream passes having high **Ar** values.

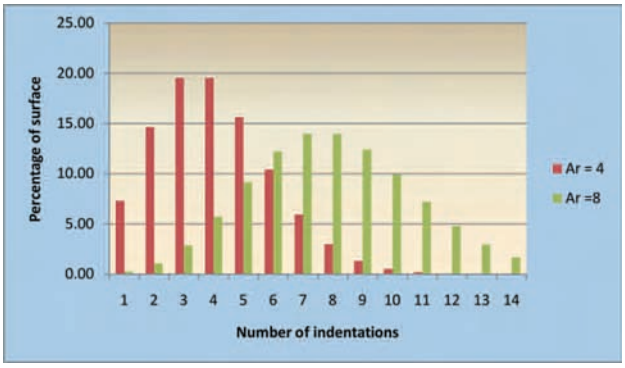

Fig.8. Percentage of surface receiving different numbers of indentations.

DISCUSSION and CONCLUSIONS

Practical shot peening is multifarious in that a wide variety of component geometries and materials are involved. Skill and ingenuity are required in order to achieve acceptable levels of coverage and intensity at all specified locations. The concepts described in this article show why it is impossible to achieve absolute uniformity of coverage.

Coverage variation due to shot stream/flat surface interfacing has been analyzed. The unavoidable coverage variation that occurs for that situation would be greater if the shot stream was angled to the component's surface. A circular impacting area then becomes elliptical – enhancing the 'sharpness' of the normal distribution of indent ratio. Wheel-blast peening would be predicted to give even greater coverage variation - because of both angling and the enhanced shot stream 'hot spot' that is present – if applied to a large flat area.

A circular-section shot stream imparts a wide range of indent ratios and corresponding coverage levels. This is particularly significant when identical passes are to be made over the same region of a component. One familiar example is that involving the generation of Almen saturation curves. It is important that the axis of the shot stream is aligned with the major axis of the Almen strip – centralizing the 'stripe' of coverage. Misalignment will induce eccentric coverage relative to the major axis – hence affecting arc height.

The prime objective with shot peening is to induce a compressively stressed surface layer that enhances service performance of components. Coverage and intensity level attainment are secondary objectives. A completely continuous compressively-stressed surface layer is generated at coverage levels well below 50%. The magnitude of the residual compressive stress increases with coverage to a maximum value and then falls as 100% is being approached. That is consistent with the growing evidence that optimum service performance normally occurs at coverage levels below 98%. It follows that coverage variation about an optimum level is better than exceeding the optimum level at all points of the shot-peened surface. ●

Switching Over
Peening with a Cleaning Machine

Kumar Balan is a Product Engineer with Wheelabrator Group

Present times call for innovative approaches. If your blast cleaning workload has decreased, can you take on peening projects to put idle machinery to work? Yes, there might be business out there that won't require a big investment to get it; however, it is important to understand the differences between blast cleaning and shot peening before you make any changes.

Cleaning is an Art, Peening is a Science

It's not unusual for blasting operations to expect shot peening results from their equipment. Though seemingly similar processes, a bit of understanding will reveal that cleaning is an art and peening is a science.

The first difference that sets peening apart from cleaning is the evaluation of the success of the process. The most common cleaning evaluation method is visual inspection. If a particular surface roughness is a requirement, the surface is checked with a profilometer. In comparison, peening results are more quantifiable and defined. The shot peening operator is required to achieve and maintain a particular intensity by checking the process with Almen strips, an Almen gage and saturation curves, and then achieving 100% or greater coverage on the part. This process is crucial since the intensity represents the compressive stress imparted onto the component. Compressive stress prevents premature failure.

The end users of peened components are typically in aerospace and automotive. They work with stringent specifications and require conformance without compromise. These requirements are always passed on to their vendors with no room for subjectivity. To meet specifications, peening shops are required to:

- Monitor media velocity (air pressure or wheel speed)
- Classify shot size and shape (rounds versus non-rounds)
- Monitor media flow rate
- Provide real-time information about the process
- Trigger and shut down when such process parameters stray outside of set limits

In addition, though specifications may not stipulate a particular method of monitoring and controlling process variables, the following means are popularly adopted:

- Variable frequency drive for blast wheels and PID loop for air pressure (a PID – Proportional – Integral – Derivative controller attempts to correct the error between measured and set-point values)
- Vibratory classifier with different screen sizes (listed in most specifications for particular shot sizes) for size classification and spiral separator for separating rounds from non-rounds
- Flow control valve (example: MagnaValve) with regular drop tests for verification
- PLC-driven operator interface with graphic display of the process

The Right Shot is Crucial in Peening Operations

The choice of shot size in cleaning applications is forgiving in nature. In peening, the engineering drawing and intensity requirement will stipulate this variable. Also, contamination between different shot sizes is not permitted for peening. Centrifugal wheel type blast machines flow a greater amount of blast media (five or more times) than air type machines. Therefore, changing media to a different size is not as easily achieved in wheel machines.

Based on the number of wheels, classification of shot in a wheel type machine can be continuous, but not economically at 100% of the flow rate. In a nozzle type machine, 100% of the flow rate of shot (or other media) can be classified on a continuous basis.

Wheel type machines are also not effective in propelling non-ferrous media such as glass bead and ceramic bead— the two types of media used in some aerospace peening applications.

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It is important to understand the limitations of your equipment before attempting conversion.

Can You Make it Work?

Your marketplace and existing client base may offer the potential for peening projects while your equipment sits idle, waiting for cleaning work. As daunting as the difference between cleaning and peening seems, it is worth your time to explore the possibilities.

First, evaluate your current cleaning process and determine the 'health' of your machine. An audit of the different components will help you determine the feasibility of a switchover. For example, installing a frequency drive to your blast wheel and retrofitting your existing flow control valves with more sophisticated MagnaValves isn't difficult or capital intensive.

Shot maintenance is critical in shot peening. If you are seriously considering peening projects, you are at the stage where you have to identify which of the two (cleaning or peening) will assume importance. In other words, it benefits you to minimize or totally eliminate media changeover. Assess the peening projects that you are interested in and determine the media size. Until you are ready for greater equipment investment, you may have to restrict your business to projects that require the same shot size. This task is easier if you have multiple machines and you are able to dedicate a machine to a shot size. When you make the switchover, establish a regular practice of cleaning your blast media offline in order to retain only good media in your machine. This will go a long way in achieving consistent and repeatable peening results.

Industry sectors like medical, mining and power generation are warming up to the idea of shot peening as a life-enhancing process for their parts that undergo cyclic loading. Peening specifications for these sectors are not as clearly defined as in aerospace and automotive. Therefore, such prospects will require more education on the benefits of peening. You will need to have stress tests performed on the parts to demonstrate the benefits.

An important responsibility rests with the operator of a machine that's converted to peen. The operator has to recognize the importance of this new process and treat it more scientifically than required by a cleaning project.

Lastly, if you can forecast new business by converting your cleaning machine into a peening machine, don't be overwhelmed by the task. The shot peening industry is fortunate to have professional, comprehensive training programs (workshops and on-site) that will get you and your staff up to speed quickly on every aspect of shot peening. Your operators can earn a Certification of Achievement that will give your customers the confidence to trust your facility with their shot peening work.

The revenues associated with being a prime mover and enrolling new customer segments can far outweigh the upfront expenses and time involved with a switchover. ●

This discussion is part one of a two-part series. Part two in the fall issue of The Shot Peener will discuss how your peening machine can be utilized for cleaning and other special applications.

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- preparing for an audit, including Nadcap audits
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Photo credit: Arizona Shot Peening Workshop. Mark Skalny, Photographer.

Christchurch, New Zealand
August 25-27

Shenzhen, China
September 2-4

Albuquerque, New Mexico
October 27-29

A sampling of survey comments from our workshops:

"The workshop was a wonderful experience for myself to spend time with people who are both passionate and extremely knowledgeable with regards to this field."

"This was a great workshop for a rookie like me. I am a Maintenance Super and learning more about the process makes me a better troubleshooter."

"I learned more in 2 ½ days at this Workshop than in 25 years of what I thought was right!"

"This was my first. I learned a lot and will definitely try another Workshop and recommend to others!"

"Very nice workshop. I will recommend it to my colleagues!"

"Great job—I appreciated the classes, the tours and the food."

"The most beneficial classes were 'Coverage', 'Intensity' and 'Putting it all Together".

"Very positive experience. I would definitely like to return."

Electronics Inc.
Education Division

56790 Magnetic Drive, Mishawaka, Indiana 46545 USA

Industry News

Integration of Surface Treatment Businesses and Establishment of Sinto SBtec Company

Nagoya, Japan. Sintokogio merged its subsidiary, Sintobrator, Ltd., which manufactures and sells surface treatment equipment, steel shot and other abrasives, and inspection and measurement devices, and establish a new in-house company named "Sinto SBtec Company," effective as of April 1, 2009.

By integrating the business of Sintobrator, Ltd. and the surface treatment business of Blastec Company of Sintokogio, the strength of both companies will be consolidated and the businesses of equipment, consumables and maintenance will be developed globally. A total 3-in-1 solution will be available to customers in the surface treatment industry.

Organization Responsible for Nadcap Audits Gets "Guru Validation" of New Training Program from Goodrich Employees

As part of Customer Solutions & Support (CS&S), the Performance Review Institute (PRI) has launched eQuaLified. eQuaLified represents an industry-recognized special process personnel qualification system developed and validated by industry subject matter experts.

One objective of eQuaLified is to ensure consistency and competency validation in the aerospace industry, while mitigating knowledge loss or disparity due to attrition, turnover and/or relocation. By using the industry's subject matter experts to develop this training and qualification program, eQuaLified will contribute to the successful knowledge transfer to the next generation within the aerospace workforce.

Based on Bodies of Knowledge established by participating Primes, PRI has worked with industry experts to objectively characterize the special processes skills and knowledge of aerospace personnel levels:

1. Process Operator - Process Operators understand and perform the basic hands-on operations of the special process.
2. Process Planner - Process Planners are capable of designing manufacturing processes and interpreting process procedures to conform to customer specifications and requirements. Process Planners are capable of problem solving and resolving day-to-day issues.
3. Process Owner - Process Owners capable of writing, reviewing and approving processes, procedures and qualifications of lower levels. Process Owners are capable of designing new processes and resolving issues among all the other levels.

Goodrich Corporation Perspective

No one is more qualified to size up the effectiveness of a training program about a special manufacturing process than the people who perform that process day in and day out. PRI - the organization that administers Nadcap, the aerospace industry's cooperative program for ensuring that companies performing special processes comply with exacting standards - got just this kind of guru validation from Goodrich and Honeywell employees. In February 2009, PRI instructors were at the Goodrich Corp. Chula Vista facility to conduct a pilot training program on heat treating, non-destructive testing and welding.

"Inadequate training in special manufacturing processes - or the lack of any training at all - is a common finding during Nadcap accreditation audits conducted around the globe to ensure the competency, capability and consistency of companies performing special processes," according to Goodrich Enterprise Quality Director Kevin Ward. "In recognition of this shortcoming, aerospace prime contractors and suppliers - including Goodrich - have pooled their resources to help PRI develop special manufacturing processes training. By gathering input from these sources, PRI has put together a cohesive, global training package."

eQuaLified is part of PRI's Customer Solutions & Support (CS&S), which exists to provide quality customer-driven and cost-effective business solutions to continually improve organizations throughout the world. Learn more at www.pri-network.org

Wheelabrator and DISA Complete Merger

DISA Group, the biggest name in moulding and casting technology, has merged with Wheelabrator Group, the world leader in surface preparation technology, to form the world's leading metallic parts enhancement company. Effective from 1st May, the two companies, both owned by Mid Europa Partners, have been given official approval by the German Bundeskartellamt to complete their merger process, begun on September 4, 2008.

Robert E. Joyce Jr., President and CEO of the newly merged company said: "This is an incredibly exciting time for the company, our employees and our customers. I am confident that the merger of DISA and Wheelabrator will provide our customers with world-class technologies and local service offers unparalleled in our industry.

"In preparation for the merger, the management teams from DISA and Wheelabrator have been working together to combine the best of both companies. 'Best of Both' became a theme during the planning process, and now it becomes reality as the result of all the planning comes to fruition."

"Our central focus as a merged company is simple - enhance our customers' metallic parts and components. We will do this by driving down their overall costs in two ways. First, we will focus on lowering their manufacturing cost-per-part and second, by providing a longer component life."

As a united organisation, DISA Group and Wheelabrator Group employ 2,500 people across five continents and together serve such diverse industries as Aerospace, Automotive, Energy, Foundry, Medical Components, Rail and Marine.

Robert E. Joyce, Jr. concluded: "The combined DISA and Wheelabrator teams present a tremendous advantage for our customers. Our technology can be found in multiple industries throughout the world. Our breadth of technical knowledge and local service delivery mean that we can provide our customers with solutions to their technical challenges anytime, anywhere and in any language. From East to West and North to South, we stand ready to enhance our customers' metallic parts."

Study of the Wear Failure of the High Carbon Cast Steel Shot for Blast Cleaning

Jinana, China. A new study from researchers at the Shandong University, LAIWU Steel Corporation and Shandong Kaitai Metal Abrasive Company is available at the online library at www.shotpeener.com. The Abstract and Introduction follows.

Xinhua Zhao[1], Ruwei Liu[1], Hongwei Wang[2], Hongju Gao[1], Laibin Zhang[3], Ruiguo Wang[3]

1. College of Materials Science and Engineering, Shandong University, Jinan 250061, P.R.of China,
2. Chemical Products Recovery Shop of LAIWU Steel Corporation, Laiwu 271104, P.R.of China

3. Shandong Kaitai Metal Abrasive Co. Ltd, Zouping 256217, P.R. of China

Abstract
In this study, five different samples of high carbon cast steel shot, undergone different heat treatment, were put into the ERVIN test machine and run for certain cycles to emulate the real blast cleaning process. The wear failures of the samples were observed by SEM, the failure modes were categorized and the root causes of the failure were analyzed. The results show that the wearing of the high carbon cast steel shot in cleaning process is impact wear and the failure modes can be classified as brittle fracture, surface peeling, core spall and massive split.

Keywords: high carbon cast steel shot; wear failure; surface peeling; core spall

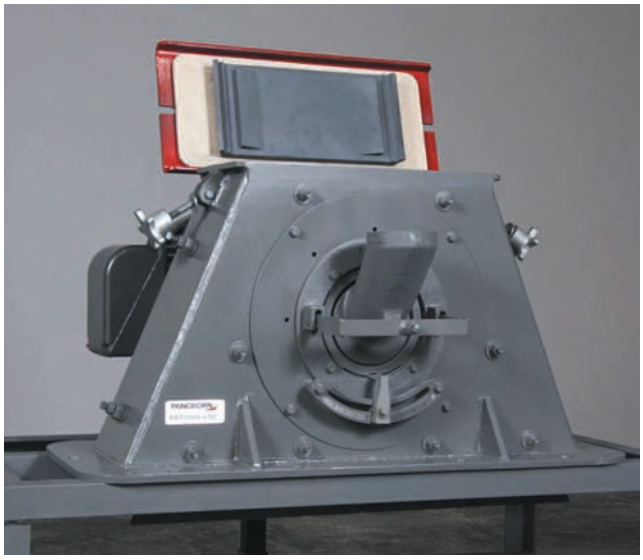
Introduction
In the blast cleaning studies, most researchers only focus to the blast cleaning equipments and the applications of the abrasives, not the wear failure process of the abrasives, a key factor which decides the cleaning effectiveness, abrasive consumption and overall cost. High carbon cast steel shot is one of the most commonly used metal abrasives and widely used in the blast cleaning applications. At present the abrasive manufacturers only provide the technical data and physical characteristics in the data sheet based on related standards[1,2]. Based on the material, hardness, shape of the work piece and required blast cleaning effect, end users only pay attention to the chemical composition, hardness and size of the abrasives. The ERVIN life and wear failure modes are not given enough importance.

In practice, the cast steel shot abrasives, used for shot blast or air blast cleaning, are impinged to the work piece at a velocity of 50?80 m/s [3]. The work piece is cleaned and strengthened while the abrasives are deformed, worn and lost its size and weight. In this study, the ERVIN test machine is used to mimic this process, high carbon cast steel shot is run for a certain cycles and ERVIN life is determined by percentage of replacement or breakdown curve[4,5], furthermore different failure morphologies of the high carbon cast steel shot are observed and analyzed.

Organizing Committee Sets Dates and Location for ICSP-11
Mishawaka, Indiana. The Eleventh International Conference on Shot Peening (ICSP-11) will be held on September 12-15, 2011 at the Century Center in South Bend, Indiana USA. The Century Center will be an ideal venue for the event: it has well-appointed auditoriums, trade show space and dining facilities and it's connected to the Marriott Hotel by a skyway so that attendees can walk to and from the conference in comfort.

The South Bend Century Center on the St. Joseph river will be the venue for ICSP-11.

Pangborn Introduces Genesis Blast Wheel Technology



Fairburn, Georgia. Pangborn Corporation announces its innovative Genesis family of wheels. The Genesis family of wheels offers unmatched performance, better cleaning and significantly lower operating costs.

The Genesis line includes high-speed, 14"-18" diameter wheels with either single or double-sided runnerheads. The low-speed, 19.5" – 26.5" diameter wheels provide reduced consumption of abrasives, better cleaning and lower horsepower requirements.

Pangborn's new Genesis blast wheels offer major improvements over traditional blast wheels. Key advantages:

Easy assembly and maintenance. Front-of-housing access to runnerheads is just one of the Genesis features that enable full assembly in less than one hour. Setting the pattern length is now a quick, one-step job. Dual-tapered vanes eliminate "shot locking."

Long-lasting parts. Genesis has replaceable housing liners, which are less expensive to replace than one-piece cast manganese housings. Cast linings are made with Pangborn's proprietary P-41 metallurgy. Tight tolerances result in significantly less wear.

Economical operation. Users of all Genesis wheels can expect rapid ROI from simplified maintenance, faster cleaning cycles and high longevity of parts. In addition, the low-speed wheel saves money through reduced consumption of abrasives and lower power requirements.

Increased safety. New safety innovations include a lid with pin-locked safety hinges, an integral U-shaped feed spout safety lock, and rapid release vanes.

"Customers who want to save time, save money and improve efficiency will be ideal candidates for the Genesis family of blast wheels," said Donna Gordon, Pangborn's vice president of business development. "Genesis represents change versus traditional thinking in blast technology. Shot blast customers will find a range of choices, all with the ability to tailor features of the equipment to best meet their specific needs."

For more information, visit www.pangborn.com or call 800-638-3000.

Pangborn Merges with European Shot Blast Industry Leaders

Fairburn, Georgia. Capital Equipment Resources LLC, the parent of Pangborn Corp, a North American shot blast wheel manufacturer, has signed a final agreement with Wheelabrator/Disa Group to acquire Pangborn Europe, V+S and Berger.

The merged companies will operate six facilities – two in the U.S., two in Germany, one in Italy, and one in the U.K. These industry leaders will continue to design, manufacture and distribute trusted brands of shot blast machines, dust collectors, and after-market products, and offer rebuilds and related products and services in the surface preparation industry.

The formal names of the European companies are WG Technology S.r.l. (Pangborn Europe), Vogel & Schemmann Maschinen GmbH, (V+S) and Berger Strahltechnik GmbH (Berger).

"This merger expands our product and service offerings for our customers around the globe," Ken Dickson, President of Pangborn Corporation said. "The addition of these leading brands brings tremendous synergies and resources in technology, products and talent."

"Each acquired company is a perfect fit for Pangborn," Dickson said. "They expand our global presence and position us for further growth in the surface preparation industry,"

Pangborn Corporation has designed and manufactured shot blast machines since its inception in 1904. Pangborn's worldwide headquarters is in Fairburn, Georgia. It also operates facilities in Maryland and the U.K. Capital Equipment Resources, an affiliate of Atlas Holdings LLC, acquired Pangborn in June of 2006. Atlas Holdings operates businesses in industrial sectors that include: the paper, packaging, wood products and steel industries. Atlas operates more than 30 facilities in North America and Europe. Its companies employ about 3,000 people. For information, visit www.atlasholdingsllc.com.

New Coverage Predictor Program is Available

Mishawaka, Indiana. Dr. David Kirk has made another substantial contribution to shot peening practices with the development of the Coverage Predictor Program that will help predict peening coverage. Evaluate the amount of coverage achieved in a single pass, or one pass, and enter that percentage estimate into the Coverage Predictor Program (Excel spreadsheet format) and the graph will display an estimated number of passes to achieve full coverage. Dr. Kirk is offering this tool, **free of charge**, through Electronics Inc. Request a copy today at www.shotpeener.com and try it for yourself.

SAE Specifications Update

As chairman of the Surface Enhancement Division of the Fatigue Design and Evaluation Committee, I have had a unique opportunity to participate in the development of shot peening standard practices. I have witnessed the evolution of concerns from media production and maintenance issues to practices of determination of coverage and measurement of intensity. Throughout this association I am impressed with the enthusiasm of the many dedicated committee members that forge ahead with new and exciting practices.

At our last meeting on May 12 in Troy, Michigan at the SAE Detroit office, we discussed several significant changes and these will be posted at the SAE web site for ballot as you read this. There were minor changes suggested for J442 regarding the Almen holder. The dimensions of the holder described in AMS-S-13165 (now cancelled) are different than those describe in J442. We decided to adopt the 13165 holder drawing as an alternate acceptable device thus prolonging the life of those holders. A change in J2277 would add the word "Determination" to the title to make to "Shot Peening Coverage Determination" since the document deals with methods of determining coverage, not specifying how much coverage should be obtained.

Changes in J443 address methods of determining intensity when "saturation" is achieved in one pass through a machine or one rotation on a turntable. It also addresses a new method of selecting the exposure time for intensity confirmation when two or more holders are mounted on a fixture. The present practice requires exposure of each strip location at its T1 saturation time. Multiple holders will have multiple saturation times. A very common practice is to expose the holder fixture to the longest duration saturation time and then accept/reject based upon the resulting arc heights. That's not valid with the present specification. A novel technique is introduced that allows a single exposure time but with a new accept/reject criteria. In my four decades of involvement with shot peening I found one, and only one, shop that actually performed the confirmation tests appropriately. I was visiting Holger Polanetzki (2008 Shot Peener of the Year) at MTU and during a shop visit I asked the operators how they performed the confirmation tests since there were five holders on the fixture. I was flabbergasted. They ran each strip holder location at its own saturation time. I was impressed. I never thought I'd see it happen. I understand that both Boeing and GE are addressing this issue in their own standard practices. It's great to see this improvement in shop practices.

The spring meeting of this committee is held each year at the SAE Detroit office in Troy, Michigan. The fall meeting will be held on Monday, Oct 26, in Albuquerque, New Mexico (prior to the annual Electronics Inc. Shot Peening workshop).

Other meeting news: The Aerospace Materials Engineering Committee meeting will be held in Chicago, Illinois on August 4-5. The Surface Enhancement Division will meet on Monday and I will report to the main group on Tuesday. Hot topics for that meeting are cancellation of AMS-S-13165, modifications to AMS 2430 and AMS 2432 and various sub-parts of AMS 2431 regarding media.

If you are not already a member of these committees and would like to become involved, send me an e-mail at jack.champaigne@electronics-inc.com.

Other news: Dr. Kirk's new versions of his Saturation Curve Solver programs are compatible with Microsoft Office 2007. Microsoft rearranged the tool bar location for "Solver" and Dr. Kirk had to revise the instructions to comply with the newer version.

He has also made available a spreadsheet program called "Coverage Predictor." It's a teaching tool to illustrate how much time might be needed to obtain full coverage when you have performed a partial coverage experiment. For instance, if you expose a part to one minute of peening and estimate that it has 40% coverage, how many minutes would be required to achieve 98% coverage? Fire up this program, enter 40 in the appropriate cell and observe the size and shape of the accompanying graph. This would work with a turntable application as well. Plug in the estimated coverage after one rotation of the table and the graph will illustrate a predicted time needed for full coverage. Thank you Dr. Kirk for making these programs available to everyone free of charge. ●

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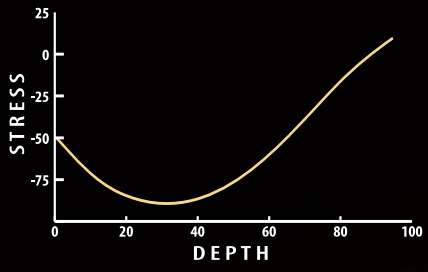

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