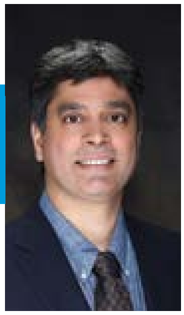

AN INSIDER'S PERSPECTIVE
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Misconceptions in Shot Peening

To err is human, to forgive, especially in shot peening, might need a new saturation curve! Much as we discuss peening fluently within our circles, fundamental concepts of the process continue to be misunderstood even among regular users. Though users that operate the process with strict conformance to specifications such as AMS 2430 and 2432 are expected to have a better understanding of the process, I have noticed gaps there as well.

In this article, we shall discuss some of the common misunderstandings I have seen in our industry. Misconceptions range from deflecting the Almen strip and referring to the arc height as intensity, to several other areas of equal, fundamental significance. The purpose of our discussion is to help current users and those that will be specifying new peening equipment in the future to make informed decisions.

Saturation Time "T" and Cycle Time

Unlike in aerospace, automotive applications are highly motivated and driven by throughput or production volumes. Though I do not intend diminishing automotive users' earnestness in peening a component correctly, I have often seen automotive components either under- or over- peened. Acknowledging the perennial time constraint within this industry, their actions are not surprising. "More" and "faster" are key words. On top of that, the universal statement, "we have always done it this way" is often offered to defend their actions. Our discussion is geared to all such users.

Assuming you have a developed a saturation curve for your process which is re-tested regularly, time "T" from the curve is defined as the time your process has taken to achieve saturation on the "test strip" and under those specific set of process parameters such as air pressure or wheel speed and media flow rate. This is **not** the cycle time to peen your component to. In fact, your process has not yet introduced the component into your machine. You have only dealt with the Almen strip to develop this saturation curve. So, how long do you peen your actual component? The actual peening time is the duration it takes to visually identify 100% (98% is acceptable) indentation on your component. This can be established by visually examining the part at repeated intervals by interrupting the cycle. After assuring yourself of 100% coverage, repeat the process to reconfirm and only then appoint that as your cycle time. It is important that you continue to inspect the peened components at regular intervals even in an established process. Blast machines are dynamic and shifts due to wear of machine components are common.

As an Applications Engineer, I used to cringe when an automotive end user stipulated cycle time and threatened unreasonable penalties if that was not met. My best guess usually was a conservative one, but the valid answer was (and continues to be), "we will know only when we peen the actual part in a production machine and check visually for coverage." Nobody likes uncertainty, especially automotive. However, the solution to coverage time is not simple.

An associated discussion with cycle time and coverage is related to over-peening a component. I have met customers that believe that it is acceptable to peen for a longer duration than required. To add to their belief are process sheets that call for greater than 100% coverage. Unless your process sheet calls for greater than 100%, please do not peen in excess. You run the risk of damaging your part by altering the surface topography of the component. Stress risers are not always visible to the naked eye but are a common occurrence on a component that has seen more than its deserved share of peening media!

Cleaning and Peening Machine

An end user during a recent visit proudly introduced me to their "peening and cleaning" machine that did double duty during lean times for either process. If your former cleaning machine has been retrofitted with process control for peening components, you would be ill-advised to go back and forth between the two processes in the same machine. Even though assessment of cleaning result might be subjective, cleaning machines have a clear purpose! The purpose is to eliminate rust, scale, or similar contaminants at a designated cycle time from the component and prepare it for a downstream coating.

If your machine has been used for shot peening, you would have (expectantly) built up enough process control devices in the machine to ensure that your peening results are repeatable, consistent, and accurate. Among other aspects, this involves keeping the media size consistent and free from contaminants. On the other hand, blast cleaning is a process that thrives on a work mix which is defined as a mix of small and large sized particles. In some situations, the work mix might involve angular grit particles as well. Such angular particles, if mixed with your peening media stream, could impact the component being peened with nicks that could potentially pose as stress risers leading to eventual failure.

The requirements for shot peeing are starkly different. When your peening project volumes are running low and to keep your machine utilized all the time, if you choose to run components in the machine with the purpose of cleaning, you are setting yourself up for difficulty in a future shot peening project in the same machine. Contaminants from the cleaning process such as, scale, rust, etc., could result in FOD (foreign object damage) and be disastrous to your peening operation.

On a related subject, if a component covered with contaminants such as scale and rust is presented for shot peening, instead of impacting the substrate where the residual stress needs to be imparted, you will have scale that is installed with the residual stress meant for the component's substrate. This will be of no benefit given that the scale will flake off at some point.

Plotting Saturation Curves

Though saturation curves do not have to be (re)plotted regularly, with a verification strip being adequate, it is advisable to run saturation curves at least every year. A large prime requires plotting saturation curves every six months unless the process is clearly documented. This is a dynamic process with machine components wearing regularly. Therefore, do not adopt a "once and done philosophy" with your saturation curve. Saturation curve must be re-plotted when a machine issue is narrowed down to bad media, faulty gage, or anything else that could influence the result of intensity. must be peened and measured every shift or with change in the batch of parts.

Machine Flexibility

When specifying a new machine, particularly centrifugal wheel blast for shot peening, please consider the following. It is essential that you have the flexibility to alter the shot velocity and shot flow rate. These are critical parameters that have a major influence on peening results. A machine where these cannot be varied renders your operation extremely rigid and incapable of critical adjustments to tune your process as your machine components wear. Moreover, if you need to shot peen a different component than the one that your machine was originally purchased for, such flexibility helps you repurpose it with relative ease. As compared to wheelblast, process flexibility is easier to achieve in an airblast machine where altering the air pressure and media flow rate leads you to this goal.

Finishing after Shot Peening

Shot peening is the last stage of a manufacturing process. If your work instruction calls for dual or double peening, that is considered continuation of your peening process even though the purpose may partially be to achieve a smoothen surface.

Most specifications, including AMS 2430, will allow fine finishing if it is limited to removing material to a maximum of 10% of the A scale intensity value. Anything more than that is to the detriment of the previously installed residual compressive stress. AMS 2430 also lists the maximum temperature limitations from any post peening thermal process. Therefore, if you are painting your component that has already been peened, refer to these temperature limitations since your process might involve curing the painted components using heat.

Wheel or Air?

I came across a specification from a prominent landing gear manufacturer that restricts processors to use centrifugal wheel type media propulsion for peening landing gear components. Though end users do not need to cite reasons for their choices of media propulsion systems, it is important for you to be aware if you are at the receiving end of such limitations.

Before you embark on a project, survey your potential customer base about the use of a particular type of media propulsion, even if both or more types will satisfy the requirements of the application. With reference to wheel blast machine, please be aware that common sizes of classifiers up to 48-inch diameter will not be capable of handling 100% of your media flow, unless you are peening with a single wheel driven by a 15 or 20 hp motor (media flow rate limitations). However, specifications will permit continuous classification of media and 100% is not a necessity, in which case sampling of the total media flow (about 25%) is common practice. Be mindful that you do not overload your classifier and diminish its sieving efficiency. For most air blast machines, the media flow rate is low enough to allow for 100% classification even on smaller diameter classifier screens.

Multiple Media Sizes – One Machine

Media size is determined by the intensity of your process and provided to you in the drawing. Certain applications require different areas of the part (ID and OD) to be peened to different intensity values. Or you might be multi-purposing the machine for a family of parts, some of which might need to be peened with different shot sizes. The above situations are only applicable for airblast machines (and a specific type of wheelblast machine for etching mill rolls—

(Roll-etch machines are not commonly used and will not be part of our discussion). When more than one media size is used in a shot peening machine, you should plan to mitigate cross-contamination. This is minimized by selecting media sizes that have at least a one size buffer between them (e.g., S-110 and S-230). Keep the sizes distinctly different in terms of storage hoppers and blast tanks. Do not rely on "flushing/draining" the tank of one size of media and loading with a second size during switchover. Though this may have been sold to you as an economical means of getting around using multiple sizes, dedicated blast tanks and hoppers are the most effective means to minimize cross-contamination.

In addition to media sizes, certain applications require peening with steel shot followed by glass bead or ceramic. This requires magnetic separation in your machine since cross-contamination both ways are not acceptable. You must confirm with your end user about them permitting this process to continue in the same machine. Some OEMs require distinct machines for metallic and non-metallic media.

Almen Strips

Shot peening causes plastic deformation on the component surface. A peened strip displays physical deflection as soon as the four constraining screws are loosened. Once deflected, it remains in that state and cannot be re-fastened on the test block given the arc that it has deformed into. A strip once peened cannot be re-used and every data point will require a new Almen strip.

Rotary flapper peening is a technique where the strip is fastened on a magnetic holder. Since subsequent fastening for additional data points is not dictated by screw style fasteners, the Almen strip can be re-used in flapper peening.

Where Do We Go From Here?

It is not my intention to leave you with the impression that peening operations are fraught with mistakes and misunderstandings. "Top five things my customers are doing right" is a discussion published in *The Shot Peener*, Spring 2015, exactly a decade ago. The list identified advanced customers that validated their peening process using X-ray diffraction. Other positive user attributes included their comprehension of the true purpose of peening, consideration to maintaining constant impact energy, and their emphasis on techniques to monitor and control parameters to get their process deliver consistent and repeatable peening results. My goal is to proliferate this message within the shot peening community in all industry sectors. The benefits of this process are many and when done right, with realistic expectations, it opens up the possibility for further development.