Developing a Peening Process Specification

Specifications can be broadly classified into two categories – (a) process and (b) monitoring. Process specifications are determined after thorough testing of the component and conducting tests for failure and residual compressive stress. This is directly related to the component and its expected life term. Monitoring specifications are more involved and are created after years of equipment use, a thorough knowledge of the process, and an understanding of its evolution. The shot peening industry relies on a few select specifications such as AMS and MIL for monitoring information.

Most of us working with or within the aerospace and automotive sectors are familiar with specifications. The requirement to conform to specifications, and design the peening process around them, is critical to these industries.

While the typical shot peening operation would never be involved in developing a monitoring specification, there are situations where a new peening process specification is necessary. For example, a new process in a mature industry, like automotive, that hasn't been clearly defined would benefit from a process specification. In addition, several new industry sectors have realized the benefits of peening and are eagerly seeking its adoption in their production processes.

This discussion will show how to develop process specifications by starting with the basics of a controlled shot peening process.

Before we begin, you might be wondering why anyone would want to bind themselves down with a specification, when one doesn't exist. The justifications are as follows.

Railway wheel with Almen blocks at areas of intensity verification. Rail transportation is a good example of an industry outside of shot peening's typical aerospace/automotive client base.

Why Do You Need a Specification?

You Sub-Contract Your Shot Peening Services

Many manufacturers depend on sub-contractors to handle commodity-type work that isn't part of the company's core, value-added tasks. Some companies outsource the entire shot peening process because they don't have the knowledge and/or production volumes to justify the purchase of peening machines. In order to conform to their own quality systems, they must specify how this operation will be conducted by their sub-contractor.

You Have Multiple Facilities

Consider another situation where a large company is bringing shot peening in-house in several of their facilities. They have the volumes to justify purchasing multiple peening machines. Without a specification in hand, commonality of the peening results in all the plants will be almost impossible to achieve.

You Want a Competitive Advantage

Specifications provide a benchmark to differentiate a company's product in today's competitive environment that requires higher quality standards.

The Basics

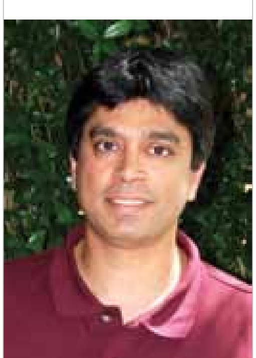
Let's discuss the basic elements of the shot peening process.

- The purpose of peening is to induce a residual surface compressive stress.
- The depth of the compressive stress is determined by the shot stream velocity which is controlled by the blast wheel speed or air pressure.
- Intensity is determined by using Almen strips.
- Coverage is a function of exposure time and media flow rate.

A controlled shot peening process will be sequenced as follows:

1) The operator sets the proper velocity by adjusting the blast wheel or air pressure for the required target intensity.
2) Once this velocity is established, the operator determines the optimum shot flow for conditions in Step 1.
3) Saturation curve is plotted and intensity is determined.
4) The part is exposed to the blast for the required time to achieve 100% coverage.

Now that we've covered the basics, let's review the work that goes into developing a process specification.



Kumar Balan is a Product Engineer with Wheelabrator Group and a presenter at the Electronics Inc. Education Division workshops.

Intensity, Shot Specification and Coverage

The designer of a new process is likely starting with a clean slate and some idea of the life-cycle expectation after peening. Commonly, a fair amount of reverse engineering has gone into determining the intensity. Peening tests are conducted on the component and it's peened to several ranges of known intensities. The component is then tested by the designer for residual compressive stress and life cycle/failure, where possible. With the establishment of an acceptable stress value and life cycle, the corresponding range of intensity is determined. These tests can be carried out with the help of an equipment vendor or through a job shop specializing in shot peening services.

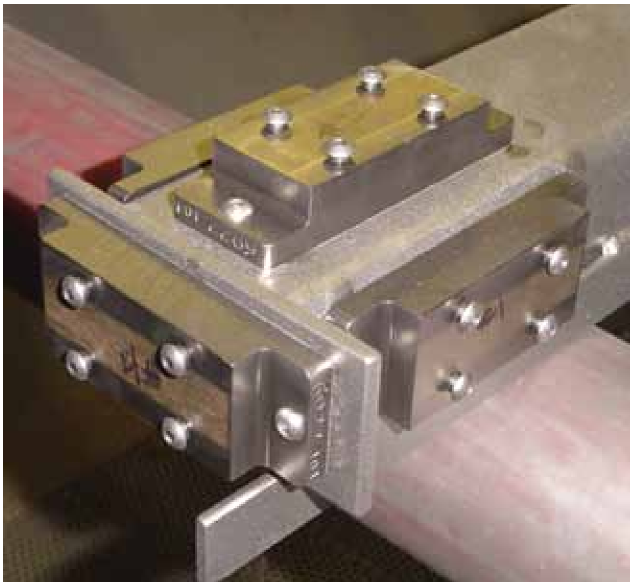
The tests also provide information on the type and size of peening media used during the test for inclusion in the specification.

When peening the part at the specified intensity, the designer will decide if 100% coverage is sufficient. The complexity of the part geometry may dictate a higher percentage of coverage. As an example: The intensity needs to be between 0.010 – 0.012 A, achieved with S 230 (specify hardness if required) and the coverage at 150%.

Component testing and the part geometry will determine the type of media propulsion system — compressed air or centrifugal wheel. Production volumes and type of peening media will also play a role in this selection. Most specifications will not dictate the type of equipment, but will list the variables to be monitored in each of the systems. The machine variables, such as speed of the wheel and air pressure in a compressed air system, will be governed by the process itself and are not bound by any specification. Measuring and monitoring these variables will be required.

After the process parameters are defined, it's then relatively simple to list the machine components. These include the following:

- Closed loop feedback for air pressure or wheel speed
- Closed loop feedback for media flow control



Machine Verification Tool (MVT) with intensity verification in multiple planes.

- Vibratory classifier for shot size control
- Spiral separator for shot shape control

Other process-related checks could include:

- Drop tests to verify shot flow through each blast wheel/nozzle
- Shot size sampling during the process with a sieve shaker

Intensity Verification and Location

The intensity tests would have been conducted with one of three commonly used Almen strips – N, A, or C. In the earlier example, we used an 'A' strip as a reference. The designer of this process and the component's designer will be aware of the critical areas on the part such as those with high tensile stress concentration. These are the areas that will need attention for peening coverage, and these are the locations where intensity will need to be measured.

Therefore, for a particular component, in addition to the above process details, the designer can also clearly specify the areas where intensity will be measured in order to qualify the process. There could be multiple areas for a given component.

This becomes a bit challenging when the user is faced with several parts to peen, as in a job shop. Special Machine Verification Tools (MVT) are employed to verify the intensity in multiple planes and geometries.

In certain cases, it may be critical to protect the areas around the critical peening surfaces. In this situation, the specification will have to specify masking and prevention of overspray. Such areas may include, but are not limited to, threaded portions and machined areas.

Reference Specifications

Specifications such as AMS 2432 have evolved over the years. They're very comprehensive and include critical process monitoring requirements:

- Air pressure/wheel speed measurement
- Nozzle position verification
- Criteria for shot (or other peening media) screening
- Shot shape control
- Part exposure control (such as monitoring table or conveyor speed)
- Nozzle holding fixtures (equivalent control cage setting in case of a wheel type machine)

This list is an example of the depth of information in these specifications that can be used for reference when developing your process. After determining the process details, intensity, coverage, etc., your spec may refer to AMS or similar specifications for conformance.

If your process specifications have been determined with the proper parameters, monitoring specifications will provide a healthy background to develop and conduct your peening operation.