You Asked, We Answered

We receive many emails requesting advice on shot peening processes and we try to answer as many as we can. By far, most of the questions pertain to the confusion between saturation, coverage and intensity so we've included a very good explanation by Dr. David Kirk. We've simplified the questions so that they do not reflect upon one particular company in respect for requests for confidentiality. These topics are a compilation of the questions we get on the same subjects.

Q

If the specified coverage level is achieved, why is saturation important?

A

by Dr. David Kirk

Peening intensity curves (a.k.a. saturation curves) are designed to establish the peening intensity of the shot streams. They are not designed to establish coverage requirements. The time, T, defines the peening intensity point—it does not define coverage. Coverage has to be established using a separate procedure as described in specifications and discussed in my Shot Peener magazine articles. (Editor's Note: Dr. Kirk's articles are available for download from the online library at www.shotpeener.com.)

Some experts state that there is absolutely no connection between the Almen peening intensity and coverage. I do not subscribe to that view because I believe that there are some secondary relationships between T and the coverage achieved on parts. The following account illustrates these relationships.

> "Joe (a fictional character) sets up a peening procedure. Using prior experience he sets the machine parameters and runs a peening intensity test. This shows that he has succeeded in achieving the customer's required intensity range. This intensity occurs with a range of two-minute passes varying between 1 and 4—depending on location of the strip holders. Joe's next problem is to satisfy the customer's requirement for 80% coverage. Knowing that peening intensity occurs when the coverage on Almen strips is well over 80%, Joe predicts that fewer than 4 passes will be needed on the actual parts. This is because he is also aware that the parts to be peened are softer than Almen strips. After using just one pass on the actual parts Joe found that almost complete coverage had been achieved. Eureka—a very economical solution.
>
> If, however, the customer complains that the coverage was excessive, Joe knew that he would have to carry out a proper coverage assessment procedure—modifying the flow rate to reduce the coverage without significantly affecting the peening intensity. Having satisfied both of the customer's requirements, Joe was able to shot peen a large order profitably. Suddenly, months later, the Almen peening tests (carried out daily) showed that the time T had shot up while still indicating that the peening intensity requirement was being satisfied. Joe realized that this was an alert signal because the coverage requirement might not be satisfied. He therefore tested for coverage and made appropriate adjustments to the flow rate."

Regarding the word "Saturation." It is firmly imbedded in shot peening's vocabulary. It is both ambiguous and confusing which is why I have campaigned for years to have it expunged. Saturation does not occur during shot peening in terms of either arc height or coverage. Unfortunately we have to live with the word because it is so firmly imbedded. In order to understand what is intended by "saturation" consider the following:

A "saturation curve" is a plot of arc heights induced by different amounts (time or passes) of shot peening. This curve allows a defined point to be deduced. That unique point is defined as the one on the curve for which the arc height increases by 10% when the amount of peening is doubled. The coordinates of this point are its corresponding arc height and amount of peening (T). "Saturation intensity" is, unfortunately, commonly used to describe that arc height. Better terms would be "Almen Peening Intensity" and "Almen Peening Intensity Point".

At the Almen Peening Intensity Point the coverage of the Almen strip is high—well above 90%. It would require a much smaller amount of peening to induce only 80% coverage of an Almen strip—roughly half. If the parts had the same hardness as Almen strips, then only about half of the Curve Solver analysis time T would be needed to achieve 80% coverage on your parts. If the parts are softer than Almen strips, then even less time is needed to achieve the specified coverage. That explains why you achieve 80% coverage in a fraction of the predicted 'T times'.

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Q
How does "T" relate to the peening process?

A
by Dr. David Kirk

There are no direct applications of T values in everyday peening. They simply define the peening intensity point. Indirect applications can apply – see previous explanation.

You should not peen actual parts to the derived Almen test T times. You have to peen them for times, separately determined, that result in the specified coverage rate being satisfied. Excessive peening can cause part deterioration.

Q
If the requested intensity is 14-18A, what happens when I need 200% coverage and the intensity goes out of the range?

A
by Jack Champaigne

The requirement 14-18A intensity is met when the arc height value is within the .014 inch to .018 inch when the "A" thickness strip is used. If you've met that requirement, then the arc height value of the curve at time T2 may, or may not, be within the 14-18 tolerance band. As long as the arc-height of the T2 data point is 10% (or less) than the arc-height value of the T1 point then you have determined "intensity." It is VERY common for the T2 data point to actually be above the tolerance band.

Q
What does 200% coverage mean?

A
by Jack Champaigne

Peening for twice the time needed to achieve 100% coverage as determined by examining the actual peened surface—not twice the time for the Almen strip to reach intensity. Peening soft aluminum parts will take much less time than the intensity time of the Almen strip because the aluminum is softer and therefore has larger dimples than the Almen strip.

Conversely, hard gears will require much greater peening time since the dimples will be very small compared to the Almen strip. The part's hardness compared to the Almen strip HRc 44-50 range is the key factor in determining coverage time.

Q
Why isn't there a "B" Almen strip?

A
by Charles Barrett, former Chairman of the SAE Surface Enhancement Division - Fatigue, Design and Evaluation Committee

We all know that there are three strips used to qualify the intensity of a shot peening machine. Each of the strips has a different thickness. The "A" strip (.050" thick) was probably named for J.O. Almen who conceived the idea of using a strip of C-1070 cold rolled spring steel to qualify the intensity of peening on coil springs. The "N" strip (.030" thick) was developed by Charles Noble as the "A" strip was not sensitive enough to measure the low intensities used on jet engine parts. The "C" strip is .094" thick and used to measure high intensity shot peening.

I attended a dinner at an SAE Fatigue, Design & Evaluation Committee meeting some years ago. The entertainment for the evening was an amateur magician named John Straub. What some of you may not know is that John Straub was J.O. Almen's assistant at the GM laboratories, and was involved in much of the early experimental shot peening. Later on he directed the Wheelabrator R&D shot testing laboratory, where he developed the Wheelabrator shot testing machine. Among other things, John was a proponent of excluding fines in operating shot mix for optimum peening results. He also authored many papers in the late 1940s and also holds a patented dual intensity peening process.

When he finished his astounding demonstration of magic, John was asked by Dr. Ralph Stevens, University of Iowa, to relate some of the early events of shot peening in which he was involved. The question was asked why there was no "B" strip. John replied that during World War II the government was investigating the attributes of the German "Tiger" tank over U.S. tanks at the Aberdeen proving grounds. It was found the Tiger had shot peened torsion bars, which gave them a greater fatigue life over U.S. tanks. A deep depth of compression was required in the surface of the bar. The peening intensity was too high for the "A" strip, which warped under the shot impact. So a "B" strip of approximately .078" thick was tried. But it was also too thin.

The "C" strip of .094 was finally developed for the application. The "B" strip was superfluous as the "A" and "C" strips cover the intensify range. The "B" strip was discarded and not used again. There was another "B" strip used by the Douglas Aircraft Company. However, it was made from aluminum and used primary to determine coverage on aluminum aircraft parts.