Discussion on Intensity and Coverage

by Jack Champaigne

Confusion over separation of the concepts "Intensity" and "Coverage" (or "Cycle Time") is often encountered as a problem in the shot peening industry. Consequently SAE Committee (Fatigue Design and Evaluation) decided to remove references to coverage from SAE J443 Procedures for Using Standard Shot Peening Test Strip and created a new document SAE J2277, "Shot Peening Coverage" issued in January of 2003.

First, let's discuss the problem and then the solution. In peening, the goal is to impart a dominantly compressive stress distribution in the surface layers of a part that may be subjected to cyclic stress, hence improving its fatigue life or load bearing capability. The depth of the effective compressive stress distribution is determined by the peening intensity. Intensity is influenced principally by impact media size, hardness and velocity. To achieve the desired effects from peening, it is reasonable to ensure that the entire part or critical area receives sufficient impacts to achieve uniformity in the resulting compressively stressed surface layers. This embodies the concept of coverage and uniformity thereof. So, to obtain desired results from peening, we must accomplish two things: determine (and control) intensity and determine (and control) coverage. As will be outlined below, it is necessary first to determine intensity and then to determine coverage i.e. establish the correct peening cycle time.

There is presently no Intensity Meter that allows direct determination of peening intensity. Instead one must employ the Almen method for intensity determination. By making impact dents on one surface of a standard Almen test strip we cause the strip to curve (deflect). It will continue to curve as it accepts more impact dents. With increasing time of exposure to media impacts the rate of curving diminishes eventually to the point that curvature no longer increases. Plotting a graph of Almen strip curvature (expressed as arc height) versus exposure allows one to determine peening intensity. This graph has become known as the Almen Intensity Saturation Curve, or saturation curve. This leads to the 10% rule devised by Almen that states, The intensity is the first arc height point on the saturation curve whose value, when the exposure time is doubled, increases by no more than 10%. The intensity, thus determined, characterizes and represents the combined characteristics of the media and equipment operating conditions. Please note here that the Almen method involves only the concept of peening intensity. Determination of coverage or cycle time is an issue which must be addressed on the part to be peened.

If one were to examine a single dent on the Almen strip one would observe that (approximately) a .009-inch dent diameter occurs after impact with shot at a .010 inch A (or 10A) intensity. Accumulation of sufficient dents of this size on the Almen strip causes it to curve as exhibited by the saturation curve. But what happens with denting another target material that is different from the Almen strip? The Almen strip material is SAE 1070 cold rolled steel with a hardness range of 44-50 HRc. If one were to substitute a part of much higher material hardness, perhaps a carburized gear at 60 HRC, much smaller dents would result from media impacts at the same intensity. If one were to substitute a much softer part, e.g. aluminum with hardness equivalent to 80 HRB, then much larger dents would occur. Therefore, to completely cover the hard gear would take a lot more dents and much longer exposure time than for the much softer aluminum.

So, my question to you (or your friends) is Why would one use the Almen strip denting characteristics to set the machine cycle time for peening your parts? Complete coverage of your part means complete denting of the intended target, not the Almen strip! The Almen strip is correctly employed ONLY for intensity determination and not for coverage. End of discussion.