Defects and Virtues of the Almen Intensity Scale

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ABSTRACT: Integration of numerous parameters is a major advantage and minor disadvantage of the Almen method. The size of the test strips prevents direct application in some cases. Simple methods for overcoming these disadvantages are presented. Careful distinction between measures obtained by the standard method and similar measures obtained by other means is needed to avoid confusion.

KEYWORDS: Shot Peening - Almen - Peening Intensity - Standards.

The Almen intensity scale is almost fifty years old, well documented, and widely used. Numerous attempts have been made to replace it by other measures. Some of these other measures have also been called "Almen intensity." It seems useful to reconsider the advantages and disadvantages of the old system to see whether any changes in current practices are in order.

Briefly summarized, the Almen system involves standard test strips of three different thicknesses, called A or C or N (for 1.29; 2.39; 0.79mm); a standard measuring device, called the Almen gage; a standard nomenclature such as 12A or 8C or 10N; and standardized procedures (SAE 1952/1979).

The following defects of this system have been observed:

Incomplete definition

Specification by Almen intensity may or may not define the results of a peening process. The same intensity can be obtained by small shot thrown at high velocity or by larger shot thrown at lower velocity.

It has been shown that equal Almen intensities produce equal fatigue lives in valve springs (Zimmerli 1948) and in leaf springs (Mattson & Coleman 1954) although the intensities are obtained by different combinations of shot and velocity. For other steel parts of hardness similar to that of the Almen strips (44 to 50 Rockwell C) equal fatigue results for equal Almen intensities have been assumed and no contrary evidence is known.

For other materials, and for steel of hardness below 35 Rockwell C or above 60 Rockwell C, the size and the hardness of the shot can make a difference in fatigue performance. The difference in surface roughness may also be important in some cases: At equal Almen intensities a smoother surface is obtained with larger shot.

What can be done to overcome these shortcomings? One can make strips of the same material as the part which shall be peened and use their curvature as a measure of the desired intensity. Such special strips must be carefully prepared to be free of self stresses (residual stresses); they are not readily available; if the peening job is done outside the home plant, the special strips must be supplied to the peening shop. Using such special strips seems to be a useful method for research and for development of a good specification, but not for use in a purchasing specification with suppliers of peening service.

For purchasing specifications it is more suitable, when necessary, to specify by Almen intensity together with the required shot size and shot material. This will produce the desired effect on the work piece. In some cases an "equivalent" treatment can be worked out (Fuchs 1957).

If the arc height is measured on special strips (not on standard Almen strips) it should be called "arc height" but not "Almen intensity." Confusion will result if the difference between the standardized Almen intensity and the arc height measured on non-standard strips is not clearly expressed.

Excessive size

The recommended practice for using standard test strips (SAE 1952/1983) requires "a fixture to support the test strip in a manner to simulate the most critical surface of the part to be peened." This cannot be done for small parts such as automobile valve springs nor for surfaces such as small holes in large parts.

To overcome this shortcoming one might think of developing special small test specimens. The writer has attempted to do this by using small washers and special measuring devices (Fuchs 1978).

Others have arranged the strip so that only a small part of it is exposed to the shot stream in a manner which simulates the surface of the part to be peened. The arc height of this partly peened strip is then correlated with the Almen intensity measured on another strip which has been peened on its whole surface in such a manner that each part of its surface was treated in the same way as the small area of the other strip which simulates the part to be peened (Sharma & Mubeen 1983). This can be done for instance for small holes (Smith 1972). For valve springs one manufacturer has developed a method of control which does not use the Almen intensity, but coil spring specimens (Sanderson & Slingsby 1981). These defects are small in comparison to the following virtues.

The Almen intensity is an integrated measure

A principal advantage of the Almen intensity is the integration of relevant factors. Velocity of the shot, size and hardness of the shot pellets, angle of impingement, quantity thrown per second, shape of the shot pattern all are integrated in the Almen intensity. From a research viewpoint it might be desirable to know all these variables separately. For specification of the desired treatment of medium hard steel parts it is sufficient to call for the Almen intensity. For other parts one should specify Almen intensity together with size and material of the shot. For the comparison of research results from different investigators it is also useful to state Almen intensity in addition to velocity, etc. because different methods of measuring velocity cannot easily be correlated.

A standard measure of intensity

A great advantage of the Almen intensity is the clear and easily available definition (SAE 1952/1979 and SAE 1952/1983) of the method of measurement, and of the simple equipment required for the method: standard test strips, a fixture holding the strips in the shot stream, a dial gage, a simple device for holding the strips during measurement, and a clock or watch.

If another method of measurement is desired or needed, as for instance the coil spring specimens used by Sanderson & Slingsby (1981) or the disc used by Meguid & Duxbury (1981) it is necessary to define all details of such a method explicitly and clearly.

The widespread use of the Almen intensity is another advantage. In the United States it is the only accepted method, used by thousands of specifiers and by hundreds of operators of peening equipment. These people have learned to associate 10C with a forceful peening treatment and 6N with a gentle treatment.

On the continent of Europe dial gages graduated in 1/1000 inch per division are not commonly available. Gages graduated in 1/100 millimeter per division are generally used. They can be substituted in measuring Almen intensity if one remembers that 10/100 millimeters equal 4/1000 inches within the accuracy needed for peening intensity specifications. If it is too difficult to provide suitably divided dials for the gages or to multiply all readings by the factor 4/10, one can specify a European style Almen intensity as, for instance, 0.2A(mm) which is equivalent to 8A. To call out "20A" for an arc height of (20/100)mm will surely lead to confusion with the standardized Almen intensity 20A. The number "20" should be understood as a number like "400" in "400 Brinell hardness," where a certain load, certain ball diameter and a certain ball hardness are implied. No one would convert this number which is based on kilograms and millimeters to another based on pounds and inches, or on Newtons and meters. The same conservative practice is in order for specifications of peening intensity.

Conclusion

The standardized Almen intensity measurement has major virtues and minor defects. It is the preferred method for specifications. Other methods may be more useful for special cases and for research. If other methods are used they need to be clearly defined and distinguished from the standard Almen intensity.

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