SURFACE VEHICLE RECOMMENDED PRACTICE

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Computer Generated Shot Peening Saturation Curves

RATIONALE

The purpose of this recommended practice is to provide an objective method of determining the intensity of peening from a saturation curve. SAE J443 provides instructions for use of the test strip and a review of that document illustrates the need for a standardized procedure.

Procedures for determining intensity have evolved slowly – as illustrated by the following summary: SAE J443 January 1952, Procedures for Using Standard Shot-Peening Test Strip states: "The gage reading corresponding with the point A where the curve flattens out is generally taken as the measurement of the intensity of that particular peening. In some cases, this point is difficult to pick out and requires some judgment." This same description appears in the June 1961 edition of SAE J443. SAE J443 January 1984 states the following: "Saturation has been attained when the "knee" of the curve is passed and increasingly longer periods of peening time are required for a measurable increase in test strip arc height. The location of the knee, point A shown in Figure 1, can be defined as that point on the curve beyond which the arc height does not increase more than "X" percent when the peening time is doubled. An arc height increase of 20% for doubled peening time may be adequate for some applications. An increase of 10% for doubled peening time defines the knee for critical applications. A smaller percentage increase than 10% requires longer peening time to reach this "knee" in the curve." The practice of determining the 10% increase was left to the artisan and they often referred to arc heights at double the exposure times until "10% or less" was discovered without focusing on the curve.

The universal availability of computers and curve-fitting capabilities now provides the mechanism for introducing an objective, unambiguous, procedure for intensity determination. Using a computer algorithm to draw a "best fit curve" and to derive a specified "intensity" will give substantial improvements in terms of process control accuracy and repeatability.

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1. SCOPE

This SAE Recommended Practice defines a procedure for the use of computer generated saturation curves to determine peening intensity. Calculation of intensity within a tolerance band for each data set in Table 1 one is required for compliance with this practice.

1.1 Purpose

Manually constructed saturation curves are difficult to generate and are subjective. The use of computer algorithms will provide a consistent treatment of data and also allow a convenient method to archive the data. This Practice includes examples of computer algorithms. It is the users responsibility to develop a suitable computer algorithm which generates data within the tolerance bands of Table 1.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J442 Test Strip, Holder, and Gage for Shot Peening

SAE J443 Procedures for Using Standard Shot Peening Test Strip

3. PROCEDURE

Ten data sets are shown in Table 1. Each data set contains values for exposure times and test strip arc heights and a corresponding intensity answer. The candidate computer program must generate a saturation curve and numerical declaration of intensity which is within the tolerance band for each data set. The algorithm must produce results compliant with SAE J443.

3.1 Caution

Users are cautioned to examine and evaluate the validity of any graph generated or intensity value declared. There may be instances of curve construction from erroneous data that results in invalid intensity values. It is the user’s responsibility to validate the data and the results obtained independently of the saturation curve program.

3.2 Documentation

The program must include means to identify revision levels and dates of modifications.

TABLE 1 - SATURATION CURVE DATA SETS

1		2		3		4		5	
time	arc height	time	arc height	time	arc height	time	arc height	time	arc height
4	0.0060	2.5	0.0030	3	0.0065	1	0.0038	4	0.0062
6	0.0069	5	0.0036	6	0.0081	2	0.0051	6	0.0070
8	0.0070	10	0.0044	12	0.0088	3	0.0052	8	0.0072
12	0.0070	20	0.0044	24	0.0090	4	0.0053	12	0.0072
	0.0064		**0.0040**		**0.0080**		**0.0048**		**0.0066**

6		7		8		9		10	
time	arc height	time	arc height	K/Feed	arc height	K/Feed	arc height	K/Feed	arc height
1.1	0.0046	2	0.0055	0.25	0.0081	0.25	0.0108	0.25	0.0045
2.3	0.0087	3	0.0066	0.50	0.0096	0.50	0.0129	0.50	0.0054
4.5	0.0101	4	0.0067	0.75	0.0100	0.75	0.0137	0.75	0.0059
9	0.0107	6	0.0068	1	0.0103	1	0.0144	1	0.0058
	0.0098		**0.0063**	2	0.0108	2	0.0157	2	0.0062
				4	0.0113	4	0.0164	4	0.0064
					0.0093		**0.0137**		**0.0054**

NOTE: Target answers are shown in bold print. Candidate programs must reach all ten target answers to within ± 0.001. For example, an acceptable derived intensity for data set 1 would be within the range 0.0054 to 0.0074. The arc height values in Table 1 are in inches - for illustration purposes only. Some curve solver programs will not function properly with such small values. It is therefore acceptable for the data in Table 1 to be converted into thousandths of an inch for computational purposes. For example: use 12 instead of 0.012.

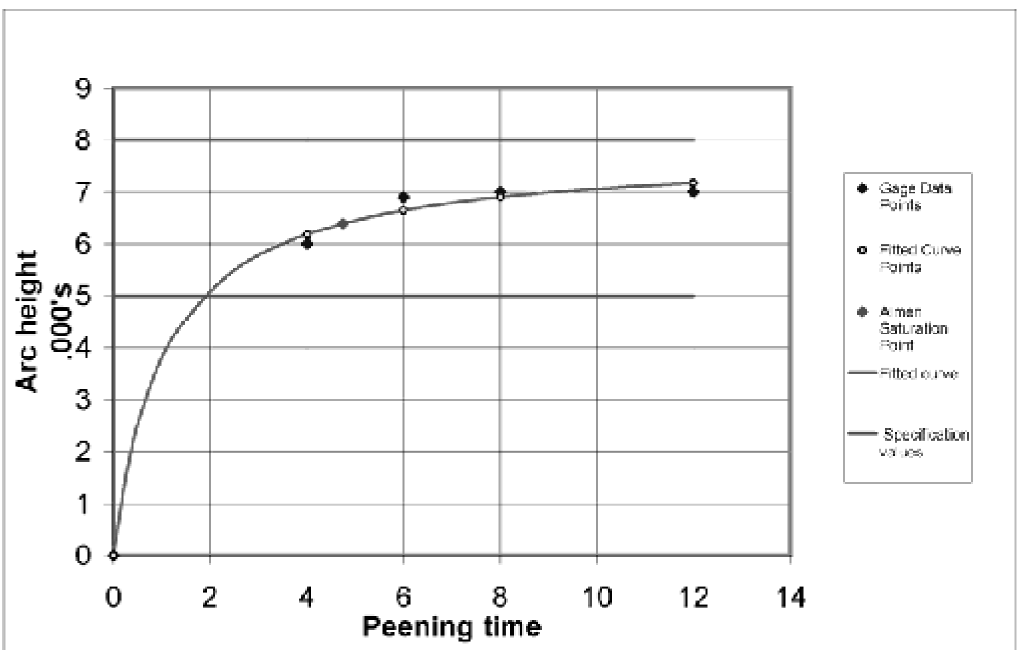

FIGURE 1 - GRAPH OF EXAMPLE 1, SHOWING DERIVED INTENSITY IS 6.39
(Graph courtesy of Dr. David Kirk)

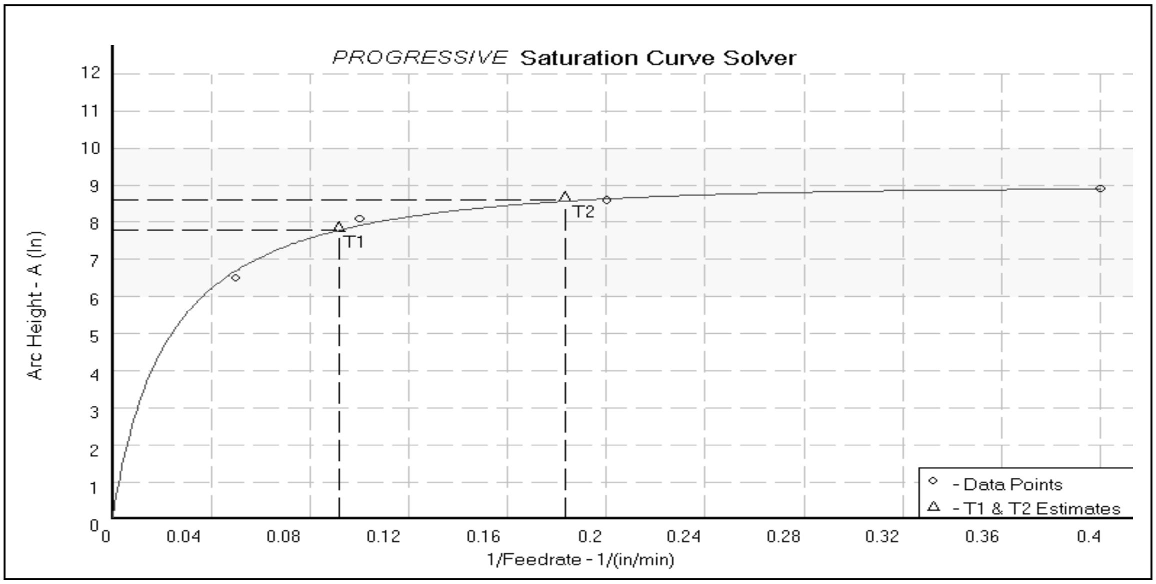

FIGURE 2 - GRAPH SHOWING THE USE OF INVERSE FEED RATE
(Courtesy of Progressive Technologies)

4. ALGORITHMS

The following examples are for illustration only and are not meant to be exclusive. Other algorithms may be used which meet the requirements of data in Table 1 and the note therein.

Example algorithm 1: This program fits data points to a two-parameter exponential equation:

$$h = a(1- \exp(-b*t) \quad \text{(Eq. 1)}$$

where

h is Almen arc height,
t is corresponding peening time and
a and **b** are the two parameters.

The program is recommended for use whenever the data set contains only four points.

Example algorithm 2: This program fits data points to a two-parameter ‘saturation growth’ equation:

$$h = a*t/(b +t) \quad \text{(Eq. 2)}$$

where again

h is Almen arc height,
t is corresponding peening time and
a and **b** are the two parameters.

This algorithm is recommended for use whenever there is a requirement to conform to French specification NFL 06-832.

Example algorithm 3: This program fits data points to a three-parameter exponential equation:

$$h = a(1- \exp(-b*t^c) \quad \text{(Eq. 3)}$$

where

h is Almen arc height,
t is corresponding peening time and
a, **b** and **c** are the three parameters.

This program is recommended for use whenever the data set contains more than four points.

5. NOTES

5.1 Marginal Indicia

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