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Curve Solver Template Update

Professor David Kirk's Saturation Curve Solver (SCS) was one of the first offered to us shot peeners. The original spreadsheets debuted as a demonstration of Microsoft Excel's usefulness, but the industry quickly embraced it as a replacement to traditional graph paper and French curves. Today it remains the most used tool for finding peening intensity.

The last major revision of the SCS Template Suite was in 2009 when it was updated to work with Microsoft's then new Excel program and file extensions. More recently the COVID-19 pandemic slowdown gave me the opportunity to add features to a new version of the SCS templates – Version 10.

Aesthetically, the coloring has been changed and some text softened to direct focus on the more pertinent information ① (see the screenshot on page 11).

Years ago, I created macros for some of my personal SCS templates. Doing this along with adding a button ② make using the templates easier by automatically running the last few steps to find intensity. Only a few on-site training students got copies of my personal versions because email systems would usually red-flag files containing macros thus preventing them from getting to the people that requested them on the shotpeener.com website. All SCS Version 10 templates now have a macro version and are bundled in a ZIP file to make distribution via email easier.

Periodically verifying intensity of a process involves peening a single test strip for a specific time to confirm an established saturation curve is still valid thus verifying the intensity has not changed. Often the test strip is peened for a time not equal to the established curve's solved saturation time (T). SCS Version 10 templates can now provide a target arc height ③ for a peening time ④ other than the solved saturation time (T).

As an SAE Surface Enhancement Committee member, I've advocated for computer-generated saturation curves to have a minimum "fit" quality, and the SCS Version 10 templates include my recommended method of evaluation. To declare the fit of a curve as "Good" or "Poor" the template calculates the percentage difference of each data point's given arc height value to the arc height value from the fitted curve. All the data points' error percentages are also averaged to evaluate the curve as a whole. The whole curve fit, as well as each individual data point is declared "Poor" if an error is 5% or more, or "Good" if an error is less than 5% ⑤. Please note that this declaration is for informational purposes only as saturation curve fit quality is currently not required by SAE J2597, however this may be added in future revisions.

Lastly, the template's file naming convention has been changed to reflect the template's legacy name, its purpose, the curve generation method, and its individual release date.

Excel Curve-fitting to Almen Strip Data
Height = a(1 - exp[(-b*time^{c}))

SATURATION CURVE SOLVER, PROGRAM SCS3m

EXP3P STANDARD vers.10 Macro

⑤

Strip No.	Time	Arc Height	Pre-bow	Corrected Height	Calc Y	Residuals	Res Sqrd
	0	0	0	0		0	0
1	2	3.5	0.2	3.3	3.4	877	0.0352
2	4	5.2	0.1	5.1	4.7120	-0.3880	0.1505
3	8	5.6	0.1	5.5	5.7985	0.2985	0.0891
4	16	6.8	0.3	6.5	6.4515	-0.0485	0.0023
5	32	6.8	0.1	6.7	6.6633	-0.0367	0.0013
6				0.0	0.0000	0.0000	0.0000
7				0.0	0.0000	0.0000	0.0000
8				0.0	0.0000	0.0000	0.0000
9				0.0	0.0000	0.0000	0.0000

①

Parameter Values		AvError
a	6.69	4.0%
b	0.45	POOR
c	0.73	5.7%
Start value for a=	6.7	7.6%
Start value for T=	7.5	5.4%
Sat. Intensity =	5.91	0.7%
T=	8.72	0.5%
f(x) =	-7.92342E-05	0.0%
		0.0%
		0.0%
		0.0%
If WARNING or ERROR appear above, read note below graph.		0.0%

Upper Limit = 7
Lower Limit = 4

SUM = 0.27856 RMS-R= 0.2360

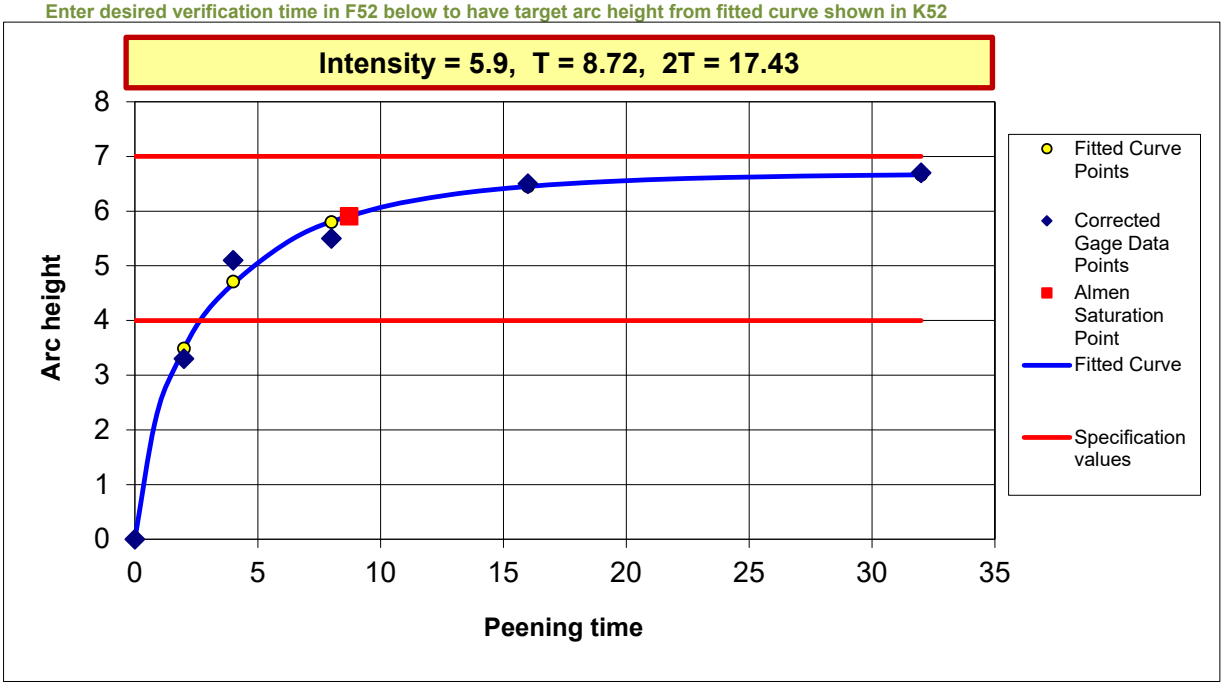
STEP 1 Enter data values within blue frame after deleting previous values
Arc heights to be in thousandths of an inch or micrometers

STEP 2 Enter I
Enter a
STEP 3 Select
STEP 4 Select
and K

RUN SOLVER
EXECUTES STEPS 2-4

②

STEP 5 (Options) Enter lower and upper intensity spec limits in the E17 & E18 above to display on graph below
Enter desired verification time in F52 below to have target arc height from fitted curve shown in K52



Verification time 13 ④ Verification target arc height 6.3

NOTE: "ERROR" signifies that the longest strip peening time is less than 2T.
"WARNING" signifies that the shortest strip peening time is greater than T. ③

This updated version of Dr. Kirk's Curve Solver is a free download at www.shotpeener.com.