



Date: February 8, 2013

Effect of Activol 1803 Concentration on J932 Steel Weight Loss and Gage

Purpose:

J932 grade steel was experiencing gage loss during extended line stops on a continuous pickle line. The current pickling conditions are 10% HCl (w/v), 7% Iron (w/v) and 0.25% Activol 1803 based on the weight of the acid. Testing was completed to determine the most effective way to reduce the gage loss of the J932 while pickling.

Experiment:

J932 panels were cut into nine 3/4in X 3 in long strips, measured for gage using a micrometer to 0.0001 inches, and weighed on an analytical balance to 0.0001g. The panels were then pickled at 190°F in 10% HCl (w/v), 7% Iron (w/v), with varying % Activol 1803 as shown in the chart below for 4 hours. Two trials were run. Weight loss, gage loss and % Efficiency values were observed periodically throughout the testing period.

A. Weight Loss:

	TRIAL 1					TRIAL 2			
Panel ID	B	A1	A2	A3	A4	C1	C2	C3	C4
% A1803	0%	0.125%	0.25%	0.50%	1.00%	0.125%	0.25%	0.50%	1.00%
<i>Panel Weight in grams</i>									
Initial	11.7626	12.2239	11.9464	11.9357	12.1647	12.0659	11.5984	11.9996	11.7872
30min	10.0462	12.1574	11.8943	11.9027	12.1395	11.995	11.5458	11.9659	11.7624
1 hour	8.8763	12.0742	11.839	11.8713	12.1187	11.9096	11.4896	11.9334	11.7429
2 hour	6.5760	11.8015	11.6955	11.8005	12.0764	11.6822	11.3512	11.8599	11.7018
3 hour	5.2034	11.4427	11.5032	11.7316	12.0372	11.3977	11.1769	11.7888	11.6641
4 hour	3.5856	10.9897	11.1734	11.6385	11.9902	11.0300	10.9075	11.6855	11.6173

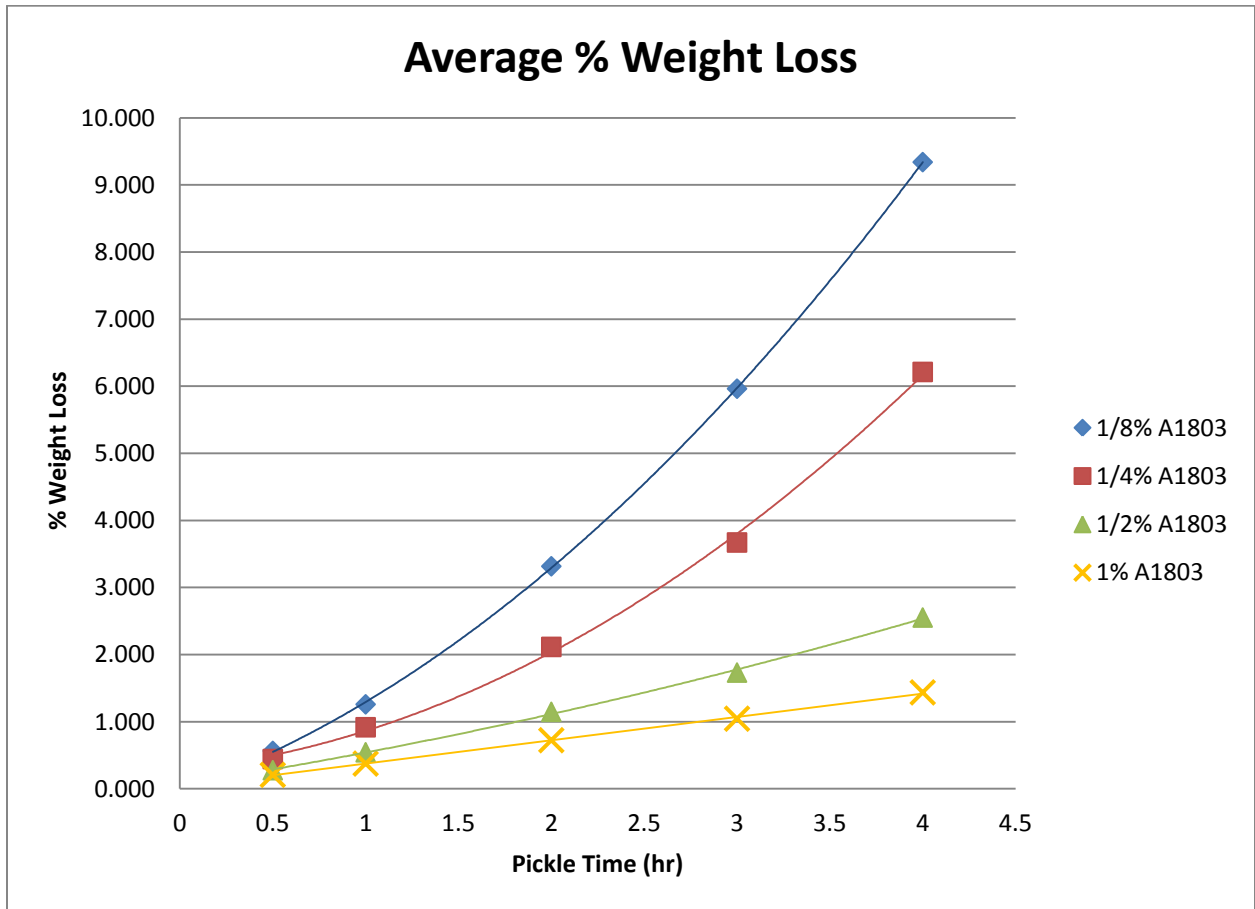
The data for the two trials was combined and averaged to determine the % efficiency, gage loss and weight loss.

% Total Weight Loss over time:

Below is shown the average % weight loss at timed intervals during pickling. The Blank data (0% Activol 1803) was omitted from the graph to highlight the effect the inhibitor concentration had on weight loss over time. As shown, increasing the concentration of Activol 1803 greatly reduces the weight loss of the J932 Steel.

Average % Weight Loss	
Time (hrs.)	% Activol 1803

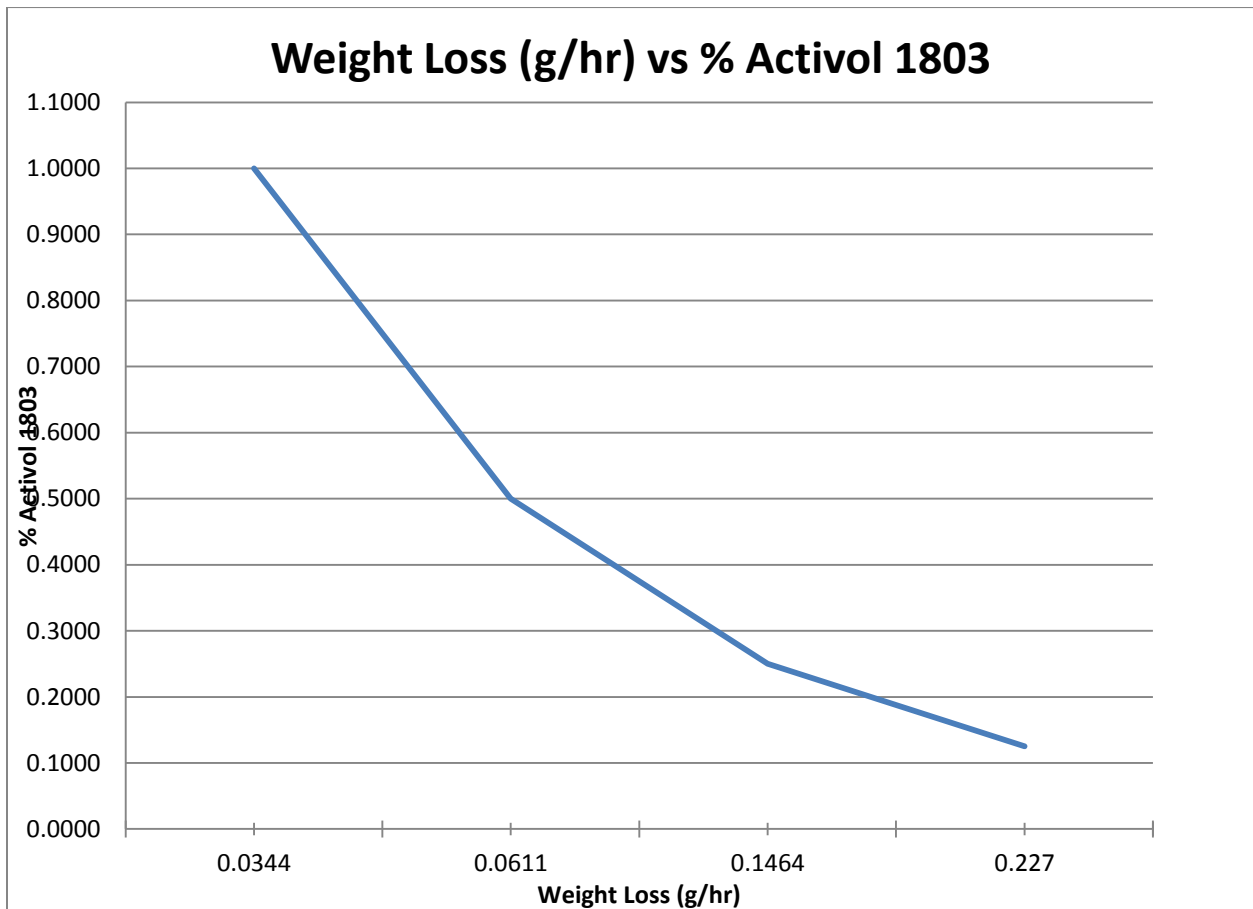
	0	0.125	0.25	0.5	1.0
0.5	14.592	0.566	0.445	0.279	0.209
1.0	24.538	1.260	0.919	0.546	0.377
2.0	44.094	3.318	2.116	1.148	0.725
3.0	55.763	5.964	3.672	1.733	1.046
4.0	69.517	9.341	6.214	2.554	1.438



Weight Loss Rate (g/hr.):

Average Weight Loss (g/hr.)	
% Activol 1803	Rate of Loss
0.000%	1.6354
0.125%	0.2270
0.250%	0.1464
0.500%	0.0611
1.000%	0.0344

The average rate of weight loss per hour was also calculated from the above data. It is seen that increasing the % Activol 1803 from 0.25% to 0.5% significantly decreases the slope of the graph indicating a slowing in the weight loss rate:



B. Gage Loss



Gage was measured in the center of each panel using a micrometer at the times indicated below. All measurements were taken to 0.0001 inch accuracy.

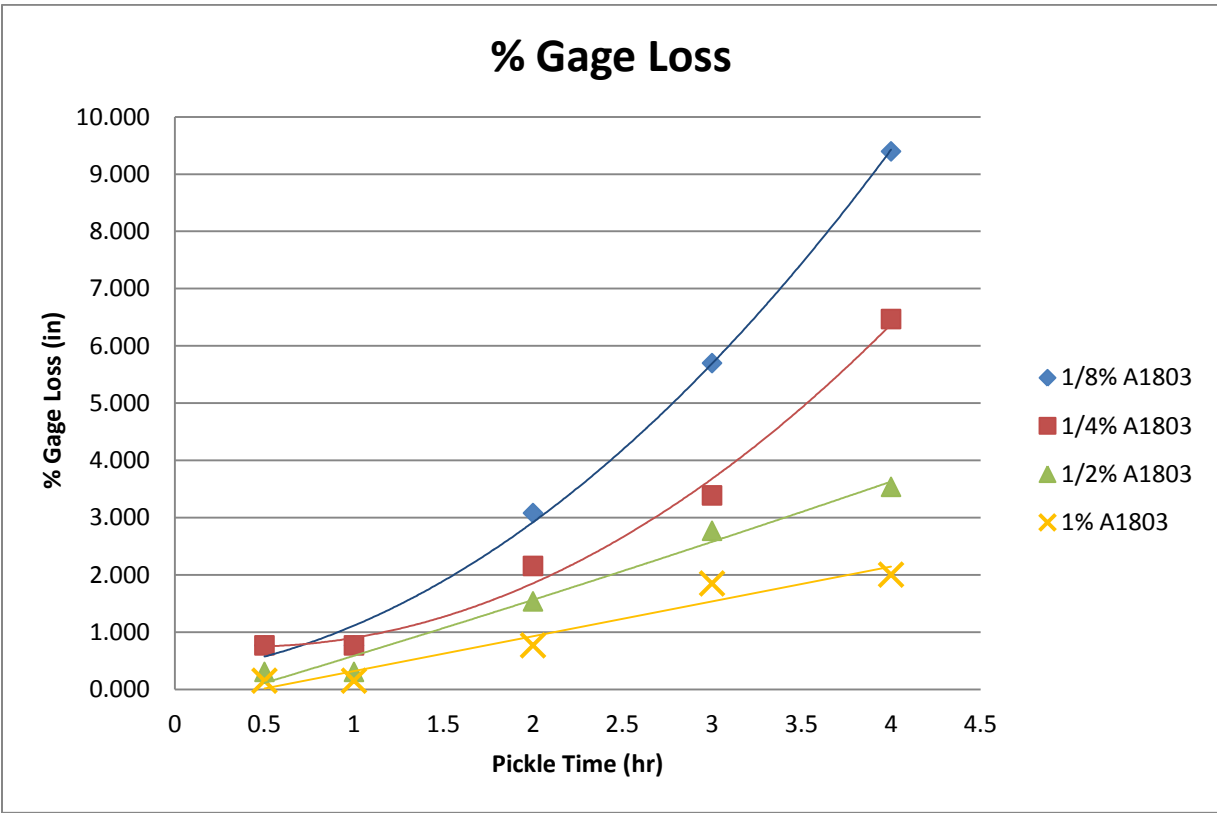
	TRIAL 1					TRIAL 2			
Panel ID	B	A1	A2	A3	A4	C1	C2	C3	C4
% A1803	0%	0.125%	0.25%	0.50%	1.00%	0.125%	0.25%	0.50%	1.00%
<i>Gage measurement in inches</i>									
Initial Gage	0.0321	0.0324	0.0325	0.0326	0.0325	0.0325	0.0324	0.0324	0.0323
30min Gage	0.0280	0.0322	0.0323	0.0325	0.0324	0.0322	0.0321	0.0323	0.0323
1 hour Gage	0.0253	0.0322	0.0323	0.0325	0.0324	0.0322	0.0321	0.0323	0.0323
2 hour Gage	0.0192	0.0313	0.0319	0.0322	0.0322	0.0316	0.0316	0.0318	0.0321
3 hour Gage	0.0156	0.0305	0.0315	0.0320	0.0320	0.0307	0.0312	0.0312	0.0316
4 hour Gage	0.0122	0.0291	0.0303	0.0316	0.0319	0.0297	0.0304	0.0311	0.0316

The data for the two trials was combined and averaged to determine the % efficiency, gage loss and weight loss.

% Gage Loss over time:

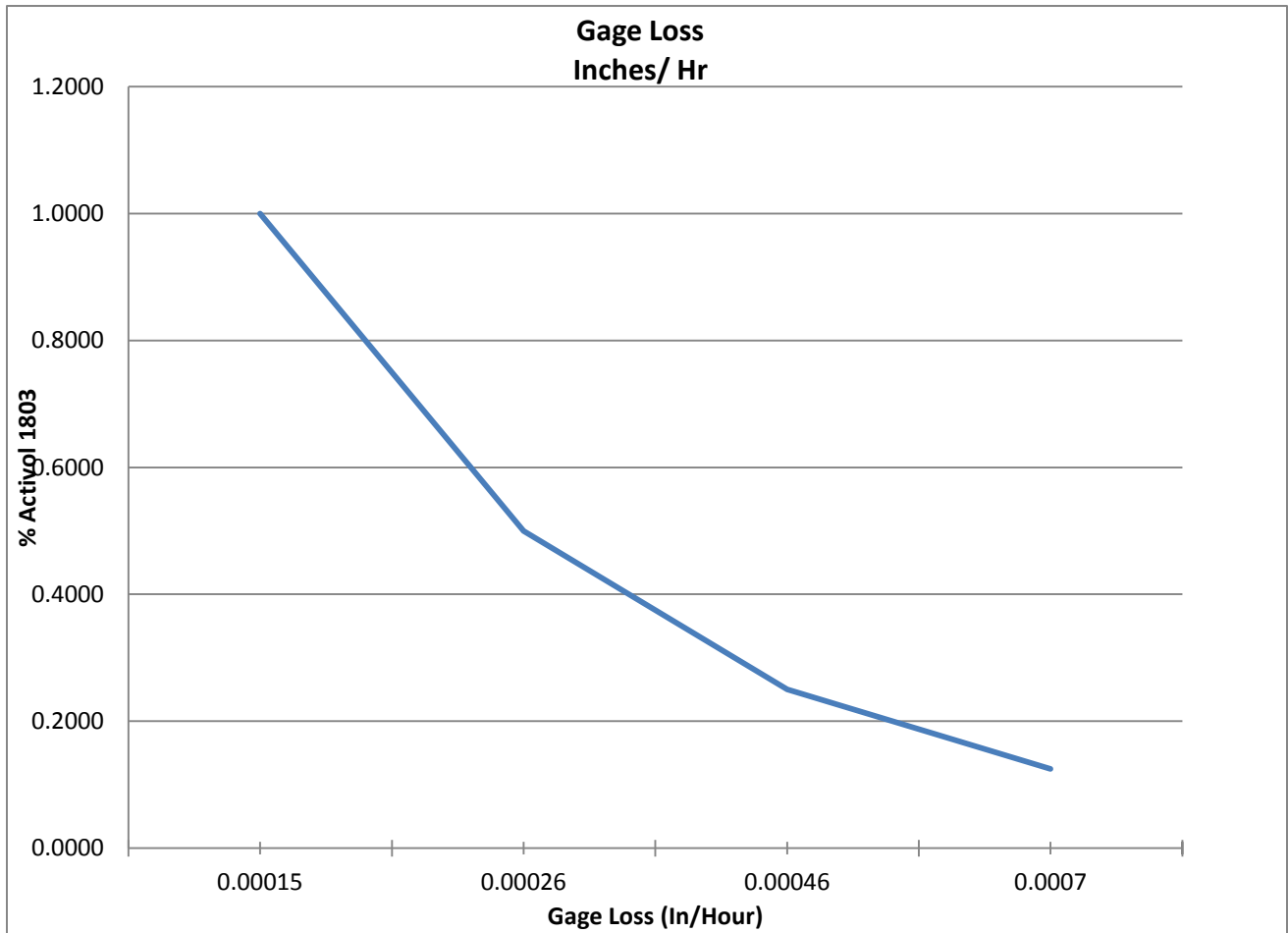
Time (hrs.)	Average % Gage Loss				
	% Activol 1803				
	0	0.125	0.25	0.5	1.0
0.5	12.773	0.770	0.771	0.308	0.154
1.0	21.184	0.770	0.771	0.308	0.154
2.0	40.187	3.082	2.158	1.539	0.771
3.0	51.402	5.701	3.390	2.772	1.853
4.0	61.994	9.400	6.471	3.540	2.007

Increasing the % Activol 1803 from 0.25% to 0.50% decreases the average Gage loss by 42% while increasing the concentration to 1.0% decreases the average gage loss by 67.6%



Gage Loss Rate

Gage loss (in/hr.)	
% Activol 1803	Rate of Loss
0.000%	0.00400
0.125%	0.00070
0.250%	0.00046
0.500%	0.00026
1.000%	0.00015

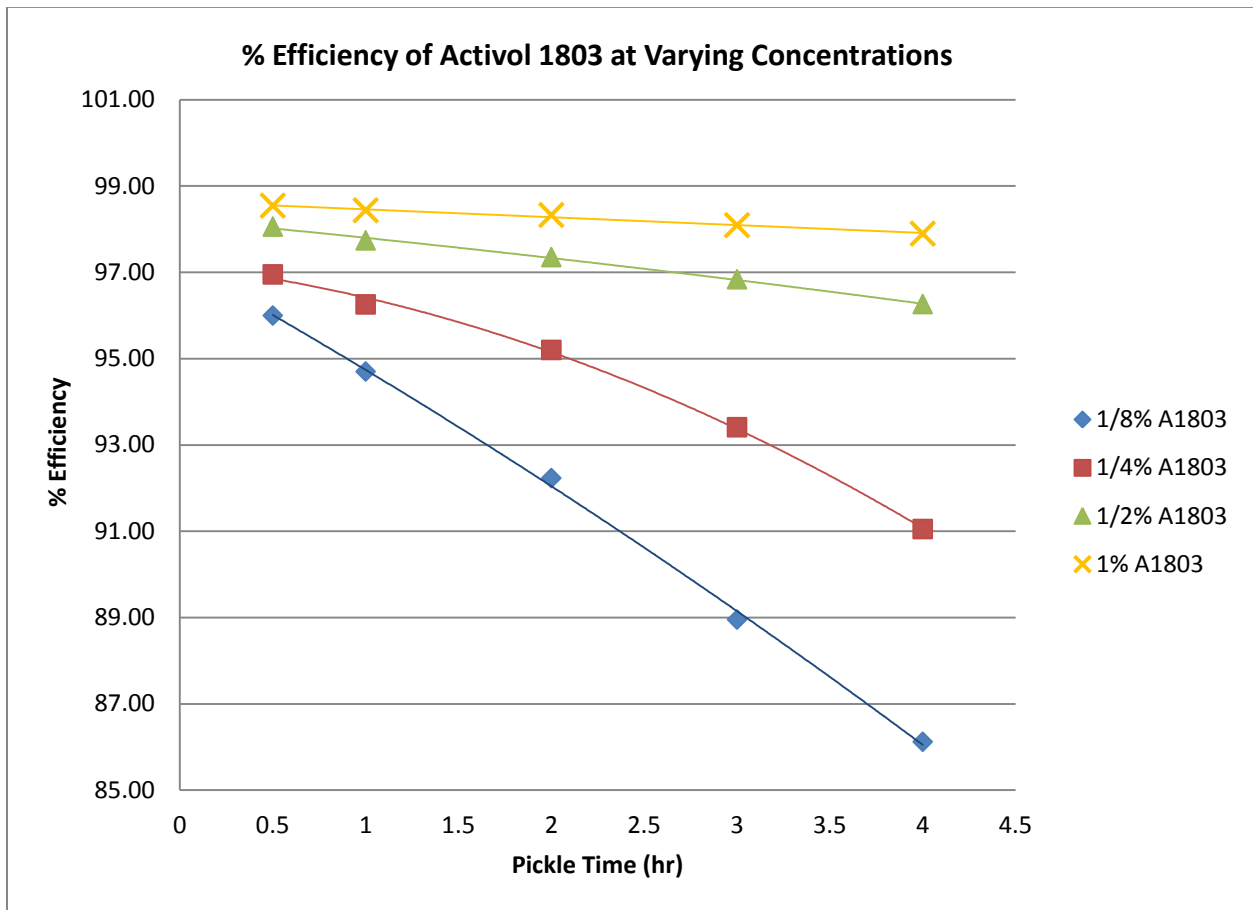


Similar to the weight loss rate of the steel panels, the slope of the gage loss rate significantly slowed when the inhibitor concentration was increased from 0.25% to 0.50%. Panels pickled in uninhibited acid showed a gage loss of 0.004in/ hour.

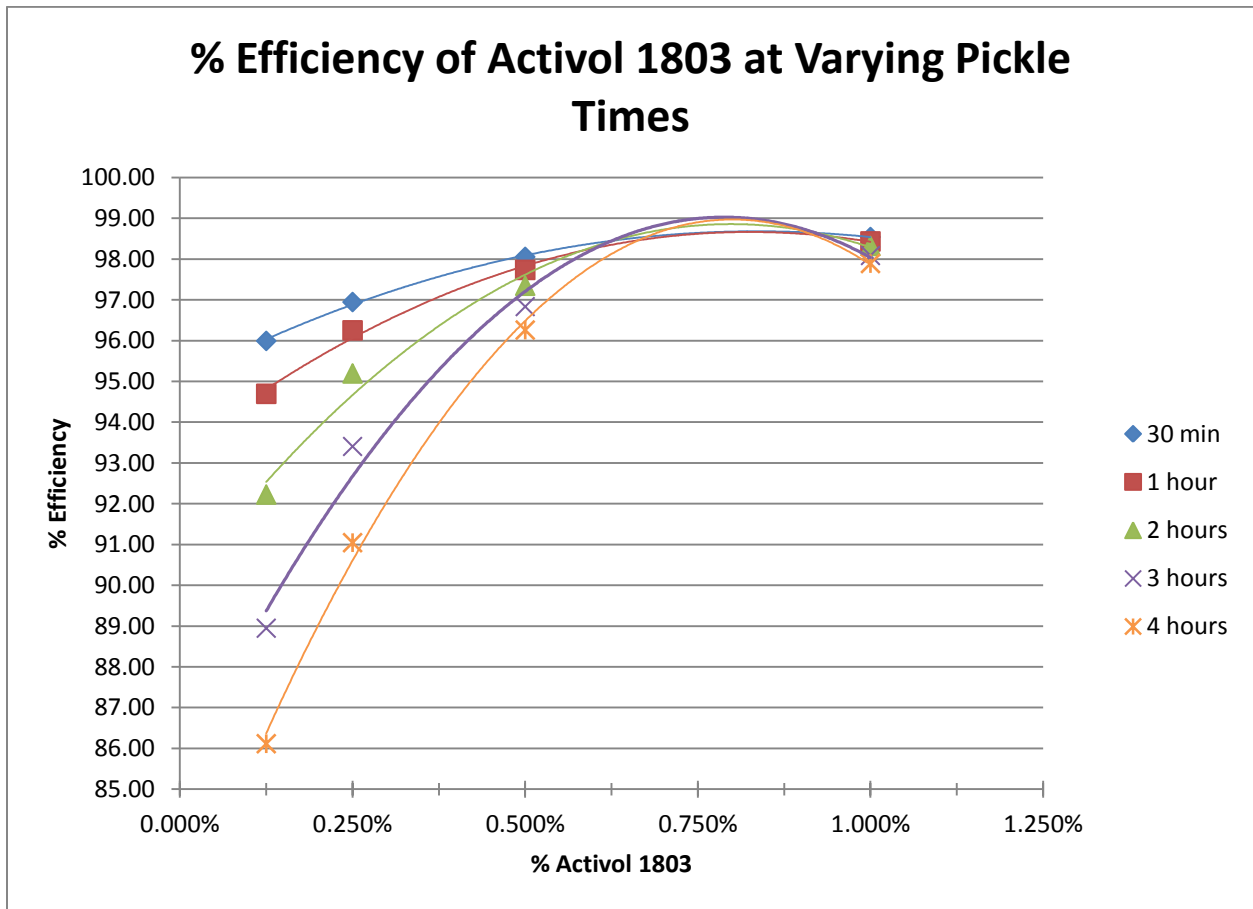
C. % Efficiency of Activol 1803:

Time (hrs.)	Average % Efficiency			
	% Activol 1803			
	0.125	0.25	0.5	1.0
0.5	96.00	96.95	98.06	98.54
1.0	94.70	96.25	97.74	98.44
2.0	92.23	95.20	97.35	98.33
3.0	88.95	93.41	96.84	98.09
4.0	86.12	91.05	96.26	97.89

The below graph illustrates the relationship between the % Inhibitor and the length of the pickle time for varying concentrations of Activol 1803. The current usage at this customer is shown by the red line, 1/4% Activol 1803. As shown, 0.5% Activol 1803 and 1.0% Activol 1803 maintain efficiencies above 95% throughout the duration of the 4 hour test period.

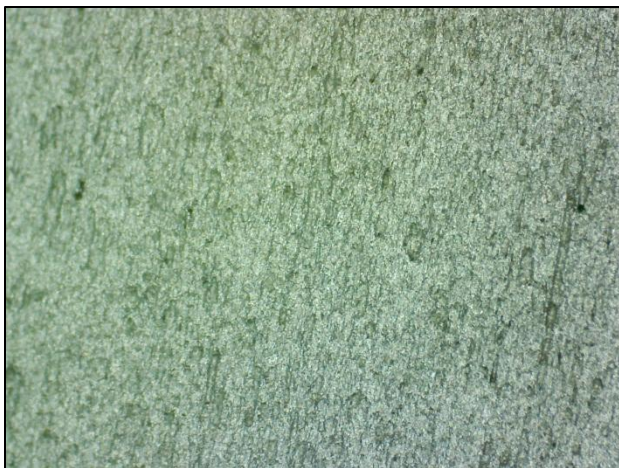


The second % Efficiency Graph on page 8 illustrates the relationship between % Efficiency and inhibitor concentration at the various pickle times. Activol 1803 at 1% concentration maintains a very high efficiency up to the 4 hour pickle length. While the lower concentrations do offer high efficiency up to two hours, only the 0.5% and 1.0% performed above 95% during the extended test period.



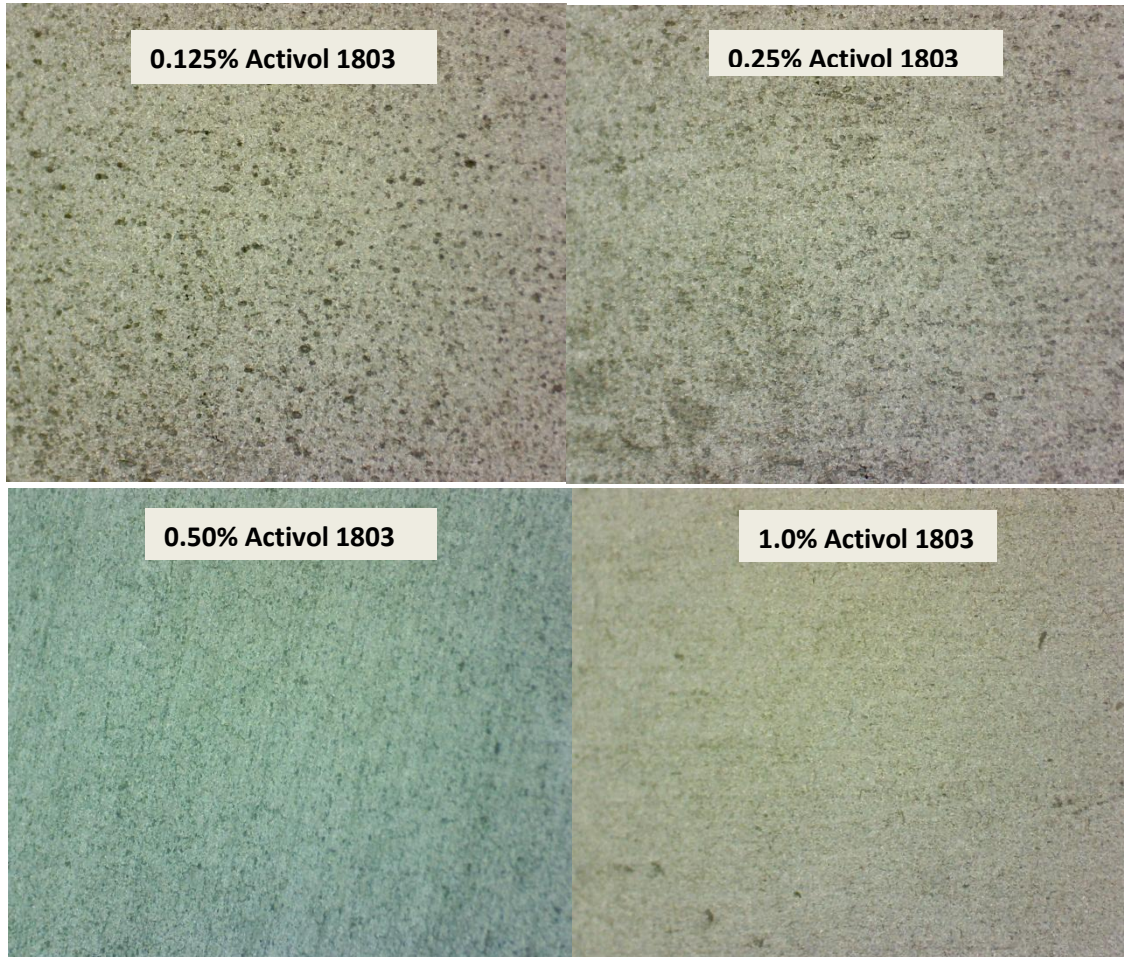
D. Surface Appearance:

After the 4 hour pickling, the J932 steel panels were observed and photographed under a microscope at 40X magnification for visible surface damage.



To the left is the J932 panel pickled for 4 hours without Activol 1803. The panel was very brittle and contains pitting seen in the 40X photograph.

Panels under 40X Magnification pickled in varying concentrations of Activol 1803.



The panel pickled in 0.125% Activol 1803 exhibits significant pitting and scarring on the surface. When increasing the concentration of Activol 1803 to 0.25%, the pitting is still present on the panel surface; however, it is reduced. The panels pickled in 0.5% and 1% Activol 1803 show little to no surface pitting or scarring after the 4 hour test. All panels photographed were from Trial 1.



Conclusions:

The addition of Activol 1803 to pickle baths where J932 steel is processed greatly reduces the weight and gage loss of the steel. Increasing the concentration of Activol 1803 on the HCl continuous pickle line from 0.25% to 0.50% when pickling the J932 steel further improves the reduction of gage and weight loss of the panels up to 4 hours in pickle liquor. Additionally, the surface appearance of the steel is greatly improved. It is recommended that the concentration of Activol 1803 be increased to 0.5% during extended down times and line stops to minimize any surface pitting or gage losses that could render that portion of steel to be a problem when passing through the cold rolling operation.