FIVE LESSONS IN PICKLING

by
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Twenty-five years as a consultant in pickling have produced a lot of surprises, some of which are less surprising the second, third, fourth... time. Here are five recurring themes, with actual case histories to illustrate them.

Most of these problems are the result of the decline of the design engineering function in the steel industry. In plant after plant we find there are no drawings, no equipment manuals, no flow diagrams, no material balances and no operating manuals. The pickle line has been assembled, rather than designed to do a job. Ironically, in an age that worships quality control standards, almost to the point of absurdity, industry is systematically abandoning the discipline that can design quality into the process, and is trying to operate using procedures, rather than scientific and engineering principles.

1. It's not a <u>cleaning</u> house:

Many picklers call their pickling operations cleaning houses. This is not just a misnomer, but also gives the operators the wrong idea of what the equipment can do. Many problems can arise from the idea that the pickling equipment can handle any cleaning task.

What must be clearly understood is that a pickle tank is designed to do one thing only - remove scale from metal. It is not designed to remove oil, dirt, lube, phosphate or poor plating or galvanizing coatings.

We were working on improving a rod coil pickle line (called a cleaning house), where one of the owners' complaints was that the acid had to be hauled away every 3 months, even though the plant was equipped with an acid recovery system. Certainly, the acid looked brown and dirty, and there was evidence of sludge build-up in the tanks, but we know from experience that usually it is only necessary to haul away acid from a recovery system about once a year, to remove accumulated solid fines and dissolved tramp metals.

A short period of observation soon revealed the problem - the rod was being stored outside, and the coils were being put into the pickle tank with mud and stones caked on the bottom. Which brings us to lesson number 1:

(a lot) x (a little) = quite a bit

or, as an example

250 ton/day x 0.01%	=	50 lb/day
	=	250 lb/week
	=	1000 lb/month

In other words, if the average amount of dirt on a coil was 0.01% (that's less than half a pound on a 4400 lb coil), this was adding 1000 lb per month of dirt to the acid tank. Now, acid does not dissolve clay, dirt and stones, so this was just building up in the bottom of the pickle tank, making the acid dirty, and leaving solid particles on the cleaned steel.

Pickling acid also does not dissolve oil or lube; it does dissolve zinc, but this contaminates the acid and makes it expensive to recover or dispose of.

What this lesson teaches us is to keep contaminants out of the pickle tank. If the metal requires treatment to remove dirt, oil, lube or coatings, provide separate tanks for these purposes; this allows the removed material to be disposed of (see lesson #2) without it being mixed with acid.

2. What goes in, must come out

Pickling does not get rid of anything. The purpose of the pickling operation is to separate what we want - clean metal - from what we don't want - scale. However, the scale does not disappear - it is converted into a metal salt which is dissolved in the pickling acid, or into sludge in the pickle tank, or into cake in the wastewater treatment plant.

The principle that what enters, leaves, is the basis of the material balance. Whenever we do a pickle line study, we do a material balance, and it is amazing what we can deduce from it. The material balance applies to everything - every lb of acid added must leave, somewhere; every gallon of water added must leave, somewhere; every lb of dirt added must leave, somewhere.

Many years ago, we were consulted by batch rod coil pickler about a plant relocation and upgrade. The old plant had concrete pickle tanks in the ground (which the owner hoped to move to the new location, but that's another story), with acid brick lining. It also had a batch acid recovery plant, so, as part of our study we looked at records of the amount of iron sulfate crystals made. To our surprise, the production of crystals was very low - far too low to account for the amount of acid being consumed, and for the amount of iron being removed from the rod coil. In accordance with procedures, every second day, the operators faithfully pumped the pickle tank into the recovery plant, added fresh acid, cooled it, and filtered it, frequently without making any crystals at all! No acid was being hauled away, and no-one seemed to think that there was anything odd about the lack of crystals.

We knew that this could not be right - the acid was going in, so it had to be coming out. Sure enough, it was coming out - into the foundations and drains of the building through cracks in the pickle tank walls.

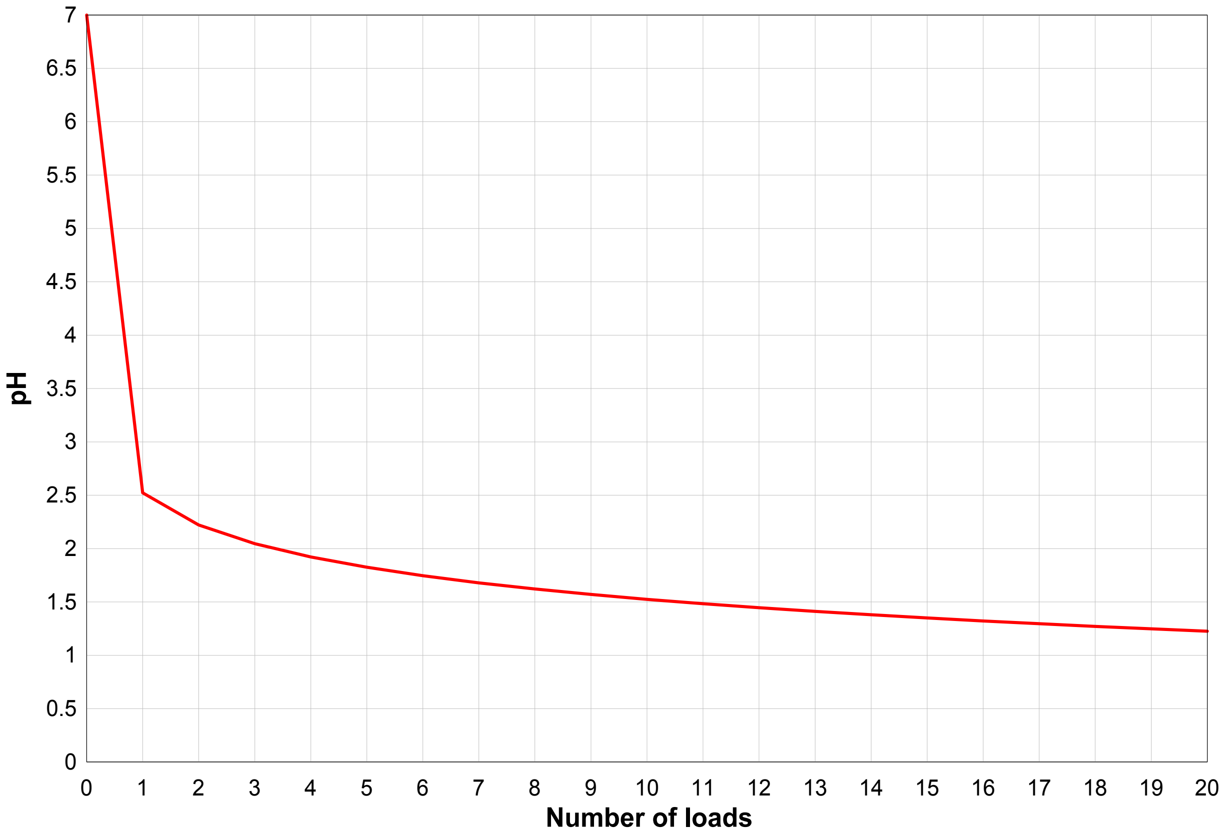
What this lesson teaches us is that nothing disappears. Keep a close watch on your material balance, and, if something is apparently disappearing, remember - it's not disappearing, but merely going somewhere else, probably somewhere you'd rather it didn't.

3. Nothing lasts for ever

Recently, during a sales/courtesy visit to a batch pickler, the plant engineer was complaining that his product was rusting very quickly in storage. When we asked what his rinse-water flow was, he said they just filled the rinse tank with clean water at the start of the week, and dumped it at the end of the week.

This is by no means the only plant where this sort of thing is done - where the operators do not realize that, for good rinsing you need clean water.

FIGURE 1
STATIC RINSE
2000 GAL TANK, 2 GAL/LOAD, 15% ACID



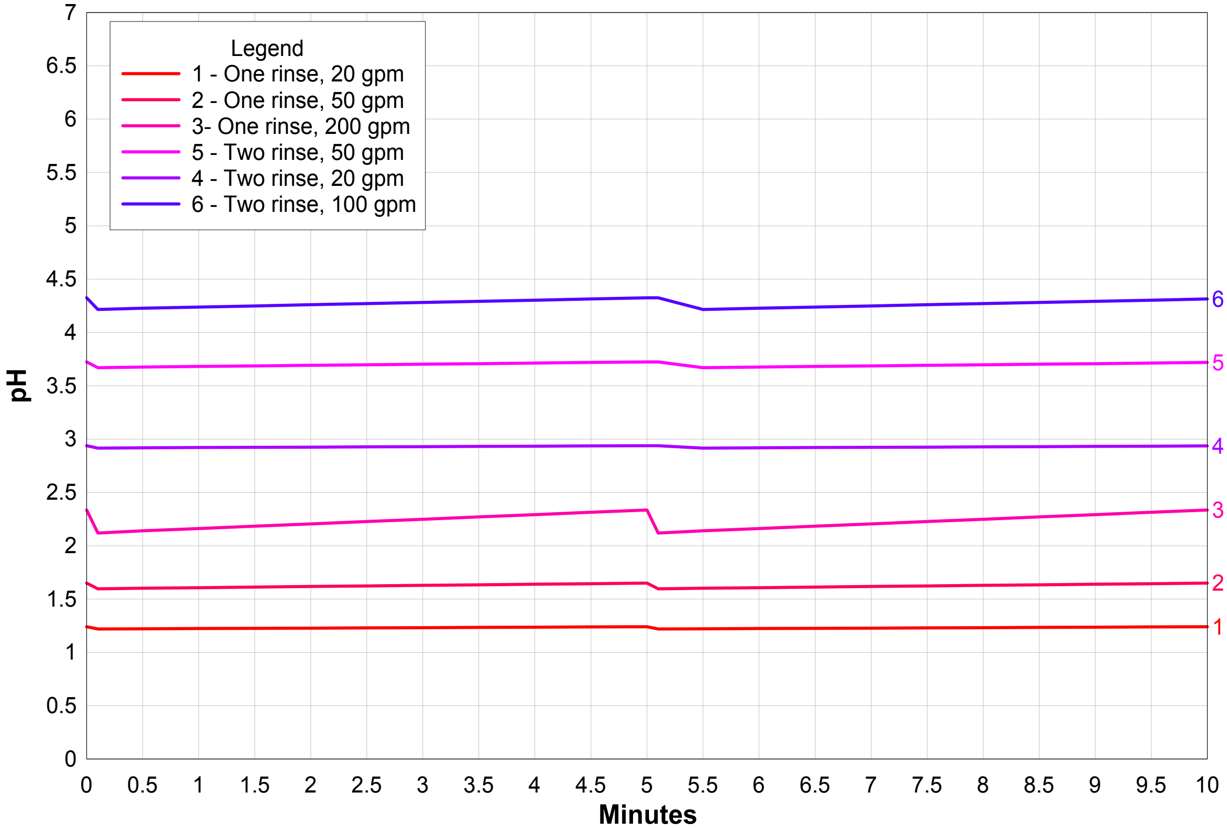
Statrins.grf

A batch rinse tank is never clean. Looking at figure 1, which is a graph of pH vs number of loads, for a static rinse tank, you can see that, after the first load is rinsed in clean water, the tank is contaminated to pH 2.5, and continues to get more and more contaminated. For a clean product, a pH of 4 to 5 is required - not 6 or 7, which can lead to the rinse water turning brown and leaving iron hydroxide particles on the clean surface.

Even with a steady flow of water, a single dunk rinse is inadequate. Figure 2 shows the pH of a rinse tank with different water flows. At 20 gpm, the rinse is very acidic - close to pH 1 - but, even at 200 gpm, the pH is only just above 2. This is still far too contaminated for good rinsing. The top three curves in figure 2 show the advantages of multi-stage rinsing. Even with only 20 gpm of water, a two-stage rinse is significantly letter than a single rinse in 200 gpm.

What this lesson teaches is that multi-stage rinsing pays - in better rinsing, and in reduced water flow and thus reduced waste treatment plant size.

FIGURE 2
DUNK RINSING
2000 GAL TANK, 2 GAL/LOAD, 15% ACID, 5 MINUTE INTERVALS



Dunkrins.grf

4. You can have too much information

Information is only useful if it is meaningful, if it is looked at and if it is understood. Information that is meaningless, or which is collected and filed without review is a waste of resources - for collecting it, filing it and storing it.

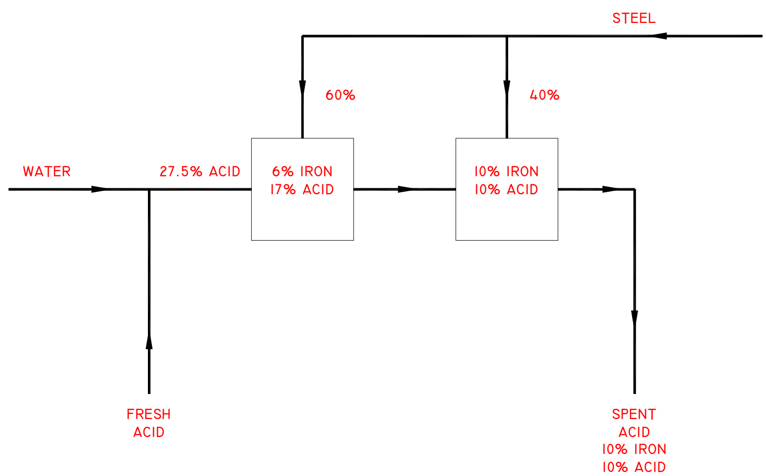
In one batch pickle line the operators were assiduously analyzing the pickle acid every 2 hours, using a technique that was accurate to +/- 1%. A simple calculation showed that it required 12 hours of operation to change the acid concentration in the tank by 1%, so one analysis per shift would have been quite adequate. In fact, the 2 hourly results were quite meaningless, and any variations were due more to analytical errors, or differences in operator techniques than to any real changes in acid concentration.

In another large strip pickling operation we analyzed the monthly statistics on acid usage and disposal. This monthly report went to the pickle line superintendent and several other line managers, all of whom were astounded when we showed, using figures from these reports, that over $1 million per year of acid was being wasted. The information was all there in the reports, but no-one had the time to properly understand what it meant.

We have, on many occasions, been proudly shown SPC charts for controlling pickle tanks, but, in most cases, the operators had no idea what they were supposed to do if the variables went outside the limits. Even worse, the corrective measures taken were sometimes intended more to make the chart look right than to actually improve plant operations. A common mistake is to try and control the conditions in all the tanks in a continuous or cascade acid flow system - it cannot be done. Only one tank can be controlled independently; the conditions in the other tanks are set by the material balance (see 2 above). Figure 3 illustrates this for a simple, two-tank cascade on sulfuric acid - if the acid leaving the second pickle tank is controlled at 10% iron, 10% acid by adjusting the input water and acid flow rates, the concentrations in the first tank are completely determined by the amount of pickling done in each of the tanks.

This lesson teaches us to measure and record only information that we plan to use in controlling the operations, to think carefully about the meaning of what we are measuring, and not to overcontrol.

FIGURE 3
MATERIAL BALANCE FOR CASCADE PICKLING
(SULFURIC ACID)



5. Hope is not enough

Good fume control is crucial to the operation and performance of a pickle line, yet many owners, after spending $100,000 or more on fume control equipment, then allow it to deteriorate, or do not operate it correctly - they just 'hope' it keeps working.

One of the most common mistakes is to turn off the push air. Any open-topped tank over 2'-6" wide, with lateral exhaust, requires push air because the influence of hood suction is negligible beyond 30". However, if the push air system is not properly designed to withstand the rigors of the pickling environment, it is easily damaged, and rarely repaired! Without push air, all you have is general building ventilation.

Ideally, the push air header is designed into the pickle tank - in fact, the design of any pickle line should include consideration of the equipment needs for efficient fume control. All too often, fume control is an afterthought, so that: insufficient space is available for ducting and scrubbers; openings and drafts in the pickle house interfere with fume control air flows; and equipment is placed in inaccessible locations, which guarantees minimal maintenance, and no operating attention.

Fume exhaust system problems usually manifest themselves in one of two ways:

- fumes in the work place
- emissions from the stack

Emissions from the stack are always an indication of scrubber problems - fumes in the workplace may be caused by scrubber problems, but may also be the result of poor fan performance, blocked ducting or lack of push air. Here are some examples:

> Poor performance on a packed scrubber on an HCl pickle line, using once through water - the main water supply valve was closed!
>
> Poor scrubbing in a packed scrubber on a batch nitric/HF pickle line – the pump impeller was worn away, so there was no circulation of water over the packing. In the same plant, at another location - no circulation because the pipe was plugged with calcium fluoride.
>
> No draft on hoods in a galvanizing operation - fan running backwards.
>
> No draft on an HCl pickle line - low point in duct full of liquid (carryover and condensate), cutting off the air flow.

Every one of these exemplifies the ‘hope’ approach. The pump is running, let’s hope it’s working; the water line is connected, let’s hope the water is turned on. But hope is not enough - in addition, there must be care and attention to be sure. Someone must be observing what is happening, thinking about what is happening, and doing something to correct problems.

So, there are the five lessons in pickling. Will people learn from them? Fortunately for us, not always, so we can continue to solve these problems for picklers, along with the more difficult ones.

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