How Long Should Cleaners & Acids Last?

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This is the ninth in a series of reviews looking back on "AES Update," the 25-year-old series begun and coordinated by the late Dr. Donald Swalheim, and continued by others. This is "old stuff" but just as relevant today as the day it was written. This year we felt it worthwhile to resurrect some of these articles for the sake of people coming into the field, as well as those who feel a little rusty in some areas and are looking for a refresher.

This month, the featured article is eminently practical. It deals not with the plating process itself. Rather, it deals with the front end of the processing cycle—the cleaners and acids used to prepare the workpiece for plating. Of course, "it's what's up front that counts." Larry Durney, a longtime and valuable contributor to this journal, prepared the following article for the "Update" series in 1980. As usual, my own words or comments are shown in [ ]. This is one of the more valuable practical articles in the series. It helps you determine just how long that cleaner or acid dip should last. All these years later, we hope that it may help today's metal finishers optimize their operations, increase productivity and reduce costs.

"I am frequently asked to estimate how long a cleaner or an acid should last before it is necessary to dump it or replenish it. The question can be stated in a variety of forms: How often should I dump my cleaner? Or my acid? How much will it cost per piece? Or per day? How much cleaner should I add per day? Or per week?

"Unfortunately, it is not possible to answer these questions with any degree of precision. The best and only answer is to run a production test. Why is this? Basically, because there are just too many variables to permit a reasonably accurate prediction. Let's discuss cleaners and acids separately and consider some of these variables and how they affect the performance and the life of the material.

Life of Cleaner

"The life of a cleaner is dependent on:

(1) The formulation of the cleaner,
(2) The nature and amount of soil introduced,
(3) The amount of dragout, and
(4) The maintenance procedures used.

Formulation

"Obviously, cleaners can be formulated with varying degrees of cleaning capability, and with varying degrees of tolerance for soils. Increasing either of these capabilities usually adds to the cost of the cleaner. As a rough rule of thumb, more expensive materials either do a better job or last longer. It is not good policy, however, to buy habitually the best and most expensive material. It may be too good for what you are doing. And, even though it might last longer, the dragout cost will be higher than that for the least expensive material that will perform adequately and provide a slight margin of safety.

Soil

"Heavily soiled parts contaminate a cleaner more rapidly than lightly soiled parts. Sometimes, a very minor ingredient in the soil can build up in a cleaner and interfere with its performance. Soils from slightly different sources often can present a completely different cleaning problem. All of these things affect both the life and performance of the cleaner. And who knows enough about all the kinds and possible combinations of soils to be able to predict what will happen in production?

Dragout

"If dragout is high enough (as in some barrel operations) it may be equivalent to building a new cleaner every week or two. In such a case, a steady state may be reached and the cleaner will have an almost indefinite life. It is almost impossible to figure this particular factor with any acceptable degree of accuracy.

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Maintenance

"Skimming of oil that has been removed from parts, filtering to remove solids, careful titration to insure proper concentration of the cleaner, etc., often can extend the life of a cleaner. Ask yourself how much of this type of maintenance is done.

"Add to all of the above the fact that some soils may selectively strip out a key ingredient of the cleaner. Certain types of oils, for example, may rapidly remove particular wetting agents that are soluble in oils. This could leave you with a cleaner that is up to strength, according to titration, but which has lost almost all of its cleaning capability. As a result of all of these variables, cleaner life can vary from a few days to as long as six months.

"How do you go about determining the best operating period for a cleaner? The procedure I usually recommend is to use the cleaner until you encounter trouble attributable to the cleaner. This needn't necessarily mean that rejects be encountered. For example, you can often tell when a soak cleaner is running downhill while parts are still acceptable, but

Analytical procedures can help determine when a cleaner or acid bath should be replaced.

not quite perfect. Then, set the dump schedule at one week less than the observed time from bath makeup to the first sign of inefficiency. Obviously, if production increases or decreases after the determination has been made, the dump schedule should be adjusted proportionately. Remember especially that, because the dump cycle in many instances is carried out on overtime, it may be desirable to sacrifice some cleaner life in order to coordinate all the dumps and thereby utilize the minimum amount of overtime hours.

Cost of Cleaners

"The cost of a cleaning cycle comprises the following:

- The cost of the chemicals—both makeup and replenishment. Call this "S."
- The cost of dumping and rebuilding the solutions—*i.e.*, the effect of cleaner life. Call this "M." This consists of the labor and/or downtime required to dump the solutions, clean the tanks and build fresh solutions.
- The cost of reprocessing any rejects that result as a consequence of the cycle. Call this "R." This sometimes is affected by the end result more than anything else and may therefore become an overriding factor. For example, in the space program or in preparing repeater circuits for use in underwater telephone cables, zero rejects are a must. Therefore, all other cost factors may be disregarded. In most cases, some reject rate is tolerable and, by relating cost of reprocessing these rejects to the total production, a meaningful figure is obtained. Don't forget to consider the production lost while reprocessing the rejects.
- The cost of special treatment such as waste disposal. Call this "W." This cost [was becoming increasingly prominent when this article was originally written and has become more so today.] Heavily chelated materials may require special waste treatment to eliminate heavy metals from the effluent, etc. Local [regulations] play an important part in determining the effect of this factor on cost. The need for phosphate-free materials, for example, may increase the cost of a cleaner. The need to use cyanide-free metal strippers also may increase the cost of reprocessing rejects ("R").

"For our purposes, we will also add two other factors —"P," the daily production expressed in thousands of square feet, and "D," the number of days of production possible between solution replacements, *i.e.*, the life of the solutions in the cleaning cycle.

"The actual cleaning cost is now represented by:

$$C = \frac{S}{PD} + \frac{M}{PD} + \frac{R}{P} + \frac{W}{PD}$$

"Note that "C" is now expressed as a function of the production standard— that is, cost per 1000 ft^2.

Acid Baths

"While the life of an acid bath cannot be predicted much more reliably than a cleaner, it sometimes is possible to set up an analytical procedure that will indicate when the dump should be made.

"If the cause for dumping the acid is not contamination by dragged in materials such as oil, the most frequent reason for dumping is dissolved metal. If [metals are] introduced by parts, racks or drag-in, [they] often can be controlled by using a suitable pickling aid. However, unless you have extremely large tanks that justify special rejuvenation procedures, there is no choice except to dump when dissolved iron reaches a critical level. Unfortunately, this level varies from one operation to another, which means that you must determine the critical level yourself. Use the acid until you have problems such as incomplete removal of rust or rust in the rinse. Then, analyze for free acid and iron content. Set up these values as a standard and thereafter dump before you hit the critical level.

"Incidentally, people often misinterpret the results of acid titration. If the wrong indicator is used, or if the bath is heavily loaded with metal, you can titrate the dissolved metal as well as the free acid. The only thing that contributes to proper pickling is the free acid. So, if you find that your sample gets cloudy and turbid before your indicator changes color, you should change your indicator. Some people use this clue, turbidity from precipitated metal, as a signal that the dissolved metal has reached a critical concentration and the bath should be dumped.

"When running these production tests, bear in mind that the ideal situation is to use the minimum concentration that will effectively do the job, plus sufficient excess to carry the bath safely from one addition to the next. Obviously, frequent additions will permit you to operate at the lowest safety concentration, which, in turn, can considerably reduce dragout losses and therefore material consumption, waste-disposal costs, etc.

"Excessively frequent analysis, however, can also be expensive. On the other hand, cleaners and acids are usually checked easily with readily available test kits. For purposes of convenience, manufacturers of these test kits have sacrificed a certain degree of accuracy. Results generally will be ± 10% in the hands of the average operator; somewhat better in the hands of someone thoroughly trained. Therefore, the limits should be set to provide this degree of tolerance, and the operator who is going to carry out the analysis should be thoroughly instructed in the use of the kit.

"It is important to remember that a dump schedule is not a sacred cow. Once established, it need not remain fixed forever. Changes in production levels, and/or the nature of the parts and the soils, influence the dump schedule. Unless you are reasonably certain that there is little or no change or variation in the throughput, the dump schedule should be checked periodically to see if it can be extended. Conversely, if you regularly encounter problems before dump time, the schedule should be shortened.

"The formula given above to calculate the cost of operating a cleaner can be used to calculate the cost of operating an acid bath." *P&SF*