Optimizing Surface Preparation: Strategies to Minimize Plating Failures and Enhance Quality Control

Our industry says that 90% of quality issues are related to poor surface preparation. It would be impossible to quantify that number, but most troubleshooters will agree that ineffective cleaning and activation are among the most common root causes of plating failures. Knowing that effective surface preparation has such a strong impact on consistency and quality, the conversation needs to shift toward how operators can proactively ensure parts are properly activated before reaching the plating tank.

One of the biggest contributing factors to cleaning issues is that most processors do not have complete control over the incoming condition of parts. Job shops have a wide range of different incoming soils that they need to remove, and there is no aqueous cleaner formula robust enough to universally remove all those different soils at the same bath parameters. Variables regularly change upstream, and processors need to react to those changes to avoid costly rework loops. Operators can provide real-time feedback on the effectiveness of a cleaning process if they know what to look for, and management can use that feedback to adjust bath parameters, update maintenance schedules, or even explore new chemistries.

Operators need to understand what style of aqueous cleaner is in place. The classic hot, alkaline, degreasing tank has two main styles: emulsifiable and splitting. An emulsifiable cleaner has components that hold oil in solution while it is being removed from incoming workpieces. A splitting cleaner will not hold onto the oil, but rather kick it up to the surface where an oil film or “slick” will form. A splitting formula requires some form of weir or oil skimmer to continuously remove this slick. If a slick forms on an emulsifiable cleaner bath, that chemistry has reached its limit and can no longer effectively clean parts. This is a signal that the tank is exhausted and needs to be recharged. Pulling a work piece out of a tank through an oil slick is at risk of having adhesion problems, contaminating downstream process tanks, and building oil slicks on other tanks that could cause adhesion issues on future parts.

Hubbard-Hall recently responded to a call at a local black oxide shop experiencing what they called “water spots” on the final product. A quick walk down the line found oil slicks on the cleaner tank, acid activation tank, and the rinses. The black oxide cannot uniformly attack the surface if oil is still in the way, so the final appearance had developed lighter spots where the oil was still on the parts. Identifying oil slicks is typically not hard, but the operator and supervisor were both new and unfamiliar with what to look for. First, turn off any agitation that the cleaner tank may have and allow the solution to settle down. Then look at the solution surface at an angle for any sign of iridescence. Investigate both the center of the solution as well as the tank edges and use a secondary light source if needed. They ran the rest of the day without visual defects after recharging the cleaner, the acid, and the rinses.

The second thing that operators can do is perform tests on the line to qualify the cleanliness and stop the parts from proceeding if they identify any risks. There are arguments and discussions in the industry about how subjective and effective the water break test and white glove test are, but regardless, they provide some point-of-use data that operators can use as a red light. The water break test is detailed in some common specifications, but the main idea is to pull the workpiece out of a clean rinse tank after it has gone through a degreasing step, hold it at an angle with good lighting, and then watch how the water flows down. Water will quickly and uniformly run down a clean surface, while any oil residue remaining will cause the water to bead up and leave a spotty appearance. The test has some shortcomings as it needs a flat viewing surface to be most effective and it is limited to rack lines that can easily view the parts up close. While the water break test is utilized after the cleaner rinse, the white glove test is utilized after the acid activation rinse. Some shops will use an actual white cotton glove, but it is more common for operators to simply wipe a racked part with a cotton swab after pulling it out of the final acid rinse tank. Black or dark gray residue on the cotton swab could be a sign of smut formation in the acid tank, which can lead to blisters in the subsequent plating tank. This test also has some shortcomings as some smuts or residues could be clear, interpreting results can be inconsistent from operator to operator, and some metals, like aluminum, can leave behind residues even when they are clean.

Hubbard Hall responded to an account once that historically did not clean parts before electropolishing. They were processing stamped discs that always came in clean enough to just rack up and run as is until everything started coming out frosty and hazy. The viscosity and metals analyses were within acceptable ranges, but oil could be felt on the parts during an on-site visit. The operator racked some parts and put them directly into a rinse tank to perform a water break test on the incoming condition. Sure enough, the water beaded up all over the flat surfaces, and in turn, they implemented an alkaline cleaner step before electropolishing.

Smut formation resulting from extended acid activation times is an easy trap to fall into during processing. If activation issues are suspected as a root cause of blisters, and the acid tank helps to activate the parts, it is not hard to see why shops would try longer immersion times as a corrective action. In practice, this typically has the opposite reaction, with extended times leading to smut forming, especially on some stainless alloys or the base material beginning to etch. Sometimes there are tenacious oxides or scales that need to be overcome, but any gassing of the workpiece can be an indicator that the acid bath is beginning to attack the substrate. Electroless nickel, in particular, prefers a smooth surface to avoid pitting, so shops should be trying to keep the activation parameters at their required minimum.

The third thing that operators can do is to familiarize themselves with the tank's appearance as they age. Acid tanks will typically darken as they build up metals, but some cleaners may become cloudier with age, and others may fade in color. Setting up regular recharges based on a calendar is a good start to solution process control, but eventually this will need to be updated as new data is gathered and the line reacts to changing workflow volumes. A common mistake that shops make is to keep maintenance schedules and rinse flow rates the same, while throughput may have increased. Asking "What has changed?" is a key part of the root cause determination, and increased surface area through the line is an easily overlooked change.

Understanding the role of each tank in a cleaning cycle, from the operators up through management, is the key to maintaining consistency and quality of surfaces entering the plating tanks. Filtration and agitation are great ways to improve the effectiveness and longevity of cleaning tanks but knowing what to look for and making process control decisions based on these observations in real time will have the largest impact on defect prevention.

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