Rack Design & Maintenance for Decorative Automotive Applications

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In the automobile and motorcycle industries, appearance sells. The most obvious attraction to a vehicle is the amount of chrome accessories that adorn the exteriors. This paper will cover design engineering, materials, auxiliary anodes, maintenance, and selecting a supplier. The proper design and maintenance of plating racks is “the right start to a perfect finish”.

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INTRODUCTION

Racking in its crudest form can consist of little more than a piece of wire twisted onto the part to be finished. This method is obviously the cheapest and just as obvious, the most inefficient. Along with inefficiency, you cannot assure a quality finish due to presentation of the part to the anodes. For decorative automotive finishes, custom racks are necessary. In this discussion, we will review rack design and maintenance for decorative automotive applications.

ENGINEERING

The most important feature of any rack is the design. Without the proper design, you cannot expect to obtain the optimum productivity that your process is capable of achieving. There are many factors that come into play when designing and building racks for decorative automotive applications. The following items will be discussed.

- **EQUIPMENT MANUFACTURERS**
- **DIMENSIONAL RESTRICTIONS**
- **WEIGHT RESTRICTIONS**
- **PART PRESENTATION and SPACING**
- **RACK MATERIAL**
- **MANUFACTURING TECHNIQUES**
- **AUXILIARY ANODES, ROBBERS, SHIELDS**
- **OPTIMIZED DESIGN**
- **ERGONOMICS**
- **MAINTENANCE**
- **SELECTING A SUPPLIER**

EQUIPMENT MANUFACTURERS

There are several automatic equipment manufacturers in the market and each has special methods of attaching or mounting a rack. There are also manual lines that have simple carrier bars where the rack merely hangs on the flight bar.

The two most common lines manufactured are the return line and hoist line. Regardless of the equipment, the first consideration is how will the rack hang on the cathode bar.

Some manufacturers of return type equipment use brass alloy castings to carry the current to the rack. Most of these castings are different and what needs to be known to assure a perfect fit is the center-to-center dimension where the rack hangs on the casting. If a rack does not hang properly onto the casting, you cannot be assured the required current flow and run the risk of the rack not having the appropriate clearance as it moves from station to station.

Hoist lines typically use copper flight bars, which can vary in length, and carry the racks from station to station. The bars are commonly rectangular but can be round. The advantage of a hoist line is the racks can be designed to have varying center-to-center locations and can vary in over all width allowing several racks to be loaded onto a flight bar.

DIMENSIONAL RESTRICTIONS

The primary dimensional restrictions are the overall height, placement of the parts, width, and depth of the rack.

Height considerations must take into account the distance from the top of the cathode bar to; the tank with the lowest solution level, the distance to the bottom of your tanks, and the distance from the top of the cathode bar with the hoist in the raised position to the top of any obstructions on the top of the tanks such as the exhaust duct. For example, if the distance from the top of the cathode bar to the plating bath is 12" and the depth of the plating solution was 48", in theory, the overall height would be 60". Because there can always be unseen obstructions in the bottom of the tanks such as airlines, dropped parts, or sludge, you will never want to have a rack too close to the bottom. Staying off the bottom at least 2" is normally sufficient so, the overall height would be 58". Now to locate the first part, we have already determined the distance from the top of the cathode to the solution level is 12". If top portion of the parts to be plated were at this 12" mark, there would be no room for error if the solution level fluctuated due to drag out or evaporation. Therefore, the part should be at least 2" below the solution level. When measuring the cathode to solution level dimension, you must take into consideration the tank with the lowest operating range. For instance, if your plating solution was your lowest level and the rinse was the highest, and the rinse tank was one that was measured, there is a good chance that the top row of parts may not be adequately plated because they would protrude out of the plating solution.

The overall width of the racks is restricted by the working area of the cathode bar and tank dimension. Regardless if the cathode bar is a casting or copper bar, more times than not, the overall width is determined by the tank. Typically most tanks have bussing, air lines, or heat exchanger piping that come into the tank from one or both sides. For large copper carrier bars, it is common to have several racks on a bar rather than one large rack unless the part necessitates it. To clarify that, if the working area of the carrier bar was
12 feet, you would probably not want to have a 12 foot rack simply because it would be too hard to handle. Instead, three racks that were 4 feet wide would be much easier to work with.

For uniform plating, parts on the rack should be equidistant between the anodes because the rate of plating varies with the distance from the anode. The distance between the anodes is required to assure the proper positioning of the parts on the rack. For example, if the distance between the anodes were 30", you would not want the part racked off center by 6" either way. That would result in the part being 9" from one anode and 21" from the other. You would end up with non-uniform thickness from one side to the other. However, there are occasions when you may want to place a part closer to the anode to improve upon uniformity of deposit due to part configuration. To accomplish this you can utilize an auxiliary anode, which will be discussed later.

WEIGHT RESTRICTIONS

All hoist systems are designed and restricted to lift a specific weight. Most importantly, the shop employees have a more critical weight restriction. The first thing a rack supplier is told

by a customer is to put as many parts on the rack that will fit. Most plants have Safety and Health Engineers who have set lifting restrictions. For any rack that is to be handled off line, the rack designer will need to know what the weight limits will be. As an example, if the request is to build a rack for part that weigh 8 ounces, and you have a work area that will hold 96 parts, the loaded rack will weigh 48 pounds. This is probably too much weight and the remedy would be to build two racks. However, if the rack is loaded and unloaded on the plating machine and the hoist has the lifting capacity, the weight would not be an issue. If weight is an issue, the rack designer will need to know.

PART PRESENTATION AND SPACING

The decorative nickel/chrome plating process is reliant on proper positioning of the parts particularly during the application of the chrome. The nickel has better throwing properties and does have some capacity to go into recesses and around corners. Still, to assure proper coverage, it is important to allow the parts to have as much exposure to the anodes as possible. The rack designers objective is to position the parts so that one part does not shadow another or placed too close one another.

Most platers who provide decorative nickel/chrome finishes know that the cosmetic appeal of their product is what sells. Parts that are shadowed, burned on the ends, have grown whiskers, or have a rough finish are a sure way to end up with rework and eventually an ex-customer. It is the rack suppliers responsibility to eliminate potential problems when designing a rack.

Shadowed parts can be a result of parts being too close together or overlapping one another. It can also be caused by improper shields, which will be discussed later. Burned and whiskered parts can be caused from mounting the part too close to the anode or not taking into consideration high current areas of the part. Sometime this problem can be resolved through mounting the parts on the rack so the high current areas are close to one another thus both pieces will share the current path. If mounting the parts like this does not work, then alternative devices such as robbers and shaders must be utilized. Again, these will be discussed later.

One of the more difficult surface blemishes to eliminate is roughness or shelving. Shelving is a result of particulate contamination in the nickel bath that falls to rest on the part during the plating process. This can sometimes be eliminated by racking the part so there are no flat areas in the horizontal plane such as racking the part vertically. However, due to the configuration of some parts, this may not be possible. You can make one surface vertical and end up with another horizontal. It may be necessary for the plater to increase the filtration rate of the bath or simply check the filter as there may be a problem causing the filter not to function properly.

There are no miracle formulas developed for proper spacing of parts, because most parts are in odd configurations and not always round or square. Most rack suppliers simply have a feel for appropriate spacing based upon experience. There are however, some general rule of thumb guidelines. It has been said that you should not place parts next to one another any closer than the depth of the part. It is also said that chrome will throw into a hole or

cupped area no greater than the diameter. Of course, if your solutions are not maintained to optimum concentrations and minimum contamination, these “rules of thumb” will not hold.

RACK MATERIAL

Copper is the predominate material used to build racks for decorative automotive nickel/chrome plating industry. To carry the necessary current throughout the rack and distribute it to the parts, nothing is as conductive as copper with the exception of silver. Anyone want to have a rack made of silver? Some rack suppliers have been known to use steel in an effort to “price down” their product to win the job. This should be avoided at all cost. Steel only carries 12% of the current for the same size in copper. As an example, if you needed to carry 125 amps in a single spline rack, you would need to use a 1/4”x1/2” piece of copper. To carry the same current in steel the material would be 1”x1”. Using a less conductive metal means that you will need more voltage to get the required amperage. This means that your rectifier will have to work harder, increasing your utilities and decreasing your rectifier life. Steel can be used throughout the rack for bracing and additional support. When comparing two suppliers that are quoting the same rack, find out what the rack frame material is made from.

Aluminum has been successfully used even though it only carries 60% of the current as compared to the same size material in copper. Normally when weight is an issue, aluminum has been used to reduce the overall weight. This is recommended only as a last resort.

Stainless steel is used throughout the industry as the preferred tip material. Both alloy 304 and 316 are used. The better suppliers will use 316 simply because it is a better product even though it costs more. Stainless steel offers adequate current carrying capacity in most cases and is resistant to most nickel strippers that are used when the racks are cleaned. There are situations when copper and phosphorus bronze are utilized to carry the current to the part, especially when the part is large and not enough current is being supplied using stainless steel. In these cases, you cannot subject the tip material to aggressive acidic rack strip solutions.

To protect the metallic framework of the rack from the chemistry of the plating line and to insulate the rack from plating up, your supplier needs to coat the rack in a good plastisol. However, not all plastisols are created equal. Some rack suppliers cut corners by using bottom shelf plastisol. This is not noticeable when you take delivery and can look as good as higher priced competitor’s racks. The problem will evolve later and is noticeable when comparing the life of the plastisol. Premature degradation of the plastisol will create cracks in the coating causing solutions to be carried from tank to tank contaminating plating baths. It can also cause acids to reach the copper framework and eat away at the metal. Coating failure and damaged framework will cost more in the end due to early repair of the rack and replacement of corroded framework. You should not buy your racks based upon cosmetics alone, because a lot can be hidden under the plastisol. Be sure that your supplier uses good quality material from the metals to the plastisol.

MANUFACTURING TECHNIQUES

One of the differences from a good supplier and an adequate supplier is quality of construction.

The preferred method of constructing the rack frame is to bolt the pieces of the framework together. There are occasions when the customer requests that the framework be soldered at the joints. This does improve the integrity of the joint by fusing the two pieces together but there is a real question if it improves conductivity. Rigidity can be accomplished by bracing.

Tips can be bolted or riveted in place on the rack. Either method works fine for smaller tips. Larger tips will require bolts. Regardless of method of attachment, the tips need to be mounted directly with the surface of the copper. Each tip needs to be mounted directly. Some rack makers will weld three or more tips to a steel bar. They then take the bar and bolt it onto the copper frame making contact in only two places forcing the current to flow through the steel before getting to the tip. This short cut creates resistance where the steel is bolted, and will not allow the proper current flow to the parts.

Racks do have a life expectancy. Over time, through wear, tips will break, the plastisol will breakdown, or your machine will crash making a pretzel out of your once square rack. When you return your rack to your rack supplier, you should expect more than repairs. On a rack that has been used so much that some of the tips have been broken from stress, you should expect that your supplier will return it to you as good as new. This does not mean that only the broken tips are replaced. A good supplier will replace all of the existing tips with new ones turning a repair into a rebuild. Yes, this normally costs a little more but what good is it to have a few tips replaced only to have a few more break within a month after getting the rack back after repair. The first tips broke due to stress. The rest of the tips are also stressed. You should never have only the broken tips replaced.

Be sure to have all of your racks dated so you will know when it was manufactured. This will help you track the longevity. Beware of suppliers who are afraid to tell you when the rack was made.

AUXILIARY ANODES, ROBBERS, and SHIELDS

Plating inside of recessed areas, such as wheels and step bumpers, is difficult and sometimes impossible to do with out the use of an auxiliary anode. The auxiliary anode is used help bring the anodic source closer to the surface of the part allowing the current to access the recessed areas. Under normal plating conditions, the tank anode can be anywhere from 12” to 16” from the part. For those recess that cannot be plated, the application of an auxiliary anode can place the anodic source fractions of an in from the recesses. The determination is at times easy to make and others not so easy. Experience and knowledge of the process is usually enough to make the decision. Other times it is decided to use an auxiliary anode due the part simply not plating correctly. Auxiliary anodes should be made removable to facilitate loading and unloading as well as adjustable. Adjustments are necessary to bring the anode closer or farther from the part in order to get the proper coverage. The auxiliary anodes can be secured to the

rack using insulated material and the plastisol coated so the anode does not cross current path with the rack. Normally the auxiliary anode has an extended tail that is located near the hooks of the rack and a jumper cable can then be attached between it and the tanks anode bar or bussing. The jumper can also be attached to a separate rectifier. For nickel/chrome processes, it is best to use an auxiliary anode made of titanium that has been platinum plated or titanium with a platinum clad niobium mesh attached. The platinum is normally plated at a thickness of 150 micro inches and depletes around 0.5 micro inches per cycle under normal processing.

Robbers are used to prevent burning in high current areas of the part being plated. Robbers also have other names like thieves or burning bars. At times, articles with sharp edges or points need special care. The current flow to these areas is typically excessive and the parts have a tendency to burn. Sometimes the parts can be placed on the rack so that the edges of the parts are close together. In this case the parts act as robbers to each other, minimizing the high current areas. If this cannot be accomplished, then robbers will need to be built into the rack to rob current from the part. Robbers are normally made of stainless steel so they can be stripped as they build up with plating. They are built into the cathodic frame of the rack. Some platers have tabs at each end of the rack and make cathodic contact. The tabs are trimmed free of plastisol in a small area and a wire is connected at each spot. The wire is now a cathode. The wire will be placed so the sharp or pointed end of the part is very near. Once the plating cycle is started, the wire will begin to plate like the part itself. The robber will take away some of the current flow toward the high current area of the part and reduce or eliminate the chance for burning.

One of the simplest means of improving coverage in low current areas and reducing the chances of burning in high current areas is to place a shield, or shader, between the anodes and the piece being plated. Unlike the robber, which will attract the current, a shield will divert the current. A shield can be a piece of nonconductive material that is placed over the high current area forcing the current path around the shield taking a longer path to reach the part surface. By doing so, the current is improved into low current areas possibly reducing the need for auxiliary anodes.

OPTIMIZED DESIGN

We in the rack business would like to sell you as many racks as we can. It is our business and the more we sell, the more we profit. However, customer satisfaction will always assure another purchase order and it's our job to help you save money when we can. You do not need a rack designed for each part. If you have a variety of parts to be plated, tell your supplier that you would like to optimize the racks where possible. Start by gathering all the parts to be plated. Identify how each part will be racked and mark each location. Separate the parts into groups with similar racking points. You should then be able to more easily design tips that will hold different parts on the same rack.

ERGONOMICS

As mentioned earlier, there is a human element in rack design that must be considered. People get tired. People wear out. Along with restraints of lifting, the other ergonomic concerns are injury from repetitive motion. Workers Compensation claims for repetitive motion injuries can be kept to a minimum if the demands of racking and unracking are considered in the design. When a worker has to squeeze tips to load and unload parts all day long, this constant motion may contribute to repetitive injuries. Since the use of gravity tips or simple hooks is risky to use in automotive decorative chrome, the alternative is to use spring tips to secure the part and maintain positive contact.

When designing spring tips, there are some tricks that can be considered to facilitate loading and unloading. Try to minimize the size of the material used for the tips. This will make it easier to squeeze the tips. Smaller material will also carry less current so you must be careful not to jeopardize the finish. The tips could also be designed so the part can be loaded without squeezing by hand. The parts can be located onto one of the tip ends and the part then pulled into alignment with the other tip end allowing the part to be racked without unnecessary hand movements.

There are occasions where you cannot design an ergonomically friendly rack due to a variety of reasons. The best thing that can be done to avoid injury to the worker is to rotate their job assignments so that one person is not always performing the same job.

MAINTENANCE

Lets assume that your supplier has done their job and you have taken possession of your wonderful new racks. It is now up to you to maintain them. Regular stripping of the tips is essential for decorative automotive plating. Some people use acidic strip tanks that work just fine if chemically maintained and racks are not left in the stripper for too long. The acid is highly concentrated. It will aggressively attack the tips and the copper frame if there are any breaks in the plastisol. There are proprietary strippers on the market that are much more forgiving. Regardless of the chemistry, stripping should be done on a regular basis to prevent nodules from building up on the tips. Excessive plating on the tips can cause shading and act as robbers diverting the current from the part. The best thing you can do for your rack supplier is to use a hammer and pliers to clean your tips of excess plating. We really like to walk into a plating shop and see people hammering tips and using pliers to twist and flex tips to release the plating.

The racks that you have purchased were not cheap and they are not made to be indestructible from misuse and abuse. They will probably need rebuilding over time but there are precautions you can use to prevent premature spending. Prior to setting your next rack budget, plan enough funds to have your supplier provide a method of storage. Organized storage will help manage production time by keeping all of your racks in a specific location eliminating unnecessary search and rescue from that huge pile or racks in the corner.

SELECTING A SUPPLIER

When selecting a supplier, the cheapest may not be the most cost effective in the end. In most cases, you get what you pay for. Look for a company that has a history of successful performance. This company and its sales force should know the plating industry in well. You will know this from the company's active involvement in industry related trade organization meetings and their personal knowledge of your plant and your processes. A machine or metal fabrication shop can bend and bolt copper but they do not know metal finishing. They would be of no help in designing or providing input that only an established designer and manufacturer of plating racks can contribute. Just remember, the right rack is, "the right start to a perfect finish"