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Guest Column

Designing products that are paintable

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I have visited many facilities over the years. During these visits, I occasionally see products that are difficult, if not impossible, to coat to the expected visual or performance standards. This situation is most typically caused by designers and engineers who design products that may be both functional and pretty to look at, but are impossible to paint. This situation is created simply because these people have no direct experience in painting systems/techniques, or more importantly, the limitations of these processes. They would never design products that couldn't be stamped, formed, welded, machined, or otherwise fabricated or assembled. However, the same eye towards manufacturability of designs is rarely applied to designing for coat-ability of a product. This article will provide some simple guidelines to designers/engineers to help them overcome this oversight in their education or experience.

Paint system design limitations

Before we can address product design, let's examine the limitations of paint systems. Generally, paint systems (liquid or powder) come in two styles: spray or immersion. Each of these has distinct limitations.

Spray systems. Spray systems are "line-of-sight" designs. If the cleaning and application equipment can "see," or be directed to "see," a part surface, it can clean and paint that surface. There are many ways a system can be designed to ensure that the equipment "sees" a particular surface. For instance, you should hang the part to ensure the intended surface(s) are facing the spray equipment. Complementing this hanging design, the conveyor can employ swivel/indexing hooks used to rotate the part to ensure multiple surfaces are "seen" by the spray equipment. Sophisticated gun movers and robots can position spray guns to paint difficult coating areas that may be somewhat hidden to simply positioned spray guns. Manual sprayers can point their paint guns or cleaning spray wands to do the same thing robots can do.

Some curing ovens can be line-of-sight as well. For instance, infrared (IR) and ultraviolet (UV) cure ovens require a direct line-of-sight to the surface to apply the needed energy for curing the coating. Both of these cure oven designs use light energy (in different spectrums) to provide cure energy to the part. Since light travels in a straight line, the energy can only be absorbed by surfaces seen by the energy source.

However, if there are areas that are hidden from the spray guns or spray cleaning equipment that cannot be overcome by part positioning, it's fairly obvious that these areas won't be cleaned or painted. For instance, such hidden areas may be inside tubing or weldments that don't have line-of-sight access to the spray equipment. If you must have paint in these hidden areas, then your only choice is to use an immersion paint system.

Immersion systems. Immersion paint systems aren't affected by the line-of-sight limitations imposed on spray paint systems. These systems immerse the part into cleaning solutions and paint solutions to fully coat all exposed surfaces without having to actually "see" them. Immersion cleaning and coating systems use tanks full of the product you intend to apply to the part surface, and you dip the part into the tank, therefore cleaning and coating the exposed surfaces. Examples of immersion coating systems are electrocoat (e-coat), fluidized bed, and paint dip processes. For the purposes of this article, convection ovens are considered immersion systems as they immerse the part in hot air to provide cure energy to the part.

Part positioning still can affect the quality of these processes. For instance, you have to position the part to allow the material in the immersion tank to enter the intended areas and position them to drain the material from these areas. In addition, the part hooks must be designed to prevent the part from "floating away" by unhooking them from the means of part conveyance.

Other paint system design limitations that are worth noting are electrostatics, electro-attraction, and aerodynamics. These limitations affect how likely the paint will

"stick" on some surfaces that result in difficulties like Faraday areas, low current density areas, and blow-off areas.

Part design improvements for improved paintability

Knowing the limitations of the paint system you have and designing products that are compatible with this design are the first steps in conceiving products that are considered paintable. If your plant has a line-of-sight spray system and you design a part that needs paint in hidden or internal areas, you will never obtain your finishing objective. Moreover, the designer should choose the appropriate time to paint a part. For instance, it may be better to paint a subassembly to ensure complete paint coverage before it's assembled into the final assembly when access to hidden areas is impossible. These subassemblies will have to be assembled through the use of techniques that are compatible with the paint, so you may have to glue, rivet, crimp, or bolt the final assembly together, as welding painted surfaces is out of the question. In all these cases, nothing else can help the designer more than common sense.

Metal fabrication methods. As a rule, all metal parts must not have sharp edges that won't hold paint. Sharp edges have little surface area to hold the paint and will readily chip. Furthermore, electrostatically applied coatings won't build sufficiently on sharp edges, causing premature corrosion. The typical design notes used to correct this problem are "Break all sharp edges" or "Radius all edges to XXX" or "Chamfer all sharp edges" or "Round all sharp edges," and so forth.

Faraday areas can be minimized with product design. Spot welds can create seams that are impossible to paint. Stitch welds are problematic for the same reasons. Providing generous clearance to apply paint can be the best solution for most of these issues.

Masking issues. Products that have machined surfaces, bearing surfaces, threaded holes, threaded studs, and so on will require masking to keep the paint off these surfaces. The designer should evaluate if these manufacturing processes can be performed post-paint to eliminate difficult masking situations.

Make it clear. The designer needs to take into account the thickness of the paint, or coating, when calculating assembly clearances. If sufficient clearance isn't provided, the paint will be scraped off or prevent proper assembly of the end-product, that is, interference fit problems.

Don't forget the holes. Parts that are painted must have some holes for hanging, drainage, or access for paint to enter. Immersion systems require holes to let the cleaning and paint/coating solutions enter, let the air exit, and allow for draining of excess cleaning and paint material. These holes may be designed for other uses, such as assembly hardware, but if

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your part has nowhere to hang from, you can't paint the part. Obviously, holes aren't required for flat-line coating processes, such as coil or blank coating systems.

Paint performance requirements. The designer must select a paint or coating that will meet or enhance the product's performance. For instance, if your product is used in an area that requires high durability, select a paint that has those mechanical properties inherent in its formula. If the intended product performance isn't suitable for paint (that is, high heat, severe mechanical stress), then look at a different coating, such as plating or anodizing, to finish your part.

Conclusions

Taking some time to understand the capabilities and limitations of your painting/coating process can make a great difference in designing parts that are considered paintable. Using smart mechanical design guidelines that encourage good coat-ability of a part will ensure that you get the coating where you want it. Providing a place to hang the part, reducing masking requirements, and providing for sufficient paint thickness clearance will make you very popular on the paint line. Finally, select a coating that meets the product performance requirements. Who knows, if you do a good job, maybe the paint line personnel will invite you to their next holiday party! PC

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For further reading, see the "Index to Articles and Authors 1990-2009," Reference and Buyer's Resource Issue, *Powder Coating*, vol. 20, no. 9 (December 2009), or click on the Article Index at [www.pcoating.com]. Article can be bought online. Have a question? Click on Problem Solving to submit one.

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