

Successful Operation of Electrophoretic Lacquers

Surindar S Tulsi*

It is almost 20 years when a viable process to deposit cathodically electrophoretic clear lacquer was introduced. This process was epoxy based amine adduct lacquer solubilised with lactic acid¹, and a working solution was made by diluting the concentrate with water to achieve a solid content of 10 to 12 percent.

Within a very short period of time a number of installations were made. However this introductory period was beset with operational problems which could be attributed to the lack of knowledge by the end user who was really new to this technology. This was an interesting period to learn and develop the technology, which resulted into the second generation of acrylic-based processes.

The acrylic based process² proved to be easier to work with, and the lacquer film had superior functional properties including better abrasion, solvent and UV resistance.

Later on what is known as 'polyurethane' based or high build lacquer³ was introduced which apart from other improvements has the ability to deposit film thickness of up to 25 microns.

Another development which has somewhat accelerated in recent years is that of producing coloured lacquer films by incorporating a suitable dye in the working lacquer solution or immersing the component with the deposited clear film in a post dip dye solution, and then curing the coloured film in the normal way.

An attempt is being made in this paper to describe some of the factors, which can make a significant difference to the operational success of the process. Probably this can be more easily illustrated by describing a typical process sequence and its significance.

*PNS Chemicals International Ltd, Guildford, Surrey GU4 7DR, UK

Process Sequence

1 Pre-treatment to ensure a clean surface free from water breaks or articles which have been electroplated, should be from the last cold water rinse.

2 Demineralised water rinse x 2: The purpose of this is to stop ionic contamination of the working solution. The conductivity of the demineralised water used should be 5 micro simonds or less.

3 Pre dip is made by diluting typically 0.5 to 1% of working solution with demineralised water. By dipping the articles in this rinse the previous demineralised water film is replaced by a film, which contains solvents or permeate. Failure to replace the water film with a lacquer film will cause the thin water film to electrolyse first thus producing gases which can easily get entrapped in the subsequent lacquer film thus producing unsightly surface defects.

4 Lacquering process (with a typical solids content of 10% by weight): It is important that the working solution is made according to supplier's make up instructions. However typically it is made by diluting the appropriate quantity of lacquer concentrate with demineralised water to achieve the predetermined solid content. Some solutions are able to start working almost immediately others might require a conditioning period of up to 48 hours, which can be significantly reduced by ultrafiltering it. It is important that no ionic contamination of the solution takes place either through the quality of the demineralised water used or from lack of proper cleaning of the equipment in contact with the solution.

5 Post dip is also made by diluting 1% of working solution with demineralised water. Pure permeate, produced from ultrafiltering of the working solution, can also be used to make it. The purpose of this dip is to rinse off the lacquer solution film from the article, which is quite difficult to remove in demineralised water alone.

6 Demineralised water rinse x 2: These rinses are required to produce the lacquer deposit film free of lacquer solution before drying and curing.

7 Drying: The drying time depends upon the geometry of the component and the amount of the drag out solution it holds. In fact it is better to use sufficient

drain time after each preceding stage to avoid excessive drag out. Hot air say at 60 to 70°C can be used to accelerate the process. However if long conveyer is used to transfer the jigs from the plating plant to the oven then it is sufficient to drip-dry the components.

8 Curing: The partially dried film on heating to a pre determined temperature cross-links the polymer to form a perfect clear and glossy film. Most electrophoretic lacquer films fully cure at metal temperature of 180°C for 20 to 30 minutes. It is important to heat the component at the desired metal surface temperature for the required time. This is because the time to reach a given surface temperature will depend upon the size and weight of the component - heavier the component more time it will require to reach the desired surface temperature.

Maintenance of the working solution

It is important to make sure that no contamination of the solution takes place. If the water quality is not right it will cause ionic contamination of the solution resulting in fine pitting which will increase with accumulation. The ultrafiltration of the solution will remove this condition; however in the mean time the source of the contamination must be eliminated. The permeate of the ultrafiltration will contain all water soluble impurities so if this is to be reused then the impurities must be removed by filtering it through an ion exchange cartridge. Most modern Ultrafiltration equipment have a built in ion exchange cartridge, which must be changed at the end of its useful life indicated by colour change.

The solvent content of the lacquer is maintained by regular additions of the concentrate (to maintain the solids content), however if the solution is occasionally used or it is ultra filtered and the permeate is discarded then extra additions of solvents are required.

It is important that pH is maintained within the narrow operational limits, and is checked regularly. However if the pH fluctuates then it is probably due to the contamination of the solution. Lower pH values can be adjusted albeit very slowly by ultra filtering the solution however it should never be adjusted by adding alkali. Higher pH values can be adjusted on recommendation of the supplier by adding very dilute acid pH adjustment solution, but extreme care should be exercised as any excessive addition will be required to be removed by ultra filtering the solution!

Coloured Finishes

There are two methods to produce a range of coloured lacquer films:

In Tank Method

In this method the dye is incorporated into the working solution. The lacquer film is deposited in a similar way to clear lacquer deposition process. The colour and the luster of the finished film depend upon the underlying substrate or the deposited electroplated finish. The integrity and the intensity of the film depend upon the kind of dye and concentration used.

Post Dip Method

In this method as the name suggests the clear lacquer film is literally dyed by dipping it in a post dip solution which contains the relevant dye.

Pros and cons of the methods

The coloured film produced by the first method has the dye incorporated throughout the depth of the film so the continuity of the colour is maintained to the end of its life. However the colour film produced by second method has the dye adsorbed on the surface and therefore its colour life is not proportional to the thickness of the film.

To produce different colours by the 'In Tank' method separate lacquer solution for each colour is required whereas for the 'Post Dip' method only one lacquer solution is used to produce clear lacquer film, which is subsequently dipped in different post dips for different colours.

Summary

The electrophoretic lacquer technology has come off age, and is now widely accepted throughout the metal finishing industry right across the world. The range of available products with improved functional properties and colour finishes have made it possible to accelerate its use for a wide range of applications. The future for electrophoretic lacquers is bright and assured, and products with further improvements in functional properties are under development. It is only a matter of time when the global metal finishing industry will be widely using this technology.

References:

- 1 S S Tulsi, Transactions of the Institute of Metal Finishing, 1983, Vol. 61.
- 2 Clearlac EP4000 from PNS Chemicals International Ltd, UK.
- 3 Clearlac EP5000 from PNS Chemicals International Ltd, UK.