

Vacuum Application of UV-Curable Coatings

By Kevin Whittle

The vacuum application of UV-curable coatings was introduced in Europe in the early 1980s.

UV-curable coatings were at this time already in general use in the furniture industry. Typical applications included the application of UV-curable lacquer by roller coating machines to flat panels.

Vacuum coating had been introduced initially in the late 1970s for the application of water-based coatings to moldings (for example, picture frame moldings). Prior to the introduction of vacuum coating, moldings were generally finished with solvent-based coatings, either by manual or automatic spraying.

Vacuum coating is not suitable for use with solvent-based coatings. The

vacuum air stream causes the solvent to be pulled out of the coating, resulting in the viscosity rapidly increasing.

However, it was envisioned that molding manufacturers would be forced to switch to water-based coatings due to the introduction of ever toughening environmental regulations. This would enable them to consider vacuum coating as an alternative to spraying equipment.

During this period, coating manufacturers were spending thousands of dollars into the development of environmentally friendly coatings, such as water-based and 100% solid UV-curable coatings. Naturally, they were keen to promote these coatings and find customers for them.

Vacuum coating was attractive to coating suppliers, since they recognized that it was easier to “get a foot in the door” with end-users if they could introduce a new, highly efficient means of applying coatings. Therefore, they formulated a lot of new coatings specifically for vacuum application.

This cooperation between equipment and coating manufacturers led to the successful introduction of vacuum coating into the market place.

How Vacuum Coating Works

The coating is pumped from the coating reservoir through a fluid strainer into the application chamber (see Figure 1).

The substrate is fed through an entry template into the application chamber and leaves through an exit template.

A vacuum pump or pumps pressurize the system. This negative pressure

FIGURE 1

Diagram of vacuum coating system

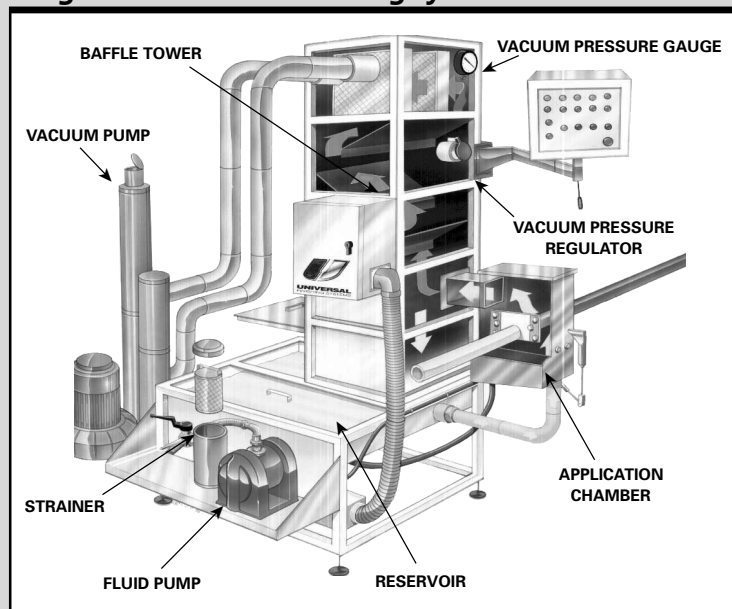


TABLE 1

Vacuum coating vs. automatic spraying

| Machine/Characteristics | Spray Machine | Vacuum Coater |
|------------------------------------|--|----------------------------|
| Max. No. of Sides in 1 Pass | 3 | 4 |
| Paint Usage | 50% transfer efficiency | 100% transfer efficiency |
| Stains | Yes | Yes |
| Lacquers | Yes | Yes |
| Solvent-Borne | Yes—additional cost | No |
| Waterborne | Yes | Yes |
| Set-Up Times | Average | Good |
| Clean Out Times | Good | Average |
| Skill Level | Knowledge of spraying and spray guns setting | No special skills required |

causes air to be pulled into the application chamber through the entry and exit templates. This air causes the coating material to be brought into contact with the substrate.

The excess coating is removed and is pulled back into the baffle tower. In the baffle tower, air and coating is separated. Air is pulled through the system toward the vacuum pump. The coating returns to the reservoir for recycling.

Regulating the vacuum pressure can alter the coating weight. The greater the negative pressure inside the system, the less coating is applied.

Vacuum Coating vs. Other Types of Application

Table 1 shows the key characteristics of vacuum coating and an automatic spraying system, which is the other generally accepted way of applying surface coatings to moldings.

Vacuum coating has two significant advantages—it can apply coatings on all four sides in one pass and there is no coating lost in the process.

Suitability for Application of UV-Curable Coatings

Many molding manufacturers were drawn by the ability of the vacuum coater to apply coatings to all four sides of moldings in one pass. However, the drawback with water-based coatings was that the coatings could not be dried as quickly as they could be applied.

This led to coatings easily scraping off on any downstream conveying equipment and contaminating the conveyors, leading to downtime for cleaning.

Furthermore, moldings could not be stacked together coming off the line and were often placed on drying trolleys, which take up a lot of factory floor space.

Alternatively, moldings could be fed into hot air or infrared ovens to further speed up the drying of the coatings, but these generally take up a lot more space than a UV-curing system.

It was against this background that the first trials were made with UV application by vacuum. It was believed that the vacuum system should be

capable of applying the coating, since there were no solvents present. It was further believed that by placing lamps in the bottom of the first section of the UV-curing oven underneath the molding that the coating could be applied and cured perfectly underneath, prior to contact with a support roller or belt.

The early tests proved to be very encouraging and that is how UV-curing ovens for use in line with vacuum coaters are still designed today. Not only is it possible to achieve curing very quickly in a compact oven, but it is also possible to guarantee a perfectly coated product all around.

The process is attractive in terms of the quality that can be attained and is also appealing on the grounds of health, safety and the environment. Unlike automated spraying, vacuum coating is a completely enclosed

process, which reduces the operator's exposure to the coating. Furthermore, the coatings are solvent-free, which improves the working environment as well as avoiding the emission of VOCs.

In general, UV lacquers cost more on a per gallon basis than water-based or solvent-based equivalents. This is due to the fact that they are 100% solid and there is no evaporation of any solvent or water diluter during the curing process. A smaller volume of coating is therefore required to coat the same surface area. The overall costs on a per-square-foot basis are similar.

Due to the relatively high costs per liter, it is important to efficiently apply the coatings. This is expressed in terms of transfer efficiency. The higher the percentage of transfer efficiency, the lower the losses. Since the coating is recycled, a high rate of efficiency is seen with a vacuum coating system, which is due to a small percentage lost during cleaning or very small ozone emissions. This makes the system ideal for applying UV-curable coatings.

A final advantage of using UV-curable coatings is that of reduced downtime for cleaning. Since 100% solid UV coatings will not cure until exposed to UV radiation, they will never cure or solidify while in the enclosed vacuum coating system. Unlike water-based coatings, which can dry out in a vacuum system if left standing without running, UV coatings can be left standing in a machine with no risk of drying out. Therefore, the system does not have to be emptied out or thoroughly cleaned at the end of shifts.

Typical Applications

The first industry to invest in vacuum coating and UV-curing equipment was the picture molding industry. Other industries, where there was a requirement for coating moldings in volume, soon followed suit (for example, furniture manufacturers and architectural joinery manufacturers.)

Other products include round products such as curtain poles, tool handles and pool cues.

Further examples of products that can be vacuum coated and UV cured are:

- Flooring Trims
- Tongue and Groove Cladding
- Venetian Blinds
- Wood Strip Flooring
- Table and Chair Legs

Vacuum application can also be used for coating or sealing the edges of panels such as doors or tables. These systems are described as edge coating systems and are often integrated with flat panel finishing lines to accurately coat the edge of a panel.

Case Study

Armstrong and Kirby Limited are a specialized and highly skilled company who have been manufacturing pool cues, tips and accessories since 1885. To satisfy a home market of over 14-million pool players, they can produce over 3,000 cues a week.

To provide a deep protective sheen on the wood, the cue was originally given between 3-5 coats of acid-catalyzed lacquer, needing 3-4 days to harden before final finishing.

The process also generated VOCs, which needed a £30,000 afterburner to comply with the Environmental Protection Act. Maintenance and wash down was taking one and a half hours a day.

Replaced by a vacuum coater and a compact UV-curing system, the cues are now coated and cured at line speeds up to 50 m/min.

The payback period on the equipment was only six months, due to the massive savings in material coating costs, labor and energy. In addition, a significant amount of floor space, previously used for drying racks, was freed up for other activities.

“The installation of the new UV-coating line has enabled us to reduce

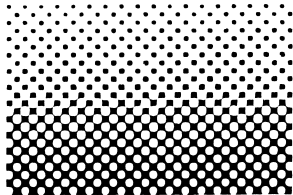
our cycle time from four days to one day, which means that we can now respond faster to customer demand. At the same time, the elimination of solvent use has made the factory a safer and more pleasant working environment, as well as giving us and our customers the feel good factor that comes from knowing our cues are finished with environmentally friendly coatings,” commented David Arnett, general manager of Armstrong and Kirby Limited.

Summary

Vacuum application and UV curing have proven to be a highly effective means of applying lacquers to moldings and round pole-type products. New developments such as inverter controlled vacuum pumps and UV lamps will make the equipment even more efficient.

In a world in which established manufacturers face tough competition from developing markets, it is more important than ever to utilize the latest technology to maximize efficiency. ▀

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