A Comparison of Application Methods for the Wood Coatings Market

By Kyle Sass

The last ten years have been exciting times in UV&EB-curable coatings because of the 7-9% average growth rate. The wood coatings market segment has been one of the areas involved with this growth. During this time frame, there have been many changes that have impacted UV&EB-curable coatings in a positive manner. These changes can be attributed to the supply of "off-shore" materials, the major impact of new home construction and the transfer of furniture coatings to Asia.

With the transfer of many furniture companies and manufacture of furniture coatings (i.e., nitrocellulose lacquers) to Asia, there has been a resolve not to lose more wood coatings market share to suppliers/producers outside of NAFTA. It has helped drive the conversion of solvent-based technology to UV-curable coatings.

Growth and Application of UV&EB-Curable Coatings

Raw material costs have dropped to new low levels due to the supply of imported raw materials. This was positive for formulators as it made formulations more cost effective for new and existing applications. With the transfer of many furniture companies and manufacture of furniture coatings (i.e., nitrocellulose lacquers) to Asia, there has been a resolve not to lose more wood coatings market share to suppliers/producers outside of NAFTA. It has helped drive the conversion of solvent-based technology to UV-curable coatings. At the same time, new home construction was booming. New home construction/remodeling supported the popularity and growth of pre-finished hardwood flooring, moulding and kitchen cabinetry. Pre-finished flooring is a perfect fit for automated equipment used to cure UV coatings. Kitchen cabinetry is another area to capture growth for UV&EB-curable coatings. With many big box type stores available, consumers can choose a new kitchen or remodel an existing kitchen with new cabinets. Cabinet manufacturers are able to deliver their goods to consumers in about six weeks. This timing makes it difficult to import from "off-shore" suppliers. Wood cabinetry offers another reason for the growth of UV-curable coatings.

Three Application Methods

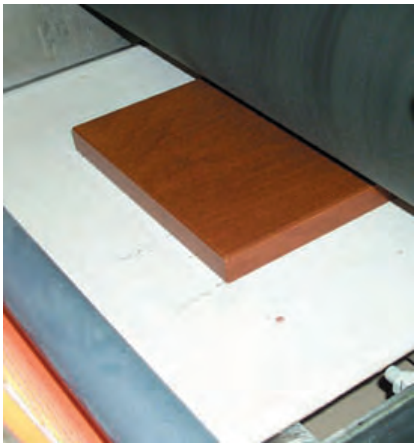
Roll coating is the most common application method. This application has had the longest history with UV coatings—more than 35 years of use. Vacuum coating has been around for about 10 years. The newest application for UV-curable coatings is spray—namely, 100% solid UV and water-based UV-spray applications. Spraying has been around for many years in many different industries including solvent-based UV-curable coatings. The use of solvent in UV-curable coatings was used

for many different reasons such as limited raw materials, education and understanding of the applicator with respect to 100% UV, type of equipment that the end user had available, and control of gloss and film build of the coating. However, as newer raw materials and equipment have been developed for this application, the ability to spray 100% solids UV and water-based UV have increased. Spray application should be a strong growth area for UV&EB-curable wood coatings because it can be used to coat 3-D substrates. Examples of this are kitchen cabinet doors, large office tables and decorative trim pieces. 3-D substrates cannot be roll coated.

Comparison of Application Methods

Roll Coating

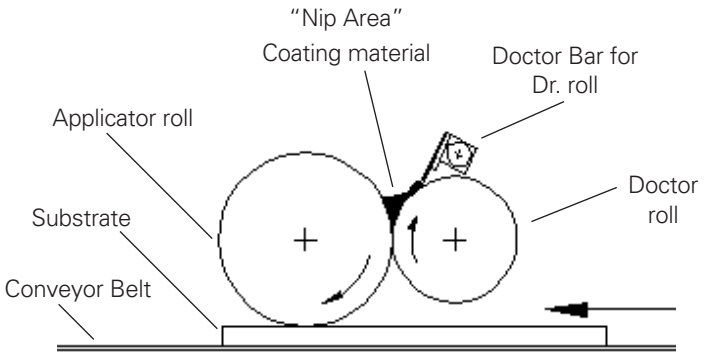
Roll coaters are very basic in design; however, there are many variations of this application method. Roll coating incorporates an applicator roller and a doctor roller or metering roller (Figure 1). The application roller is covered in rubber—soft to hard in Durometer, depending on the type of application. The applicator roller applies the material to the substrate. The doctor roll is used to help meter the amount of material that is applied to the applicator roller. Roll coating is used on flat surface substrates such as hardwood flooring.



Roll coating is for flat substrates.

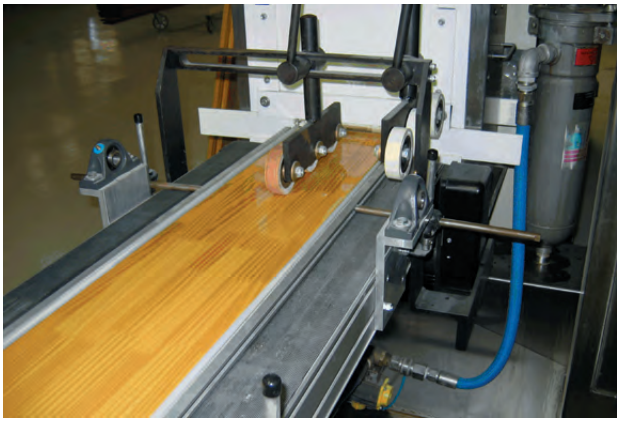
FIGURE 1

Roll coating incorporates an applicator roller and a doctor roller



Standard application rollers can apply about 1 mil of film thickness without having a streaked appearance. Increased film thicknesses are achieved by using application rollers with grooves cut into them. The coating viscosities vary greatly. The coatings can have a paste-like viscosity for applications where the pores of open wood are being filled to a low viscosity (~400 cps) in a topcoat application where appearance is very important. Roll coating applications are typically run at line speeds of 30-100 feet per minute. The line speed is dictated by other pieces of equipment in the line (e.g., sanders).

For pre-finished floor coating applications, an applicator would need multiple roller coaters to apply the necessary amount of coatings. The cleaning of roll coat application equipment is straightforward. The coating has to be removed from the equipment and cleaned with the appropriate solvent. This can be time consuming. It is not always necessary to clean at the end of each shift with UV-curable coatings. Coatings can be shielded from UV energy. Maintenance for roll coaters is routine. Energy costs to operate are nominal.



Vacuum coating is used for flat or 3-D substrates.

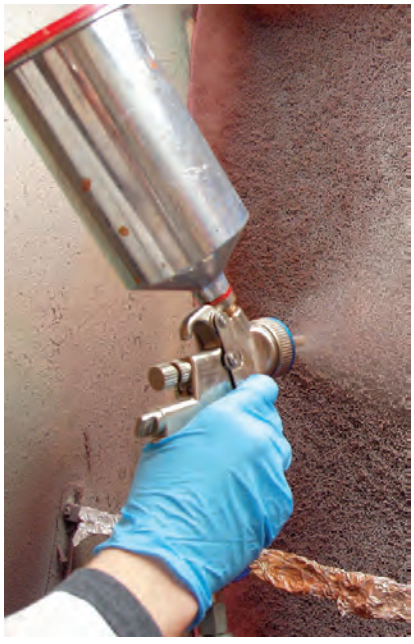
Vacuum Coating

For a vacuum coat application, the substrate can be a flat surface, but it can also be a 3-D shape (e.g., moulding or trim pieces). It is important that the substrate not have any non-linearity to it. If this is the case, the end of the substrate could break through the inlet/outlet templates.

Vacuum coaters are a lot like a black box. A part comes in one side and comes out coated on the other side. What happens in between is not seen; it is what the vacuum coater can do that is

important. It can coat all sides of a substrate at a uniform film thickness (~0.8-4 mils) at speeds up to 600 feet per minute. To achieve this, the viscosity of the coating has to be fairly low, typically less than 200 cps and even as low as 50 cps. The uniform film thickness is achieved by using a template/profile of the substrate on the inlet and outlet side of the vacuum coater. The template is designed so that the tolerance between the substrate and the template is less than 0.125 inches. This gap is used to control the film thickness. The role vacuum plays in this application would be to remove the excess uncured material prior to exposure to UV.

Because the coating is contained in the vacuum coater, the transfer efficiency is approximately 100%. Vacuum coaters can be run in series like roll coaters. Clean up is easy as the coating is contained in the vacuum coater. Maintenance of vacuum coaters is important especially the vacuum pumps, which should be maintained to ensure efficiency. Vacuum pumps tend to have larger energy requirements than roll coaters.



Spray coating can be manual or automated.

TABLE 1

Application comparison

Attributes	Roll Coating	Vacuum Coating	Spray Coating
Coating composition	Typically 100% UV Solvent typically less than 5 wt.% Water-based UV—both physical and non-physical drying	Typically 100% UV Solvent typically less than 2 wt.% Water-based UV possible	Variable—Can range from 100% UV to 50 wt.% solvent UV to water-based UV—solvent being water and/or organic
Substrate	Flat surface	Flat surface or 3-D	Any geometry
Number of surfaces coated at one time	One	Entire perimeter	Entire Surface
Application Viscosity	400 cps to paste consistency	50 to 200 cps	16 to 60" #4 Ford Cup
Film Build	Typically <1 mil	0.8 to 4 mils	<0.5 to 10 mils
Recycling of coating	Yes	Yes	Possible
Line speed	30 to 100 FPM	Up to 600 FPM	Up to 50 FPM
Transfer efficiency	~ 100%	~100%	Up to ~85%
Mattability of coating	Consistent	Consistent	Variable appearance
Energy Requirement	Medium	High	Low
Maintenance	Medium	High	Low
Cleanup	Medium	Medium	Low
Cost of Equipment	Medium	High	Low
Chemistry limitation for normal operations	Cannot premix reactive chemistry	Cannot premix reactive chemistry	100% UV with piston/gear type pumps

Spray Coating

The substrate for a spray coating application can be 3-D and any shape or surface. For example, decorative parts on furniture are best coated via spray application. Kitchen cabinet doors are predominately flat surfaces, with 3-D moulded surfaces. However, the profile is not continuous. Neither roll coating nor vacuum coating would work. If different profiles need to be coated and they require coating on three sides, spray application allows continuous production while vacuum coating requires that the inlet/outlet templates be changed out for a new profile.

There are many different types of spray equipment available for the applicator to choose. For example, airless, air-assisted airless, HPLV, and conventional are some of the more familiar types. These different types can apply anywhere from less than 0.5 mils to more than 10 mils of coating. Spray coating viscosities can vary from 16-60

seconds on a #4 Ford cup-depending on the application equipment. Even though there is a wide range of coating thickness that can be applied, controlling that thickness over the entire area of the substrate can be difficult. This is where automated spray plays an important role.

Film thickness consistency plays an important role in the visual appearance of a coated piece. For 100% spray UV, this is critical. If there is not an appropriate amount of coating atomization, there will not be consistency in film build. The speed of the spray line is dictated by how quickly the substrate can be coated. If done manually, this means how many pieces per hour the applicator can produce. The equipment available today is more than capable of keeping up. If the line is automated, it depends on how many pieces can be sprayed at one time.

Automation allows for controlled coating application and the recovery of the coating. Spraying does not have the high transfer efficiencies of roll and vacuum coating does. Depending on the type of equipment used and if the coating is recovered, the transfer efficiency could approach 95%. Maintenance and clean-up are simple compared to the other two application methods. The cost to operate is minimal as most manufacturing locations have compressed air that is needed for other operations. Maintenance and operation costs are higher if the line is automated.

Conclusion

Each application method has its strong points and are well established in the marketplace. Choosing the right application method depends on the manufacturing needs and the substrate to be coated as well as required line speeds.

Table 1 summarizes the similarities and differences between the application methods. The use of low, medium and high is a ranking between these application methods only. For spray coatings, the assumption is made that it is not an automated system. In this case, the energy and maintenance requirements would be higher.

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