Maximizing Your UV Coating Quality With Roller Coaters

The best high gloss coating can be achieved using good quality UV curable coatings by a knowledgeable roller coater operator. The intent of this paper is to assist operators in becoming knowledgeable by providing a basic understanding of the components of roller coater systems and how they function. After this background is given, several problems that may be encountered in applying UV coatings will be described with explanations of what causes them and corrective actions that have been successfully used to improve results.

Roller Coating Basics

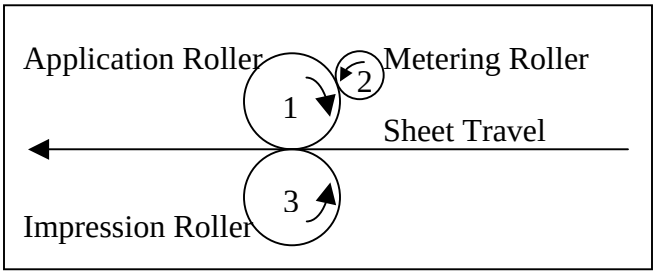

Diagram 1. 3-Roll Forward Roller Coater

The 3-roll forward roller coater (Diagram 1) is the simplest of all roller coater systems, and, indeed, perhaps the simplest of all coating systems available. It consists of three rolls: 1) The Application Roller, likely the most important component- usually made of a UV-resistant rubber compound (such as EPDM), picks up a layer of coating material that is laid down by the constant rotation of the roller against the 2) Metering Roller. A quantity of coating is held between the Application Roller and the Metering Roller via a gravity drip process or a recirculating pump. The viscosity of the coating and the pressure between these two rolls determines the thickness of the coating layer that is applied to the surface of the Application Roller. Sheets of paper (or continuous rolls on some systems) run between the Application Roller and the 3) Impression Roller. This action lays down a large portion of the coating layer from the Application Roller onto the sheet. The quantity and quality of this coating layer is related to the sheet characteristics, coating characteristics, Application Roller pressure, coating thickness, and many other factors that will be discussed in detail below. Finally, the Impression Roller acts as a back in order to grab the sheet and provide continuous forward motion to it. After a sheet exits the rollers, the coated surface is cured (with a high intensity UV lamp in the case of UV coatings).

There is a variation on the basic forward roller coater with a Metering Roller turning in the reverse direction (Diagram 2).

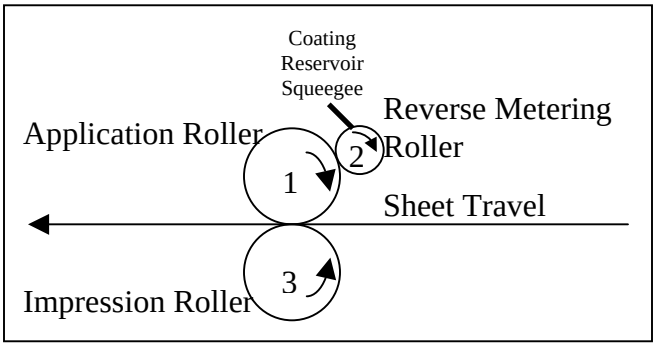

Diagram 2. Forward Roller Coater with Reverse Metering

Finally, there is a variation called the reverse roller coater with the Application Roller turning in the reverse direction of the substrate (Diagram 3). This approach allows for a slightly improved coating quality because the application roller "cuts" the surface of the coating as it is applied to the sheet for a cleaner shear effect.

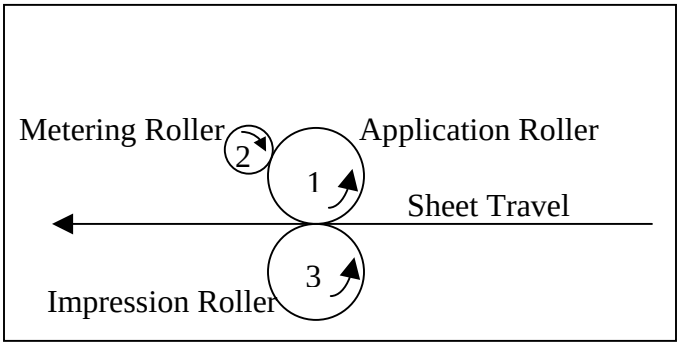

Diagram 3. Reverse Roller Coater

Coating Quality Factors

Coating Quality - The first and most important factor in results of a roller coating system is the quality, viscosity, and composition of the coating. In the end, the coating is the single most important factor in any coating system. Roller coater systems generally use coating of relatively low viscosity (thinner and runnier) than other coating systems. The low viscosity helps the coating "lay down" better on the sheet, thereby increasing flatness, and increasing gloss levels for high gloss coating. Most roller coater high gloss coatings have a viscosity in the range of 70 to 150 Centipoise. Generally, satin and matte coatings have higher viscosities. Some coating suppliers provide additives to help with the lay-down and gloss levels by reducing the coating surface tension.

Coating Bucket Temperature - The coating is purchased with a standard viscosity as measured at room temperature. In the real world, however, the coating is applied at a wide range of temperatures based on the manufacturing floor or the shipping dock where the coating sat before being brought in and opened. Ideally, the coating temperature should be regulated by the roller coater operator to be precise and consistent from job to job. Fergesen Systems LLC has found that a consistent coating temperature of 85 degrees F seems to provide consistent results, however, you should always check with your coatings supplier to be sure that your selected temperature would be acceptable to coating stability.

"Skunking" A Bucket – Coating that has been badly handled and exposed to temperatures higher than the recommended limits documented by the manufacturer can exhibit strange characteristics, such as visible cloudiness in a clear high gloss, "floaters" of gelled coating, or unusually high viscosity. This problem can occur in either a 5-gallon bucket or a 55-gallon drum. Coating treated badly may have trouble curing properly, and should not be used. Call your supplier and have the container returned. Some manufacturers' coatings are especially sensitive, and begin to exhibit poor characteristics from overheating at temperatures as low as 110 degrees F. Generally, you should purchase coating from a supplier who manufactures the coating as close as possible to your facility and uses a carrier that will ensure proper treatment.

Dwell Time – UV coating can be given time to spread out on the sheet after it is applied with a roller coater. This time is called "Dwell Time" and, in a continuous operation, this time is determined by the speed and length of the conveyor between the coater and the curing lamp. Give a sheet more dwell time, and generally you will get a flatter coating (better high gloss) and less "orange peel". This is why the larger units have long conveyors such as 11' or 14'. A 14' conveyor allows an operator to run the unit at a higher rate of speed while still retaining the same dwell time as an 11' unit. There are limits, however, based on the required curing time. There must be sufficient time beneath the UV bulb to achieve a complete cure.

Stock Quality, Coating Absorption & Dwell Time – UV coating must be applied to a stock with very low absorption characteristics. This means that the stock should be a good quality coated stock. If the UV coating is absorbed by the stock, the results will be poor: the gloss level will suffer, and the coating trapped within the paper may not be fully cured, which could generate problems for the cutting room, or even with the end users. It is vital that no uncured coating be left in the paper. Often stock problems will be exhibited as areas of high gloss on the printed or heavily inked areas of the sheet while the white (unprinted) areas appear flat or blotchy. There are two possible approaches to improve the performance of poor stock: decrease dwell time by speeding up the conveyor (and reduce coating absorption time) or increase coating viscosity. Both of these solutions have the effect of decreasing gloss levels, however, so therefore are not as effective as changing to a better quality stock.

Cure Time – Basic cure is achieved by most roller coater systems using a high gloss coating across a range of speeds. For instance, if you are using the Tec Lighting TC15/15 system, cure can be achieved at low power and relatively high conveyor speed (up to 150FPM), or with high power, cure can be achieved with conveyor speeds up to 200FPM. Folding the stock and rubbing the coated surface against itself can be done to check the cure. If the surface is sticky or is "greasy" to the touch, then the coating has likely not cured. In addition, uncured coating tends to have a stronger odor.

Overheating – An occasional problem with high gloss levels, especially with higher-powered units or very low speeds, is overheating. This condition is indicated by a decrease in gloss levels and sometimes includes a clouding or glazing of the coating or loss of adhesion. The simple solution is to increase the conveyor speed or decrease the lamp power. Sometimes over-curing the coating can cause it to become brittle enough to flake easily off of the substrate.

Coating Adhesion & Ink Composition – The single largest problem with UV coating (and, indeed, many different forms of coating and lamination) is coating adhesion. Coating some sample stock and using a fingernail to rub off the coating layer can test adhesion. The best test point on any sample is a location with high ink density. If the coating can be easily separated from the ink layer beneath, an adhesion problem is evident. There are two general reasons for adhesion problems with offset inks: silicone and wax. Offset inks without wax or silicone must be used to achieve good UV coating adhesion.

With digital printing, adhesion problems are generated from more complex issues often associated with the oils in the toner. In some cases, digital printing coating adhesion problems can be resolved by changing settings in the printer to provide a more stable ink layer. In other cases, a specialized coating must be selected to deal with the problem. Occasionally, pre-heating the sheet prior to coating or aging the printed sheets 24 hours before coating has reduced this problem. Please contact your coatings supplier to help with these issues and to select an appropriate coating.

Adjusting Pressures – Roller pressure is very important in determining coating gloss and coating quality. The following procedure is suggested to set roller pressures:

1. First adjust all rollers until they are barely touching, apply coating, and run the roller coater at a moderate speed. Be sure to apply the squeegee to the impression roller at this time.
2. To achieve the optimal gloss level, the metering roller must be adjusted to apply a moderate to small amount of coating evenly across the roller surface. Slightly increase pressure until the coating on the upper surface of the application roller thins slightly, and be sure the pressure is even across the roller. A thicker coating can be achieved to get better protection for postcards and similar applications; however, these thicker surfaces generally do not have the best gloss levels.

3. Next increase the application roller pressure slightly (and evenly across the roller surface) while watching the upper surface of the application roller carefully. By sighting down across the top of the roller, using the light reflected from the curing unit, a keen-eyed operator can judge the quality of the application roller surface. If tiny ripples appear on the surface of this roller, they will be evident on the finished surface of the coated stock (commonly know as "orange peel"). The objective is to minimize these ripples.

Warning – Excessive pressure on the rollers, especially with matte or satin coatings, is a common way for rollers to be ruined. The objective is to use as little roller pressure as possible. Heavy stock, such as 12 point, can often be coated satisfactorily by leaving a tiny gap between the application roller and the impression roller.

Squeegee Performance – The squeegee that is applied to the impression roller has a direct effect only on the back of the sheet. Poor squeegee pressures, or squeegee edges which have been compromised by over-wear or abuse, will allow for a thin film or streaks of uncured coating to remain on the back of the sheet. This coating will NOT cure, and at the least will spread uncured coating throughout the stack. This problem becomes most evident while doing two-sided coating jobs. Even a tiny amount of coating on the impression roller will leave clear streaks on the front of sheets after you have finished putting the coating on the back side of the sheet. The solution is simple: Never run your squeegee dry; and replace it often. Most roller coaters allow for the use of multiple edges on the squeegee blade, so that you can turn it at least three times before it needs to be discarded. Also, in a pinch, if you have a precise way to cut a new edge on the squeegee, you can get away by running it that way until a replacement arrives.

Post-Roller Heating – A common way to increase coating lay-down and therefore decrease "orange peel" is to heat the coated surface after it has been applied. There are many methods to perform this heating, however, the most common method is to use IR (Infrared) heating prior to the curing. An IR system with around 300 watts per inch is usually considered sufficient for this application. Fergesen Systems LLC has developed an alternate method for heat application using a blower, called our "Heat Smoother" system (Patent Pending). After all has been done for a given UV coating system, the post-roller heating option provides tried-and-true improvements in UV coating quality.

Customers & "Orange Peel" – As experts in the coating industry, or as pressmen evaluating the quality of the product in this industry, we often become highly sensitive to "orange peel" or a slightly textured coated surface. Some operators could even be called fanatical about the surface texture, and have gone to great lengths to improve it, even to the point of using over-pressure on the rollers that reduces the roller life. In the experience of this author, however, a slight texture of the coated surface almost never generates a complaint from customers. Sometimes a pronounced texture in the surface of high gloss coating has beneficial effects: it reduces fingerprinting, slightly increases the protection of the printed sheet (such as in the case of post cards), and can even be touted as an "enhancement" over a simple flat surface.

Digital Printing & Coating

Some roller coater manufacturers promote themselves as providing "Digital Coating" capabilities. There is no real merit to this claim, except in the sense that the roller coater manufacturer has selected a coating that applies well to various digital printer outputs. There are, however, differences in coating digital images:

- Unlike offset, digital images often have a slight layer of what has been called "diffuser oil" residual on the surface of the ink. This oil usually dissipates after a short time, but attempting to coat immediately after the image is printed occasionally may generate problems with adhesion (see coating adhesion section above). In the case of a small percentage of digital printers, this surface oil seems to linger much longer than others and is very difficult to coat properly. If you are considering buying a digital printer that you plan to use with a UV coater, you should also consult with a UV coating supplier to verify that the printer is not one of the small percentage of printers that generate these problems. Usually these problems can be overcome by upgrading the coating (this can be an expensive proposition), however, a small fraction of printers have no good coating solution.
- Digital "toner-based" print material often has a surface that is less smooth than offset printing. This slightly "pebbly" or raised surface is often not evident in the inspection of the printed sheet, but becomes obvious when the sheet is coated. In these cases, the "orange peel" effect is not created by the coater, and cannot be solved by the coating application process.
- Coating (whether gloss or matte) has the effect of enhancing the image and color of digital output. While this is generally a very desirable effect, it also has the effect of highlighting flaws in the digital image or the stock that may not be evident immediately to the pressman.

In Conclusion

New versions of stocks, inks, and coatings, and different combinations of them will always introduce variability to the coating operation. A fraction of these will require troubleshooting—Fergesen Systems LLC is always willing to assist with this process and suggest techniques, alternative products, or even custom formulation to help achieve your desired results.

About Fergesen Systems LLC

Fergesen Systems LLC was created by Robert Fergesen to meet the needs of the printing industry for reliable and innovative coating and curing equipment. Fergesen Systems LLC grew out of Fergesen Design Company, Inc. (founded in 1981) a business that supports applications for solvent free, environmentally safe, worker friendly coatings, inks, and adhesives. The Fergesen companies together deliver powerful solutions for the printing and manufacturing industries, specializing in water based, hot melt, and ultraviolet (UV) and other radiation (IR, EB) curing technologies.