AIMCAL FALL TECHNICAL CONFERENCE
2005

VARIOUS COATING TECHNIQUES - AN OVERVIEW

EXTENDED ABSTRACT

This paper will present an overview of the general features and characteristics of different coating techniques and methods. In doing so, the similarities and differences among the coaters will be presented, along with the applications in which they are best used. The coating methods will include direct, reverse and offset (including differential speed) gravure, kiss, direct and reverse roll, slot die, curtain, knife over roll, air knife, and saturation/dip and squeeze. Special thanks are extended to Dr. Edward D. Cohen, who generously provided some of the data and visual materials he has compiled over many years, so that a fairly comprehensive presentation could be made for all these methods.

Gravure roll coaters have long been the work horse of the coating industry. They are especially useful when applying low to medium solids coatings at low coat weights and moderate to high speed. They are very operator friendly due to the minimal number of controls required for their operation and give coating uniformity of approximately 2% across and along the web. Beginning with the two-roll direct gravure unit, where an engraved anilox roll whose pattern is mainly responsible for the amount of coating applied to the web, to the three-roll offset (differential speed) gravure unit, where the relative speed of the anilox roll to the offset roll affects the amount of coating applied, these coaters still remain in demand. However, for higher solids coatings developed to help reduce the amount of emissions and energy required to dry the coatings, other methods, such as reverse roll and slot die, are more useful.

Kiss coaters feature a single applicator roll to apply the coating. The roll can be smooth or lightly engraved, similar to an anilox roll, which aids in the pick up of the coating. If the engraved roll is used, coating can be supplied from either a pan or an enclosed feed applicator. While simple in design, the coat weight it applies is a function of a number of factors, including web tension, the wrap angle of the web on the roll, relative speed of the web to the coating roll and the rheology of the coating itself. This method is predominately used for low solids, low coat weight applications at speeds less than gravure coaters. Coating uniformity may vary up to 10% across and along the web.

Reverse roll coaters can provide high quality general and precision coatings, free of defects usually caused by ribbing, over a wide range of coating viscosities and speeds. With the ability to control both the gap between the metering and applicator rolls, as well as their speed relationship, this coater is perhaps the most versatile. Precision reverse roll coaters can provide coating uniformity within 1% across and along the web, using chilled iron rolls in precision bearings. Direct roll coaters are much more limited in their use. They normally operate over a narrow, low viscosity range at thicknesses less than half that of a reverse roll coater. The major factor that limits the speed and coating thickness

in a direct roll coater is the forward direction of the coating roll and the tendency to develop defects in the final product due to the coating's rheology.

Slot die and curtain coaters deliver a pre-metered amount of coating to the web through a precision orifice. The slot die coater normally includes a precision backing roll, adjustable die positioning system that affects the manner in which the coating is applied, gear-type delivery pump and a control system. For low viscosity coatings, a vacuum box assembly is used to maintain the coating in the gap between the die and the backing roll during the coating operation. One of the main advantages of slot die coating is the ability to pre-meter the amount of coating being applied to the web. In addition, there is no recirculation of the coating, thereby maintaining its composition and cleanliness. Accuracies of about 2% across and along the web can be expected in this process. The use of slot die coaters has been increasing in recent years as the technology continues to improve. It is also an excellent method by which to apply hot melt coatings, since the dies and the solution can be heated.

Curtain coaters are very useful, especially when used for low viscosity, thin coatings. Pre-metered coating material impinges on the web from a specific height, delivering a uniform coating even on an uneven surface. It is an excellent method for applying the coating to a low tensile strength product and will coat over most splices. Edge guides are required to prevent the curtain from contracting during the process. Coating accuracies vary from 2% to 5% across and along the web.

Knife over roll coaters operate over the widest viscosity range and can apply the heaviest coatings. Coating speed is limited and governed by the viscosity of the coating and the shear forces required to apply it. It is a " total gap" coater, so if a non-uniform web passes beneath the knife, the coating thickness will reflect that profile. Besides the gap, the entry contour and angle of the knife determines whether the coating is driven into the web or sheared clean, making it particularly useful for coating open or porous materials. Depending upon the accuracy of the anvil roll and knife contour, coating uniformity may vary between 3% and 7% across and along the web.

Air knife coaters are used primarily for low viscosity water-based coatings. For a given coating and line speed, the amount of air impinging on the web will control the coverage. Increased viscosity and line speed will result in a heavier coating application. Air knife coating can cause streaks or chatter due to the air supply system. Coating uniformity is approximately 5% across and along the web.

Saturation/dip and squeeze coaters rely on several factors, most importantly, the rheology and viscosity of the coating. It is a self-metering technique that uses the free meniscus to apply the coating. One can add nip pressure to saturate or impregnate a porous web. The length of time the web is exposed to the coating material and the surface tension of the web and coating will affect the amount applied. Saturation/dip and squeeze coaters work best to apply thin coatings at low to moderate speeds, in a narrow, low viscosity range. Coating uniformity is approximately 7% to 10% across and along the web.

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