Slot die coating provides a more efficient and controllable alternative to roll coating and other standard methods of applying fluids to web substrates. When used with hot melts, pressuresensitive adhesives, photoinitiators, magnetic media, inks, waxes, and many other fluids, slot die coating enables converters to maximize economy and productivity. In many instances, the process is consistently precise, and print quality makes it especially suitable for critical markets such as medical products, tapes and labels, optical displays, window films, barcodes, and photography.

In addition, slot die coating eliminates emissions of volatile organic compounds (VOCs) from solvent-based materials. The tighter tolerances achievable with the slot die system contribute to a 15 to 4% increase in line speed, as did the increase in drying speed made possible by higher solids content. Other improvements included avoidance of bubble formation, airborne contamination, and commingling of defects caused by bubble formation, airborne contaminants, and commingling of flaws.

Benefits of Slot Coating: Improved Economy, Quality, and Yield

Three Case Histories: Estimated Annual Savings after Switching from Roll Coating to Slot Die Coating

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Polymer</th>
<th>Adhesive</th>
<th>Paper</th>
<th>Plastic</th>
<th>Tapes</th>
<th>Waxes</th>
<th>Inks</th>
<th>Other Fluids</th>
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<tbody>
<tr>
<td>Base web coating</td>
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<td>710</td>
<td>300</td>
<td>300</td>
<td>1,500</td>
<td>1,500</td>
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<tr>
<td>Coating width, in.</td>
<td>710</td>
<td>1,500</td>
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<td></td>
<td></td>
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<td></td>
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<td>35</td>
<td>35</td>
<td>35</td>
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<tr>
<td>Coating weight (w/o)</td>
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<td>22.5</td>
<td>22.5</td>
<td>37.0</td>
<td>37.0</td>
<td>37.0</td>
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<tr>
<td>Tolerance (tolerance), %</td>
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<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line speed, ft/min</td>
<td>123</td>
<td>33</td>
<td>16</td>
<td>16</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td></td>
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<tr>
<td>F. yield, %</td>
<td>50</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Simulated with used, %</td>
<td>$1,189,664</td>
<td>$24,822</td>
<td>$1,055,719</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: Nordson Extrusion Dies Industries

Benefits of Slot Coating

- **Precise Control without Fluid Recirculation**
  - The slot die coating differs from the roll coater in two basic ways:
    - **Pre-metered system.** The fluid is pumped into the slot die and onto the substrate at a pulse-free, constant rate. The thickness of the coating fluid delivery is determined wholly by line speed, pump speed, and the design of the die. The process permits precise control over coating weight and cross-web distribution, even at very low thicknesses or very high speeds. Further augmenting this control is the fact that, even if the process is interrupted, all the coating material in the die will remain in the die and is uniform when roll coating.
    - **Closed System.** All of the fluid metered into a slot die is applied to the web, and at no time is it exposed to the atmosphere. In roll coating, however, only a portion of the fluid on the applicator roll is actually deposited on the web; the remaining fluid must be recirculated for subsequent application. This opens the possibility of defects caused by bubble formation, airborne contaminants, and commingling of flaws.

Learning Shown in Three Case Histories

In production runs of three different combinations of coating fluid and substrate, slot die coating made possible substantial cost savings in comparison with the roll coating previously used. These were the result of savings in fluid and substrate materials, reductions in yield loss, and reductions in labor costs. On an annualized basis, the economics achieved in each of the three cases amounted to more than $1 million. The data comparisons between roll and slot die coating processes are summarized in the table above and evaluated as follows:

- **Computer real tape.** The tighter tolerances achievable with the slot die system made it possible to reduce the target thickness by 40%. The greater accuracy and repeatability of the system contributed to a 15% increase in line speed, as did the increase in drying speed made possible by higher solids content. Other improvements included avoidance of bubble formation.

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For information specific to fluid coating visit www.nordsonfluidcoating.com.
Nordson to Present

AustFlex™ and makes it possible to offset variations in cross-web thickness and process parameters. The UltraCoat™ system can be used with the full range of fluid coating materials, including hot melts. The shear forces involved in coating the material onto the web maximize the uniformity of the coating thickness. The die quality of the coating line is maintained due to the full utilization of the fluid coating process. The die quality can be enhanced in non-hot melt applications to be held to +/- 3.75% to 5.3%.

**TrueCoat™ TCHP fixed-lip / slim system for hot melts**

The key advantages of this contact / wipe system are its capability for quick changeovers and its ease of use. Standard slot nozzles can be equipped with dihedral for full-width or slot coating. Rotating bar nozzles provide a non-pulsing “clear out” coverage and excellent edge control, making the die particularly beneficial for tape and label applications. The nozzles can be interchanged quickly. As soon as one nozzle is running in the machine, the other can be prepared with a shim plate, which defines the coating pattern. For larger applications, a multi-nozzle facility is available. The net changeover time is within several minutes. The die can apply coatings with viscosities in the 1 to 50,000 cps range. Minimum coating thickness is 10 microns. Coating weight accuracy is held to +/- 2.5%.

**Porous Coat™ fixed-lip system for hot melts.**

This slot nozzle provides application of hot melt in a discrete, random and open structure for breathable coatings. The system is best suited for coating laminating of nonwovens, woven fabrics, scrim and foams, but also papers and films. The die can apply coatings with viscosities in the 1 to 50,000 cps range. Along with those slot dies, Nordson manufactures a wide range of related equipment essential for fluid coating accuracy and productivity. Fluid delivery systems provide a non-pulsing, consistent feed of fluid to the die, ensuring consistent coating volumes. Die positioners or coating stations provide repeatability and adjustability. And vacuum boxes help to control the length of the coating head and the processing window for developing surface properties.

“We’re excited about introducing our expanded range of slot coating capabilities at IEC Asia, because converters in the Asia Pacific market are among the world leaders in coating-edge fluid coating applications such as optical displays and photovoltaics,” says Keith Wheeler. “With production facilities and trial laboratories at strategic locations in Asia and sales and support offices throughout the region, Nordson is ideally positioned to work in partnership with these companies as they strive to increase productivity, reduce costs, and improve quality, and develop more innovative products.”

More information about Nordson’s fluid coating capabilities is available at www.nordsonfluidcoating.com.

**Benefits of Slot Coating**

**For Hot Melt Coatings**

- **Reduction in fluid scrap, and faster changeovers.** Daily potential savings were estimated to be US$ 1,354.
- **Electronic film.** Tighter tolerances and enhanced cross-web thickness control made possible a 75% reduction in thickness. Measured when dry, the thinner coating was 2.5% thinner. Other improvements included elimination of bubbles and reduction in streaking and web breaks. Daily potential savings were estimated to be US$ 1,460.
- **Label stock.** At equivalent coating weights, the slot die system ran at twice the line speed of the roll coater, in part because of tighter tolerances. It also provided the capability of being applied over a wider range of products—thicknesses of 10 to 200 microns and viscosities of 20 to 3,000 cps. Other improvements included reductions in downtime and product defects. Daily potential savings were estimated to be US$ 1,553.

Having supplied slot die systems for more than 30 years to multiple industries and hundreds of different applications, Nordson is prepared to assist converters in making the transition from roll coating. The first step is typically to set up a trial to check on the adhesion, appearance, and other requirements of a particular application and determine the need for changes in solution formulation. The next step is to custom die manufacture—building a slot die unique to the converter’s application. Finally, the converter tops the benefits of a system that provides a new dimension of control and quality assurance.

**Multiple Options for Trial Runs:**

**On-Site or at Nordson Laboratories**

The fluid coating and laminating laboratories operated by Nordson are extensively equipped with production-line components, from roll to slot systems.

- **Chippewa Falls, WI, USA.** housed in a clean, temperature-controlled room. The lab has a maximum speed of 60 m/min. and a working width of 500 m/m.
- **Johns Creek, GA, USA.** capable of being equipped with four different hot melt applicators, the line has a maximum speed of 650 m/min. and maximum roll width of 380 mm.
- **Lüttenberg, Germany.** Nordson operates four lab coaters that can be equipped with various hot melt die sizes for continuous and intermittent coating applications, including spray head. Maximum speeds range from 350 to 600 m/min. and maximum web widths from 300 mm to 1,800 mm.
- **Tokyo, Japan.** The three hot melt lab coating lines have maximum line speeds ranging from 300 to 500 m/min. and maximum web widths from 500 to 800 m/m.
- **Shanghai, China.** The hot melt lab line accommodates five different applicators, including spray head; maximum web speed is 400 m/min; maximum line speed is 500 m/min.
- **Ansan-gu, Korea.** There are four lab coaters—two for slot coating, and two for roll coating. The slot coaters have maximum speeds of 10 to 150 m/min. and maximum web widths of 250 to 1,300 mm. The other three lines include a flat roll coater and a gravure roll coater.
- **Bangalore, India.** The line accommodates hot melt and slot spray applicators; maximum line speed is 100 m/min. and maximum coating width is 520 m/m.

**Fluid Coating Trial Labs in 6 Countries**

**FULLY EQUIPPED—FROM FLUID DELIVERY TO ROLL SYSTEM.** Trial lab at Nordson Extrusion Dies Industries facility in Chippewa Falls, WI, USA. Chippewa Falls, WI, USA. housed in a clean, temperature-controlled room. The lab has a maximum speed of 60 m/min. and a working width of 500 m/m.

**MISCELLANEOUS SYSTEM FOR LEASE OR PURCHASE**

Nordson Extrusion Dies Industries Inc is a leading supplier of fluid coating systems to eliminate hours of setup in switching from roll to slot coating. The lab is capable of carrying out product and process development with slot dies.}{3}
**Nordson to Present continued from P. 3**

(AutoFlex™) and makes it possible to offset variations in cross-web profile thickness and process parameters. The UltraCoat™ system can be used with the full range of fluid coating materials, including hot melts. The shear forces involved in wiping the coating material onto the substrate are controlled for uniform quality. The die can apply coatings with viscosities in the 1 to 250,000 cps range. Minimum wet coating thickness is 12 microns. Coating weight accuracy in non-hot melt applications is held to +/- 1.75 to 3.5%.

**TrueCoat™ TCHP fixed-lip / shim system for hot melts.** The key advantages of this contact/wipe system is its capability for quick changeover and its ease of use. Standard slot nozzles can be equipped with shims for full-width or wipe coating. Rotating bar nozzles provide a feed-through ‘clear out’ feature and excellent edge control, making die particularly beneficial for wipe and label applications. The nozzles can be interchanged quickly. As one nozzle is running in the machine, the other can be prepared with a shim plate, which defines the coating pattern. For larger applications, a multi-nozzle system further facilitates the nozzle change. The net changeover time is within several minutes. The die can apply coatings with viscosities in the 1 to 50,000 cps range. Minimum coating thickness is 10 microns. Coating weight accuracy is held to +/- 5%.

**PorousCoat™ fixed-lip system for hot melts.** This slot nozzle possesses application of hot melt in a discrete, random and open structure for breathable coatings, with the capability of controlling the oxygen permeability of the coated material. Oxygen absorbability allows walls changes without stopping. Controlled walls demonstrate soft hand andrapeable properties. The system is best suited for coating laminating of nonwovens, woven fabrics, scrim and foams, but also papers and films. The die can apply coatings with viscosities in the 1 to 50,000 cps range. Along with these features, Nordson manufactures a wide range of related equipment essential for fluid coating accuracy and productivity. Fluid delivery systems provide a non-pulsing, consistent feed of fluid to the die, ensuring consistent coating volumes. Die positioners or coating stations provide repeatability and adjustability. And vacuum boxes help to control the length of the coating head and the processing window for developing surface properties.

"We’re excited about introducing our expanded range of die coating capabilities at EIC Asia, because converters in the Asia Pacific marketplace are among the world leaders in cutting-edge fluid coating applications such as optical displays and photovoltaics," says Keith Wheeler. "With a standard slot die system, a variety of individual components can be used in combination to achieve the desired performance and can be used in a variety of applications. However, the size of the coating system can be enlarged by adding additional components," says Wheeler. "Assembly a modular coating system so that it is properly aligned, the rolls are level and can be adjusted without stopping. Filled film is provided in feeds and rolls, the rolls are adjustable. The coating system is also capable of being applied over a wide range of products—thicknesses of 10 to 200 microns and viscosities of 20 to 3,000 cps. Other improvements included elimination of bubbles and reduction in streaking and web breaks. Daily potential savings were estimated to be US$ 1,345.

**Multiple Options for Trial Runs: On-Site or at Nordson Laboratories**

Outside laboratory facilities where converters can carry out their fluid coating trials are scarce—with one exception. Nordson operates coating labs at several locations around the world. Besides using them for process improvements and innovations, Nordson makes these facilities available to converters, who otherwise be forced to use their own full-scale production lines at a cost of lost output.

In addition, Nordson can supply modular coating systems with trial converters can lease or purchase for trials at their own facilities. For companies that currently use roll coating systems, the M C S enables them to eliminate lines of setup in switching from roll to slot die coating as they carry out their product and process development with roll dies. M C S systems are equipped with either the PorousCoat™ fixed-lip or the UltraCoat™ adjustable-lip slot die.

"The fluid coating labs operated by Nordson enable converters to carry out their trial runs or application development without tying up their own production lines, and they can do so in the strictest confidence," says Keith Wheeler, director of Nordson’s fluid coating business. "Typically, nondisclosure agreements are signed with every company that utilizes our labs. Users of Nordson’s modular coating systems also save substantial time, which, in turn, means that converters can carry out their own developments much more quickly and cost-effectively. For example, the M C S contains a full range of equipment, including spray head. Maximum speeds range from 350 to 600 m/min. and maximum web widths from 300 mm to 1,800 mm.

"Japan, China. The hot melt lab coating lines have minimal line speeds ranging from 300 to 500 m/min. and maximum web widths from 500 to 900 mm. In addition, the thinning head includes a flat roll coater and a gravure roll coater.

"Bangladesh, India. The line accommodates hot melt and spray applications; maximum line speed is 100 m/min. and maximum coating width is 520 mm.

Benefits of Slot Coating

- **reduction in fluid scrap, and faster changeovers. Daily potential savings were estimated to be US$ 1,345.**
- **Electronics films. Tighter tolerances and enhanced cross-web thickness control made possible a 75% reduction in thickness. Measured when dry, the thinner coating was 2.5% thinner.** Other improvements included elimination of bubbles and reduction in streaking and web breaks. Daily potential savings were estimated to be US$ 1,465.
- **Label stock. At equivalent coat weights, the slot die system ran at twice the line speed of the roll coater, in part because of tighter tolerances. It also possessed a high tolerances and produced products. Daily potential savings were estimated to be US$ 1,575.**

Having supplied slot die systems for more than 30 years to many industries and hundreds of different applications, Nordson is prepared to assist converters in making the transition from roll coating. The first step is typically to set up a trial to check on the adhesion, appearance, and other requirements of a particular application and determine the need for changes in solution formulation. The next step is to custom design and manufacture a slot die coating line. Finally, the converter maps the benefits of a system that provide a new dimension of control and quality assurance.

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**For More Information, Visit:**

www.nordsonfluidcoating.com
Benefits of Slot Coating: Improved Economy, Quality, and Yield

Slot die coating provides a more efficient and controllable alternative to roll coating and other standard methods of applying fluids to web substrates. When used with hot melts, pressure-sensitive adhesives, phosphorescent materials, magnetic media, inks, waxes, and many other fluids, slot die coating enables converters to maximize economy and productivity. Its ability to provide consistent precision, and purity, makes it especially suitable for critical markets such as medical products, plastics, labels, and photoresists. In addition, slot die coating eliminates emissions of volatile organic compounds (VOCs) from solvent-based materials.

Precise Control without Fluid Recirculation

The slot die coating differs from the roll coater in two basic ways:

- **Pre-metered system:** The fluid is pumped into the slot die and onto the substrate at a pulse-fed rate. Uniformity is a primary advantage of this system. The thickness of the coating is determined by the line speed, pulse speed, pump speed, and the design of the die. The process permits precise control over coating weight and cross-web distribution, even at very low thicknesses or very high speeds. Further augmenting this control is the fact that, inside the die, it is designed to uniformly distribute the coating fluid in accordance with the rheology, or flow properties, of the fluid. In addition, the slot die system allows precise control of the die relative to the back-up roll or substrate and ensures repeatability.

- **Coating weight:** The coating weight is affected by a number of variables, including viscosity and surface tension. Because the coating system allows only a partial transfer of coating fluid from an applicator roll to an impression roll (or an offset roll), at high speeds product defects can develop as a result of film splitting.

In roll coating, by contrast, the coating thickness is affected by a number of variables, including viscosity and surface tension. Because the coating system allows only a partial transfer of coating fluid from an applicator roll to an impression roll (or an offset roll), at high speeds product defects can develop as a result of film splitting.

Coating uniformity in roll coating is typically held to +/- 5 to 10%, whereas it is held to +/- 1 to 2% with the Premier™ adjustable-lip slot die and 1.75 to 3.50% with the UltraCoat™ adjustable-lip slot die. Minimum wet coating thicknesses achieved with roll coating are in the 10 to 15 micron range, which is comparable to adjustable-lip slot die; a fixed-lip slot die, however, can produce coatings as thin as one micron. Coat weight accuracy is held to +/- 1 to 2%.

Large Savings Shown in Three Case Histories

In production runs of three different combinations of coating fluid and substrate, slot die coating made possible substantial cost savings in comparison with the roll coating previously used. These were the result of savings in fluid and substrate materials, reductions in yield loss, and reductions in labor costs. On an annualized basis, the economics in each of the three cases amounted to more than US$1 million. The data comparisons between roll and slot die coating processes are summarized in the table above and evaluated as follows:

- **Computer reel tape:** The tighter tolerances achievable with the slot die system made it possible to reduce the thickness by 40%. The greater accuracy and reproducibility of the system contributed to a 154% increase in line speed, as did the increase in drying speed made possible by higher solids content. Other improvements included avoidance of bubble formation, overcoat weight and cross-web distribution, even at very low thicknesses or very high speeds. Further augmenting this control is the fact that, inside the die, it is designed to uniformly distribute the coating fluid in accordance with the rheology, or flow properties, of the fluid. In addition, the slot die system allows precise control of the die relative to the back-up roll or substrate and ensures repeatability.

- **Closed System:** All of the fluid metered into a slot die is applied to the web, and at no time is it exposed to the atmosphere. In roll coating, however, only a portion of the fluid on the applicator roll is actually applied to the web; the remaining fluid must be re-circulated for subsequent application. This opens the possibility of defects caused by bubble formation, airborne contaminants, and commingling of virgin with re-circulated material. In the case of solvent-borne fluids, for example, evaporation will change the properties of the material even as the coating process continues.

- **Computer reel tape:** The tighter tolerances achievable with the slot die system made it possible to reduce the thickness by 40%. The greater accuracy and reproducibility of the system contributed to a 154% increase in line speed, as did the increase in drying speed made possible by higher solids content. Other improvements included avoidance of bubble formation.

Three Case Histories: Estimated Annual Savings after Switching from Roll Coating to Slot Die Coating

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Polymer</th>
<th>Electronic Paper</th>
<th>Plastic Printed Labels</th>
<th>Paper</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base web coating</td>
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<td>Adhesive</td>
<td>Poly</td>
<td>Poly</td>
<td>Poly</td>
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<td>30%</td>
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<td>Coat weight, mg/in</td>
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<td>25.5</td>
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<td>Tolerance, %</td>
<td>7</td>
<td>2</td>
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<td>4</td>
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</tr>
<tr>
<td>Line speed, ft/min</td>
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<td>13</td>
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<td>15</td>
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Source: Nordson Electronics Division Industries

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PREFERRED TOPICS FOR FLUID COATING SYSTEMS

- **Premier™ fixed-tip / slot die:** Key advantages of this non-contact / draw system include high precision, ease of use, and capability of applying very thin coatings. Because the lips are fixed, the die provides a high degree of precision and run-to-run repeatability with a minimum of operator intervention. Gap adjustment must be carried out by means of shafts. The die can apply coatings with viscosities in the 1 to 175,000 cps range. Minimum wetting coating thickness is 1 micron. Coat weight accuracy is held to +/- 1% to 2%.

- **UltraCoat™ adjustable-tip / slot die:** Variable gap is a key feature of this contact / wipe system, in which the coating gap and width can be adjusted without having to disassemble the die. Gap adjustment may be manual (UltraFlex™) or automated (UltraCoat™)