COATINGS & ADHESIVES CORPORATION

Low-Curl Waterbased Coating v1.1

Low-curl waterbased coating products are specialty formulations designed to help minimize the effects of paper distortion/curl during the printing/coating process on low-basis weight and/or high absorbency substrates that are inherently prone to distortion/curl. While these coating products are designated as "low-curl" solutions, there are always additional process and material considerations that need to be accounted for to ensure the most desirable results for reduced paper distortion/curl are achieved.

In addition, two types of paper distortion/curl exist in the printing process:

- **Moisture-related distortion/curl**
  Caused by changes in the dimensional integrity of a sheet due to the gain/loss of moisture contributing to paper-fiber growth or shrinkage.
- **Mechanical distortion/curl**
  Caused by sheet stress introduced by the printing process during release from the printing/coating blanket and/or use of a de-curling device.

Paper Considerations

Distortion/Curl	Paper distortion/curl due to the application of a waterbased coating can be caused by the contrasting forces of paper dimensional growth vs coating film dimensional shrinkage. Water contained in the applied wet coating film in addition to fountain solution from the printing process can become absorbed by the paper resulting in paper-fiber growth and the respective dimensional growth of the sheet. This growth is most apparent in the cross-grain direction contributing to sheet curl that is parallel to the grain-direction of the paper. Additionally, the loss of water during the drying process of the applied wet coating film causes this film to dimensionally shrink. The simultaneous paper-fiber growth and coating film shrinkage can cause the sheet to develop distortion/curl in the direction of coating application observed as being parallel to the paper grain-direction.
Equilibrium	Paper is continually changing in temperature and humidity to match the surrounding ambient conditions, with the exposed paper edges being most quickly/easily effected due to edge-wicking moisture gain/loss. If the ambient conditions in the paper storage/press-room are controlled and remain stable, the paper can eventually achieve a state of equilibrium in which additional changes can remain insignificant. The time and degree of change will be determined by the difference in paper condition and the ambient conditions in which the paper is stored. If ambient conditions are not controlled and fluctuate, the paper condition can remain is a state of perpetual change and will follow the ambient conditions.
Wavy Edges	Moisture gain by the exposed paper edges in higher humidity conditions can result in paper with "wavy" edges. In this case, the perimeter of the sheet has experienced paper-fiber growth and dimensional increase while the center of the paper remains un-changed. Wavy edges will be most evident when viewing the paper along the cross-grain directional edge.
Tight Edges	Moisture loss by the exposed paper edges in lower humidity conditions can result in paper with "tight" edges. In this case, the perimeter of the sheet has experienced paper fiber shrinkage and dimensional decrease while the center of the paper remains un-changed. Tight edges will result in a "baggy" or bulged sheet center.

REV 04/20_v1.1

Paper Considerations - *continued*

Basis Weight	Low basis weight papers, <80#, can lack the structural stability to resist distortion/curl created mechanically by the printing process during printing/coating blanket release, or by the application of moisture through applied ink/coating films. The construction of low basis weight papers necessitates the use of either minimal paper coating which can create a porous surface and contribute to poor hold-out and high moisture absorption by the paper fibers, or reduced paper fibers and increased paper coating which creates improved moisture hold-out and poor structural stability to maintain flatness. For best results for sheet flatness prior to and after the printing process, it is recommended to use basis weight papers of 80# or higher.
Paper Type - C1S	C1S papers can be subject to increased sheet-distortion/curl compared to C2S papers due to the contrasting paper construction on each side of the sheet. The coated side of the sheet will have improved moisture hold-out compared to the un-coated side of the sheet, which will contribute to moisture absorption/loss and paper-fiber growth/shrinkage at different rates for each sheet side. Increased rate of moisture absorption/loss by the uncoated sheet side will promote paper-fiber size change resulting in sheet-distortion/curl caused by dimensional instability of the paper. C1S papers can be prone to significant and continuous changes in sheet condition for distortion/curl reflective of ambient conditions, particularly after the printing process is complete.
Paper Type - C2S	C2S papers will exhibit improved stability compared to C1S papers due to a common paper construction on each side of the sheet. While moisture hold-out can vary between “wire” and “felt” sheet sides, the overall paper construction should be comparable resulting in a similar degree of absorptivity. In cases where C2S papers are printed/coated on a single-side, sheet distortion/curl may be observed. In cases where C2S papers are printed/coated on both sides, sheet distortion/curl that is observed after the first-side printing may become absent after the second-side printing due to side-side equilibrium being restored.

Paper Condition

Acclimation	Paper is typically packaged in moisture resistant material under controlled conditions for temperature/humidity to ensure that the moisture content and integrity of the paper is maintained. It is recommended to acclimate paper to press-room conditions for temperature in the supplied packaging prior to opening to avoid problems related to cold paper. Once paper has been acclimated to the ambient temperature of the press-room, the relative humidity should be measured using a probe hygro-meter and compared to ambient conditions for relative humidity. If the difference in relative humidity between the paper and press-room is >5%, moisture gain/loss along the perimeter edges of the paper can occur contributing to wavy or tight edges.
Temperature/ Relative Humidity	Paper temperature and relative humidity compared to ambient conditions will influence moisture gain/loss from exposed perimeter edges and moisture absorption through the paper surface. Cold paper un-wrapped in warm conditions can cause moisture to condense along the perimeter edges of a press load, resulting in edge-wicking and paper fiber growth contributing to wavy edges; this is particularly evident when ambient conditions are much higher for relative humidity. In addition, during the printing process when sheets are fed individually through the press, cold paper will cause condensation on the paper surface which can cause for excess moisture absorption during the printing process, and contribute to poor print quality and slow drying of inks/coating. Warm paper that is un-wrapped in cold ambient conditions can cause the air surrounding the paper to become increased in temperature. The increased air temperature will result in a humidity drop, which will pull moisture from the paper edges and cause tight edges.

REV 04/20_v1.1

Paper Condition - *continued*

Moisture Content	Paper will typically be manufactured with a moisture content of 4-7%, with 5-6% being most desirable for sheetfed applications . The moisture content of the paper in addition to the surface coating will influence the absorbency of moisture through the paper surface. The moisture content will influence the reaction of moisture gain/loss along the exposed paper edges determined by the ambient conditions for relative humidity.
Paper Acclimation Guidelines	Ideal paper storage/press-room conditions: - 72°F, 45-55% RH Paper acclimation time: - 24-48 hours, ***actual temperature should be confirmed prior to un-wrapping

Printing Process Considerations

Ink Coverage: Minimum/Light	Jobs with minimum/light ink coverage areas can result in the absorption of fountain solution from the ink-free areas of the printing plate applied to the paper surface by the printing blanket. Excessive fount absorption by the paper can result in sheet distortion/embossing between ink and ink-free areas, even without the application of a waterbased coating. The lack of ink film availability on the sheet can result in increased water absorption by the applied coating film.
Ink Coverage: Moderate/Heavy	Ink film areas can inhibit water absorption by creating a barrier between the paper and the applied waterbased coating film. Jobs with moderate/heavy ink coverage areas can become less prone to distortion/curl compared to jobs with minimum/light ink coverage areas. Minimum sheet size should be used with moderate/heavy coverage ink areas, with ink areas extending as close to the sheet perimeter as possible. On two-sided jobs with each side having differing ink coverage areas, the heavier ink coverage side should be printed/coated first to minimize sheet distortion/curl prior to second-side printing.
Ink	The use of low-tack inks will help to prevent sheet distortion/curl due to poor mechanical release from the printing blanket, particularly on jobs that contain solid ink areas with abrupt start/termination areas. Proper lubrication of the printing blanket surface must be achieved with a stable ink/damp emulsion to facilitate good sheet release.
Fountain Solution	Fountain solution chemistry selection should provide stable ink/damp emulsion and aid in minimizing ink drying time with reduced IR exposure of the drying system. Solution dosing should be performed using manufacturer recommendations and monitored for accuracy. When printing jobs that may be prone to distortion/curl, it may be beneficial to re-batch fountain solution to optimize ink/damp stability. Fountain solution temperature in the re-circulator should not be set too cold as not to negatively influence ink condition and sheet release from the printing blanket; a fountain solution temperature of 60°F is suitable.
Printing Blanket Release	The ability of the paper to release consistently from the printing blanket is necessary to ensure that the tail edge of the sheet does not remain attached and continue to follow the blanket cylinder path after the blanket-impression nip. If the paper tail edge continues to follow the printing blanket cylinder path and is abruptly pulled from the surface, this can result in a definitive curl being observed at the sheet rear edge. Variables such as press speed, printing blanket surface characteristics, ink coverage and ink tack can contribute to poor paper release from the printing blanket surface. Ink coverage areas at the paper rear edge that can contribute to an inconsistent and irregular paper release are ink take-off bars, color control strips and solid areas that begin and terminate near the paper rear-edge.

REV 04/20_v1.1

Printing Process Considerations - *continued*

Sheet De-curler	Most sheetfed presses are equipped with a sheet de-curler device to compensate for mechanical paper distortion/curl that can develop during sheet release from the printing blankets. This device allows for a down-curl that appears at the sheet rear-edge to become flattened. In the case where a rear-edge down-curl has not been developed during the printing process, the de-curler should not be used as this can result in a rear-edge up-curl. In addition, over-use of the de-curler to resolve a down-curl can result in an over-compensated up-curl being developed.

Low-Curl Coating Considerations

Coating Viscosity	Low-curl waterbased coating products are higher in solids compared to general-use products. This aids in preventing sheet distortion/curl by minimizing the amount of water available for absorption into the substrate and minimizing the amount of water-loss from the applied wet coating film to reduce film shrinkage. It is important to avoid diluting the coating product with water which can negatively impact the low-curl characteristics of the coating product.
Coating Temperature	In circumstances where the coating product is colder than press-room conditions, the coating product should always be acclimated to bring up to press-room temperature prior to use. Cold coating can negatively influence the coating application rate and release capabilities of the sheet from the coating blanket/plate.
Anilox Systems	Anilox roll engraving specifications should minimize coating application while providing sufficient coating coverage and protection of under-lying ink films. Due to controlled metering, the use of high-solids, high viscosity low-curl coating is favorable to reduce the contained water in the applied wet film.
Non-Anilox Roller/Nip System	Due to variable metering, mechanical and operational settings should be adjusted to minimize coating application while providing sufficient coating coverage and protection of under-lying ink films. Due to the metering process of this system, the use of high-solids, low viscosity low-curl coating is favorable to minimize the application rate of coating to the sheet. The use of a higher durometer metering roller compound may be necessary to further reduce the coating application rate to improve results for distortion/curl.
Drying System	The press drying system should be operated in a manner to most effectively remove moisture from the applied ink/coating films while not negatively impacting the paper by over-heating. Hot-Air Knives(HAK) and air-extraction should be operated at maximum/near-maximum output to most efficiently remove water from the applied ink/coating films without negatively impacting sheet travel. Infrared(IR) output should be minimized to achieve a measured delivery-pile temperature of 90-95°F using a probe/stem thermometer. IR output will be adjusted to accommodate the amount of ink coverage on the sheet and respective press speed. In cases of jobs with minimum ink coverage and/or reduced press speeds, IR output should be reduced to achieve the above recommended delivery-pile temperature. In cases of jobs with moderate to heavy ink coverage and/or increased press speeds, IR output may need to be increased to achieve suitable ink drying. Ink condition should always be monitored to determine proper drying when making adjustments to drying system operational settings. Reduced press speeds and increased drying system exposure will improve moisture removal and drying results.

REV 04/20_v1.1