INX COATINGS & ADHESIVES

TECHNICAL RESOURCE INFORMATION

Waterbased Coatings

Sheetfed Drying v25.1

Modern sheetfed press drying systems have become sophisticated in their components and operational software to help aid in achieving optimum drying of waterbased coatings. As press speeds and production demands increase, and job turnaround times from press to finishing to delivery decrease, the importance of achieving the most efficient and effective drying of coating films is more important than ever. Thorough understanding of the drying process of waterbased coatings, and how to use the tools available with the press drying system are critical to ensuring predictable and repeatable success.

Waterbased Coating – Sheeted Drying Principle

Scope	- Waterbased coatings in a wet state generally contain 55 - 75% water, which serves the purpose of maintaining all coating ingredients in a dispersion during storage, the distribution of these ingredients throughout the coating system and over transfer surfaces of the coating unit, and ultimately into a homogenous wet film applied onto the substrate. - Once the application process has been completed, the water component along with additional diluents are removed from the wet coating film by evaporation and potentially absorption if the substrate allows. - With the water removed, the remaining coating resin 'solids' will coalesce into the final dried coating film which will exhibit the intended characteristics of the specific coating product formulation. - Ingredients such as ammonia solution and isopropyl alcohol that can be used to improve coating performance and can influence the setting/drying rate of the applied coating film will also be removed by evaporation during the drying process. - Influences which can determine the rate and distribution of water loss from the wet coating film by evaporation or absorption: • Substrate – condition and type • Beneath ink layers – condition and type • Drying System – components, condition/capacity and operational settings • Ambient Conditions – atmospheric conditions for temperature and relative-humidity in the press area
Substrate Influence	- The amount of evaporative drying that is required by the wet coating film can be determined by the absorbency potential of the substrate and beneath ink film layers: • High-absorbency paper and paperboard substrates can require less evaporative drying due to the ability of water to be quickly absorbed through the paper coating and into the paper fibers. • Low-absorbency paper and paperboard substrates, high density wet ink layers, or dry-trap applications over dry/cured ink layers and/or primer coating can require more evaporative drying due to the inability of water to be quickly absorbed through the beneath surfaces that have low permeability – this can be due to the construction of the paper or condition of beneath ink film/primer coating layers. • Non-absorbent substrates will exclusively require evaporative drying as no water can be absorbed which may require specialized waterbased coating formulations to account for this drying method.
Drying System Influence	- High performance press drying systems that are in good operational condition and contain extended drying tunnels with component redundancy can promote efficient and effective evaporative drying, which can reduce the amount of absorption required to set and dry the applied wet coating film quickly and completely. - In cases where the press drying system lacks capacity and/or is in poor operational condition, the heavy reliance on absorptive drying may be required due to ineffective evaporation being achieved – this can result in a worse ink/coating conditions 'off-press' and longer drying times. - In cases where the drying system capabilities are limited, special 'fast-setting' waterbased coating formulations may be required to enhance the evaporative drying characteristics of the coating product.
Ambient Conditions Influence	- In cases where the press drying system lacks capacity and/or is in poor operational condition, ambient/ atmospheric conditions for temperature and relative humidity in the press area become a larger contributing factor into the drying performance of ink/coating films.

- Air can be described as a 'sponge' as it relates to moisture absorption:
  - 'Dry sponge' – like a sponge, the drier the air, the more moisture can be absorbed – the warmer/drier the air, the greater the capacity for moisture absorption from the wet coating film and faster the drying.
  - 'Wet sponge' – like a sponge, the wetter the air, the less moisture can be absorbed – the cooler/wetter the air, the lower the capacity for moisture absorption from the wet coating film and slower the drying.
- The condition of ambient air for temperature and relative humidity within the press area can greatly influence the ability of moisture to be effectively evaporated from the applied wet coating film:
  - Conditions in the pressroom that are high in ambient temperature and relative humidity can impair evaporation and require increased substrate absorption for setting and drying – this can result in extended drying times if the absorption potential of the substrate is limited.
  - Conditions that are high in temperature and low in relative humidity can improve evaporation and reduce the amount of necessary substrate absorption.

Waterbased Coating Drying

Coating Film 'Setting'

- Coating film 'setting' is achieved by exposure to the drying system during which diluents are removed from the wet/applied film by absorption and/or evaporation.
- The coating film will begin to coalesce into a final/continuous film on the substrate/ink surface and the migration of slip agents to the film surface will provide lubrication and short-term protection for scratch/rub and sticking/picking/set-off in the press-load:
  - In this state, the Operator will observe the coating film to be tack-free on press 'pull sheets' and sheets can be handled without smearing/transferring underlying ink films – conventional inks will still be in a wet/soft condition beneath the coating film.
  - While the 'set' condition of the coating film provides initial protection as sheets enter the press delivery pile, within the delivery pile, and on press pull sheets, the drying process is not complete and will continue to progress over several hours/days – the ink/coating films will continue to increase in hardness/durability.
  - The 'set' condition will not exhibit the complete/final characteristics of the coating film in terms of rub/scratch resistance, COF/AOS and block resistance.
- The set speed of the coating film can be influenced by variables such as coating product formulation, applied coat-weight, drying system capabilities/operation, substrate absorbency, ink film thickness/condition and ambient conditions.

Coating Film Drying

- Complete loss of moisture/diluents from the applied coating film will allow the resin to coalesce and harden into a final/continuous film on the substrate/ink surface.
- Complete migration of the slip agent to the coating film surface will establish the intended rub and block resistance as well as AOS/COF.
- At this point, the coating film will exhibit the final intended/formulated product characteristics.

Waterbased Coating – Sheeted Drying Equipment

Drying System

- Modern sheetfed press drying systems utilize a combination of heat exposure and forced-air impingement of the substrate surface as it passes through the drying tunnel to facilitate absorption and evaporation of any moisture/diluents from the applied ink/coating films and stimulate driers contained in the ink layers.
- Additionally, air-extraction is used to exhaust high-humidity air from the drying tunnel that is created by moisture evaporation during the drying process.
- As printing press speeds have continued to increase, modern drying systems have been adapted to be more efficient in the ability to properly set and dry a variety of ink and coating formulations applied over a wide range of substrate types:
  - Increased length of the drying tunnel in modern sheetfed presses creates an 'extended' delivery which can incorporate more drying system components.
  - Drying systems can employ redundancy of critical drying system components to achieve progressive drying for optimized performance, particularly at high press speeds.
- Modern presses that are equipped with coating units to apply waterbased coatings utilize the following drying system components to achieve proper setting/drying of waterbased coating films:

	• Infrared Emitters (IR) – most common on presses equipped to run conventional inks, IR may not be equipped on presses that are equipped to only run energy-cured inks. • Hot-Air Knife (HAK) • Air-Extraction/Exhaust (EXT) • Powder-Spray Device
Infrared Emitters (IR)	- Infrared wavelength emitters are resistance coils housed inside quartz tube 'bulbs' which are used as an energy source to generate heat in the substrate and applied ink/coating films. - IR energy is an effective heat source due to the high absorption rate by ink and waterbased coating films, which results in accelerated temperature generation of the contained diluents in a very short dwell time compared to using a forced hot air source alone. - A drying system that exclusively uses forced hot air will typically approach the necessary temperature for applied ink/coating films near the end of an extended drying tunnel, whereas the use of infrared emitters as a heat/energy source will cause ink/coating films to reach an effective temperature almost immediately after being exposed. - Redundancy of IR emitter bulbs in a drying system provides the optimum exposure of the printed/coated sheet to infrared energy relative to maximum press speed/minimum dwell. - Variability in infrared emitter output enables 'as needed' adjustment based upon changes in printing conditions and individual job requirements – adjustments to IR energy output will bring the most immediate and drastic change to sheet surface and captive press load temperatures. - Most modern sheetfed press drying systems allow for the 'automatic' adjustment of IR output based on the actual measured sheet surface temperature as it relates to a desired temperature target – a pyrometer constantly measures/monitors sheet surface temperature as sheets enter the press delivery pile and compensates IR output accordingly to achieve/maintain the target temperature value. - The most effective spectral range of infrared output for generating heat in lithographic ink and waterbased coating films is the short to medium, 0.7 - 10.0 micrometer wavelengths. - The combined use of short and medium wavelength IR emitters optimizes the efficiency of the drying system by utilizing the advantages of each spectral range for impacting the substrate, ink, coating and ambient drying tunnel temperatures. - Due to individual and collective advantages of both spectral output ranges, it is common for a combination of both short and medium wavelength emitters to be used in some drying systems. - The impact of using infrared emitters as part of the press drying system: • Lowers ink film viscosity to promote substrate absorption and release of diluents. • Lowers coating film viscosity to promote substrate moisture absorption and film flow-out/leveling. • Vaporizes fountain solution and diluents in the wet ink film for removal to promote film setting. • Vaporizes water and diluents in the wet coating film for removal to promote film setting. • Stimulates drying additives in the ink film to promote setting/drying.
Hot-Air Knife (HAK)	- Forced hot air is used to impinge the substrate surface and heat the laminate air above the sheet after IR exposure to absorb waterbased coating vapors for removal by the air-extraction/exhaust system. - Heated air is most efficient due to the greater capacity to absorb/hold moisture and effectively remove a larger volume of moisture-laden air created by waterbased coating from the press drying tunnel. - Air blowers and heating elements are used in combination to create forced hot air in the drying tunnel which is directed at the substrate surface through openings in the HAK cassette – this occurs following sheet exposure to the infrared bulbs. - With most modern drying systems, the desired temperature and volume of hot air is variable and can be individually adjusted to achieve the best results for drying of waterbased coatings. - Care should be taken to ensure that the velocity of hot air blown onto the sheet surface does not create turbulence and disrupt sheet travel – disruption of sheet travel creating waves/ripples in the sheet can cause an uneven distribution of spray powder as the sheet passes beneath the spray powder nozzles creating quality issues in the press-load.
Air-Extraction (EXT)	- To continue the coating drying process on subsequent sheets during production conditions, the humid/moisture-laden air that has been produced by evaporation in the drying tunnel must be removed and replenished with dry air supplied by the HAK. - Air-blowers connected to drying tunnel exhaust outlets allow for moisture-laden air to be efficiently removed

	without negatively impacting sheet travel or spray powder application. - If presses do not have integrated extraction within the drying tunnel, aftermarket exhaust hoods can be added above the press delivery for humid air removal. - Without adequate air removal from the drying tunnel, an excessive amount of moisture/humidity will accumulate and negatively impact the evaporation process for additional coated sheets – results can be sheets within the press-load that do not exhibit proper drying of the coating film. - To successfully remove the necessary amount of moisture-laden air from the drying tunnel, the extraction air volume needs to be greater than the supplied HAK air volume – typically by 50%. - For sheetfed applications, an exhaust volume of 1400 - 1600 cfm is recommended using a large vent – air volume is most important and should not be confused with air velocity. - When exhausting/venting air to the outside of a building (most commonly the roof), the outside ambient conditions for temperature, humidity, wind and precipitation should be considered as it relates to the efficiency and consistency of the exhaust potential – an additional exhaust fan/blower may need to be installed at the roof level to overcome outside variables and provide efficient/consistent removal of air through the exhaust system.
Spray Powder Device	- For continued drying of ink/coating films in the press load, proper spray powder selection and application volume is important. - Spray powder application to the printed/coated sheet helps to create space between the sheet surfaces in the press load minimizing wet ink/coating films from contacting the adjacent sheet surface – this is particularly important on two-sided applications. - The space created between the sheets will contain air and allow for ventilation of the press load to avoid heat retention and facilitate continued drying of inks/coating on captive sheets – oxidative drying for conventional inks and evaporative drying for waterbased coatings. - The use of spray powder is particularly important on non-absorbent substrates where oxidation of ink and evaporation of the coating film are the only means for drying – ventilation of the press load is paramount. - In addition, without powder, the highly smooth and non-porous surface of plastics can cause a 'glassing' effect where it is not possible for air to enter/exit the press-load – this stalls the drying process and retains heat from the drying tunnel exposure. - Spray powder type and granule size can be selected based on the specific application and substrate type, with volume of the applied spray powder being adjustable by the Operator based on specific job conditions. - Regular maintenance to the spray powder device should be conducted per Manufacturer's recommendations.
Drying System Capabilities	- The drying capacity/capability of a press is determined by the drying tunnel configuration regarding length, number of component cassettes, and availability/redundancy of IR/HAK/EXT components. - Drying tunnel length can determine the number of available cassettes containing IR/HAK/EXT components/ capabilities and the amount of dwell that the printed/coated sheet has available beneath these cassettes. - The available drying capacity and tunnel length will ultimately determine the effectiveness of the drying system to be able to dry both inks/coating at high press speeds. - Limitations in system components and/or drying tunnel length can cause for the operation of the drying system at near maximum capacity and/or reduced printing speeds to achieve adequate drying results – specialized 'fast-drying' coatings may be required in these circumstanced. - Limitations in drying system capability/capacity can contribute to problems of: • Reduced press speeds. • Insufficient measured sheet surface and delivery pile/captive-load temperature – this can be substrate specific based on basis-weight/thickness and substrate density. • Sheet distortion, curl/embossing – this can be substrate specific. • Quality issues in delivery pile – ink-transfer/set-off, picking, scuffing, scratching, ink-balling. • Quality issues during second-side printing – sticking, blocking, picking, ink-transfer/set-off. • Quality issues during finishing. • Variance in coating film performance characteristics – Gloss, COF/AOS, Rub resistance. • Odor issues on printed materials after packaging. - Non-functioning drying system components should be replaced/repaired immediately to ensure that no performance and quality issues are encountered. - Existing drying system components should always be maintained per Manufacturer's recommendations/ specifications to ensure that optimum system performance is achieved contributing to predictable drying results.

	- For drying systems with limitations in capability/capacity due to system configuration and/or condition, special considerations should be made when selecting substrates, ink, fountain chemistry, coating and spray powder to ensure that adequate drying can be achieved to avoid quality issues. - Substrate type limitations may exist due to drying system capability/condition.

Waterbased Coating – Sheeted Drying Fundamentals

Progressive Drying	- To efficiently and effectively promote the setting/drying of ink/coating films, redundancy of drying system components can be employed in modern printing presses to create 'progressive drying' – the ink/coating films progressively 'mature' for setting/drying condition as the sheet travels through the drying tunnel and is exposed to each component of the system. - Long drying tunnels utilizing multiple cassettes that contain redundant IR/HAK/EXT components allow for the ink/coating films to achieve the highest degree of setting/drying 'maturity' prior to the sheet reaching the delivery pile, particularly at high press speeds. - Sheet exposure to multiple drying cassettes containing IR/HAK/EXT enable the ink/coating films to become 'drier and drier' as the sheet moves through the drying tunnel by continuous absorption/evaporation and removal of humid/moisture-laden air. - Progressive drying through system redundancy allows for each component to be operated at a reduced output to protect the integrity of the substrate while achieving the desired setting/drying results. - Despite the redundancy of drying system components, component functional inefficiencies or component failure will negatively impact the drying capabilities of the system and can lead to problems associated with insufficient setting/drying of ink/coating films.
'Short-Term' Drying – 'Setting'	- The degree of 'short term' drying achieved in the drying tunnel, or 'setting' of the coating film, sets the stage for the effectiveness of continued 'long term' drying that is experienced by captive sheets in the press load. - The goal in drying system operation is to remove as much moisture from the wet ink/coating films during drying system exposure to mature all wet films to a semi-dry/'set' film condition prior to sheet delivery. - Effective 'short term' drying will achieve the protective qualities of the ink/coating films to help avoid quality issues upon sheet delivery and allow for the most effective progressive drying to be achieved inside the press load. - Ineffective short-term drying can result in prolonged drying times for ink and/or coating films and quality issues in the press load.
Sheet/Pile Temperatures	**Sheet Entry/Surface Temperature** - Most modern press drying systems use pyrometers located in the press delivery to measure the sheet surface temperature as sheets enter the delivery pile – the pyrometer location is fixed, and the measured area of the sheet can vary job-to-job for ink coverage and relative temperature results. - Handheld pyrometers can also be used to measure the temperature of the sheet as it enters the press delivery. - While the use of pyrometers can be a good indicator of sheet temperature, the use of a probe thermometer in the delivery pile is recommended to confirm the actual captive load temperature as it relates to the continued drying of inks/coating. - Press drying system and handheld pyrometers measure the printed/coated sheet as it enters the delivery pile, in which the sheet is still losing heat from the drying system exposure – a noticeable difference of 5 - 10F can be observed when comparing the measured sheet temperature entering the delivery and the captive sheet temperature inside the delivery pile; a sheet entry temperature of 105F may correlate to a captive load temperature of 95F measured immediately off-press. - It is a good practice when using the drying system pyrometer to measure and control drying system settings in an 'automatic' mode, to correlate the target drying system sheet surface temperature with the captive delivery pile temperature using a probe thermometer – in most cases, a sheet entry surface temperature of ~105F is necessary to achieve a captive delivery pile temperature of ~95F. - Keep in mind that the center of the sheet in a captive load will generally have a higher measured temperature than perimeter sheet/load edges due to increased ventilation contributing to more rapid heat loss. - Ink and ink-free areas will typically measure differently for sheet surface temperature, with saturated/high density (TAC) ink areas measuring highest. **Captive Delivery Pile Temperature** - Measuring the temperature of captive sheets in the delivery pile using a probe thermometer is a valid means of determining adequate heat exposure of the sheet in the drying tunnel.

	- A measured captive pile temperature of ~95F can help to ensure that adequate heat exposure by ink/coating films is achieved in the drying tunnel, as well as confirm adequate drying system performance and consistency. - While this temperature indicator is a helpful reference for drying system condition/settings, it does not ensure absolute success – the condition of the ink/coating films on the sheet will need to be evaluated by the Operator. - A balance between IR/HAK/EXT must be achieved to ensure that short-term setting of ink/coating films has progressed prior to the sheet being delivered. - Once the sheet has been delivered, the previous exposure in the drying tunnel as well as spray powder application will determine the efficiency and effectiveness of continued drying in the press load.
Drying Tunnel Temperature - Non-Production	- Most modern drying systems use a function of IR or HAK to maintain drying tunnel temperature during periods of press idle/non-production. - This feature is important to ensure that first sheets receive sufficient drying and avoid drastic increases in IR/HAK output during production starts and output fluctuations for extended periods when operated in an 'automatic' mode.
Automated Mode	- Locate drying system pyrometer above press delivery pile: • Pyrometer measures sheet surface temperature of sheets entering/landing onto the delivery pile. • Ensure that the drying system pyrometer is clean – observe manufacturer's recommendations for cleaning. - Determine desired drying system 'target' temperature value – drying system target value of 100 - 105F will typically achieve a captive delivery pile temperature of 90 - 95F measured with a probe thermometer. - Ensure that all drying system components are enabled/operational: • If applicable with the drying system, input correct IR format for sheet width. • If applicable with the drying system, input system parameters for upper/lower limits for IR and HAK output to create a window of operation that will minimize output fluctuation while achieving the target drying system temperature – this may require experience by operating the drying system in a 'manual mode' to determine optimum system settings based on the variables of press speed, substrate, ink/coating coverage. - During production, confirm that the drying system actual temperature achieves the target temperature value – observe stability of the actual temperature as well as consistency/fluctuation of drying system IR/HAK component output. - Correlate the actual drying system temperature with a handheld pyrometer and/or probe thermometer to confirm accuracy – delivery pile temperature measured using probe thermometer should be 90 - 95F. - The surface temperature of incoming sheets entering the delivery pile can typically measure 5 - 10F higher than the captive delivery pile temperature when using handheld pyrometer. - During production, observe drying system output of IR/HAK components and compare to the actual drying system temperature: • In cases where upper/lower limit parameters are not available for IR/HAK output, large fluctuations in system settings to achieve the target temperature value can occur resulting in sheets being produced with varying degrees of drying – this can result in areas within a single press load exhibiting different degrees of drying for inks/coating. • In cases where drying system output is erratic for IR/HAK, operating the drying system in a 'manual mode' may be necessary to ensure that all sheets are produced with a sufficient/constant amount of drying system exposure. • A press load that exhibits areas of different sheet jogging quality is an indication of extreme changes in drying system settings in an automated mode that results in varying degrees of drying exposure – dry sheets will jog into an even stack; wet sheets will not jog and have a very erratic jogging result. - Observe that 'pull sheets' exhibit good drying and short-term protection at drying system settings. - Based on drying performance observations, make necessary adjustments to the drying system target temperature value and upper/lower limit settings to optimize drying system performance while minimizing system output fluctuation to achieve a measured captive delivery pile temperature of 90 - 95F.
Manual Mode	- Determine the temperature measurement method for monitoring drying system operation: • Drying system pyrometer – measures incoming/entry sheet surface temperature. • Handheld pyrometer – measures incoming/entry sheet surface temperature and/or captive pile temperature.

	• Probe thermometer – measures delivery pile/captive-load temperature only.
	
	- Determine the desired target temperature to achieve adequate drying performance of ink/coating films.
	- An incoming sheet temperature of 100 - 105F and captive delivery pile temperature of 90 - 95F is considered a reliable temperature target – this should be correlated with actual ink/coating condition on the sheet.
	- If measuring both incoming sheet temperature and captive delivery pile temperature, it is always recommended to correlate both measurements to achieve a target captive delivery pile temperature of 90 - 95F to make both measurements interchangeable while maintaining the desired drying results.
	- Ensure that all drying system components are enabled/operational:
	  • If applicable with drying system, input correct IR format for sheet width.
	  • Preset all drying system components to an output that will closely reflect the desired temperature target based on the variables of press speed, substrate and ink/coating coverage.
	
	- During production, conduct temperature measurements and note results.
	  • Correlate drying condition of inks/coating on the sheet to the drying system settings and temperature results.
	  • Based on temperature measurement observations/trends, make necessary adjustments to IR/HAK output to target the desired delivery pile temperature.
	  • Continue making temperature measurements and necessary adjustments until the desired temperature is achieved – always observe/correlate drying performance of ink/coating films on the sheet to ensure successful drying results

Spray Powder	- Proper powder type and granule size are important based upon several factors:
	  • Substrate type/quality/smoothness/absorbency
	  • Single vs two-sided printing
	  • Ink type/characteristics
	  • Ink density/coverage (TAC)
	  • Coating formulation
	  • Drying system configuration/capability
	  • Additional surface applications – foil, film, UV coating, blister/heat-seal applications
	
	- Powder granule sizes ranging from 20 to 80 microns are available in organic and inorganic materials for use on a broad range of stock thicknesses from label to heavy paperboard.
	- Thicker/heavier substrates used for single-sided printing and stocks with inconsistent sheet caliper or irregular surfaces creating 'peaks and valleys' may require larger micron sized granules distributed in a high concentration to ensure that necessary separation is created between the sheets surfaces in the press load.
	- Thinner stocks used for two-sided printing may require smaller micron-sized granules with minimal distribution to the sheet to avoid printing blanket contamination during second side printing.
	- High quality spray powders are necessary to ensure that the granule size and shape are consistent to provide even distribution and effective separation of the sheets when in a stack.
	- As a practice, apply the least amount of powder to promote the most effective press load ventilation, separation and drying for ink/coating films.
	- Natural starch powders are the most common powder type used in the printing industry and are most desirable for their soft round shape and non-abrasive nature.
	- Starch powders are available in coated and uncoated versions depending on the application.
	- In-organic powder types such as calcium carbonate are available and have advantages due to the granule weight and that they do not clump or stick together – this powder type is very abrasive and not suitable for two sided applications.
	
	Coated Spray Powder
	- These powders are specially treated with a coating to make the powder particles resistant to absorbing water and hydrophobic/non-soluble in water.
	- Insolubility will allow the powder particles to retain their original shape and dimensional stability when being distributed over the surface of a wet/semi-dry waterbased coating film after the drying tunnel – this allows for optimum sheet separation in the press load to promote continued oxidative and evaporative drying of ink/coating films by air exchange/ventilation.
	- Coated powders are less likely to stick together and clump in the powder system or storage container, particularly in high humidity pressroom conditions.

- It is recommended to use coated powders in conditions where the 'short-term' drying of waterbased coating is not optimum or when evaporation is the only means of drying on non-absorbent substrates.
- Coated powders are recommended for substrates that have a highly irregular surface with 'peak and valleys' or stocks that have caliper inconsistencies.
- Coated powders can enhance/increase the slip of printed sheets/cartons.

Uncoated Spray Powder

- These powders are untreated and are hydrophilic/water-soluble and will absorb water when in contact.
- Due to water absorption, uncoated powder will tend to breakdown when contacting wet or semi-dry films of waterbased coating in the drying tunnel.
- As the powder particle absorbs water and breaks-down, the ability to create necessary space between the sheets in the press load to provide ventilation for continued oxidative/evaporative drying of inks/coating films will be reduced.
- Uncoated powders are only recommended when very good short-term drying can be achieved in the drying tunnel prior to sheet delivery, or with substrates with high absorbency where evaporative drying can be reduced.

Calcium Spray Powder

- These powders tend to be more uniform in size as they are easier to sort.
- A higher percentage of powder can land on the sheet surface due to the increased particle weight compared to starch powders.
- These powders are very abrasive and can contribute to scratching of the printed surface and contamination and degradation of printing plates during two-sided applications.

Drying System Checklist

- ☐ IR bulbs are functioning
- ☐ IR bulbs and reflectors are cleaned
- ☐ IR bulbs have <5000 hours operational hours
- ☐ IR bulb wavelength output has been confirmed – short, medium, combination short-medium
- ☐ HAK blowers are functioning
- ☐ HAK heating elements are functioning
- ☐ HAK supply hoses have no restrictions/obstructions – holes, kinks, collapsed, clogged
- ☐ HAK slots/nozzles are open and clear
- ☐ HAK incoming air filters are clean
- ☐ Air-Extraction is functioning
- ☐ Air-Extraction hoses have no restrictions/obstructions – holes, kinks, collapsed, clogged
- ☐ Air-Extraction volume is sufficient
- ☐ Correct powder type/size is being used for job conditions
- ☐ Powder device is functioning
- ☐ Powder device hoses and nozzles are clean
- ☐ Powder device supply air pump filter is clean
- ☐ Powder device test has been conducted
- ☐ Test powder device:
    - Print full-size sheet with complete black solid ink coverage with powder applied and observe sheet surface for complete powder coverage by side-illumination, OR place full-size sheet printed complete with black solid ink beneath powder device nozzles and active 'test' mode to distribute powder over the sheet surface and observe for individual nozzle performance.