Drying Technology Update: Meeting the Demands of Emerging Markets

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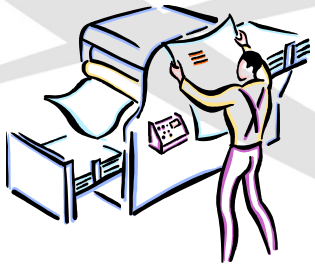
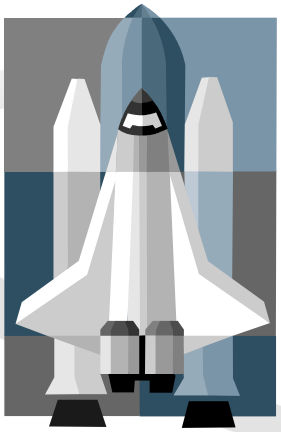
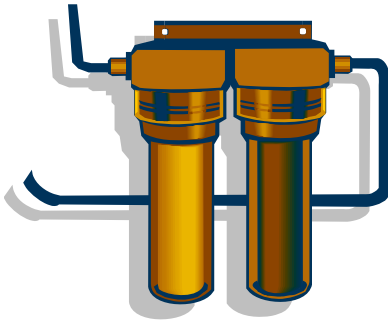
MEGTEC Systems

The bottom line is process knowledge

Defining Emerging Markets

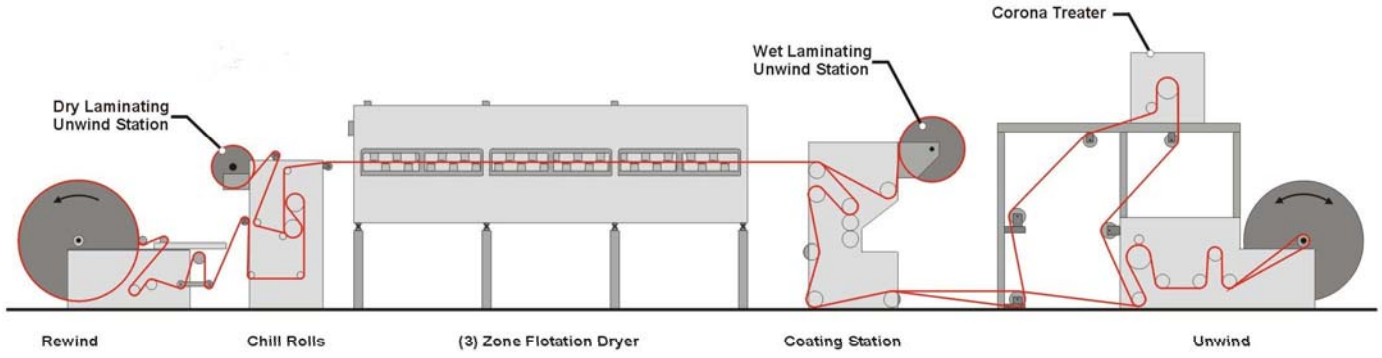
New or fast changing business segments that are either growing rapidly or show promise of rapid growth in the near future. Examples include:

Renewable Energy, Digital Printing, Advanced Composite Materials, Advanced Filtration, Metered Product Delivery Systems (Pharmaceutical & Consumer Products)

Common Needs for All Emerging Markets

- Projects Usually Joint Development Oriented
  - Advanced Modeling (CFD & Dryer Thermodynamics)
  - Identification of Process & Production Variables
  - Identification of Product Performance Specs
  - Design of Experiments (DOE)
  - Lab Trials



Emerging Markets Product Groupings

- **Webs Requiring Simultaneous Thermal and Mechanical Manipulation of the Substrate**
  - **Solar Films (photovoltaic cells etc)**
  - **Dielectric Films (batteries etc)**
  - **Synthetic Fabrics (performance clothing)**
- **Webs that Change Physical or Structural Form Independent of Mechanical Control**
  - **Foams (vibration dampeners, insulators etc)**
  - **Vinyl Tapes (wound dressings etc)**
  - **Advanced Composites (structural forming tapes etc)**

Emerging Markets Product Groupings

- **Webs or Non-webs that are Dried or Cured on Carrier Webs or Belts**
  - **Cast Films (triacetate etc)**
  - **Membrane Materials (micro-filtration etc)**
  - **Edible Films (breath strips etc)**
  - **Specialty Films (water-soluble packaging etc)**
- **Webs that are Two-Side Coated**
  - **Printed Materials (digital printing etc)**
  - **Advanced Electronic Materials (battery cells etc)**
  - **Printed Electronics (RFID labels etc)**

Emerging Markets Product Groupings

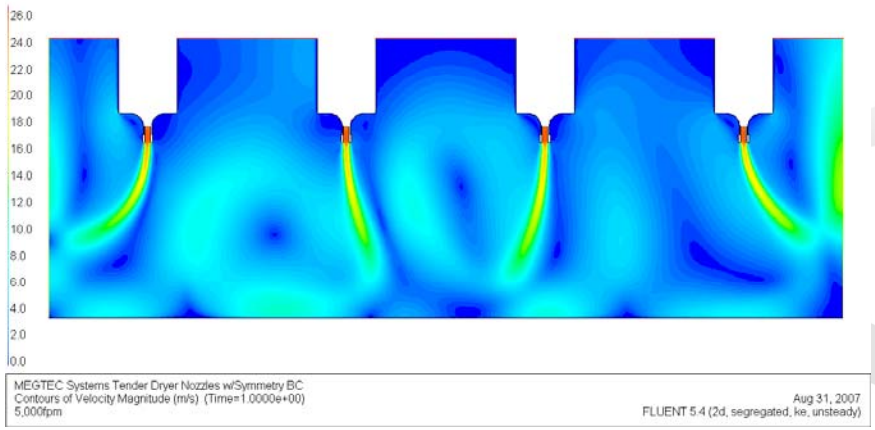
- **Webs with Active Coatings or Coatings with Performance Characteristics that are Directly Controlled by the Drying or Curing Process**
  - **Pharmaceutical Webs (transdermal patches, diagnostic test strips etc)**
  - **Performance Labels (temperature sensitive labels etc)**

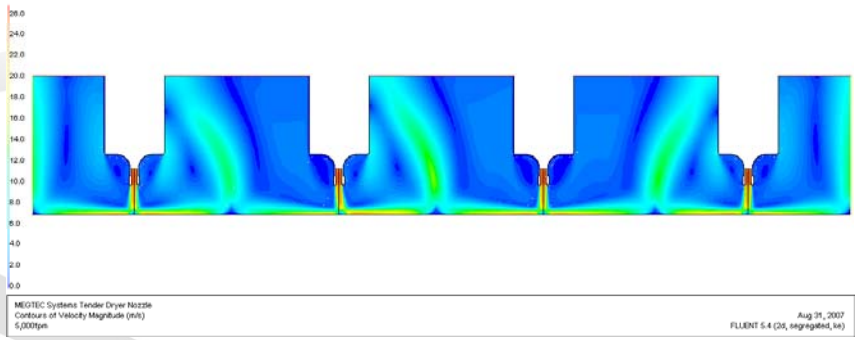
Webs Requiring Simultaneous Thermal and Mechanical Manipulation

- **Application Challenges**
  - **Tenter-frame style dryers keep web in tension in both the TD and MD risking potential non-uniform substrate thickness if dryer airflow temperature and velocity are not uniform**
  - **Certain coatings are prone to off-gassing during the drying process which can lead to solvent condensation on colder internal surfaces**
  - **Thin films can be difficult to stretch and control**

Webs Requiring Simultaneous Thermal and Mechanical Manipulation

- **Technology Solutions**
  - **Selection of optimum nozzle geometry and nozzle to web clearance is critical to insure velocity and temperature uniformity**





Webs Requiring Simultaneous Thermal and Mechanical Manipulation

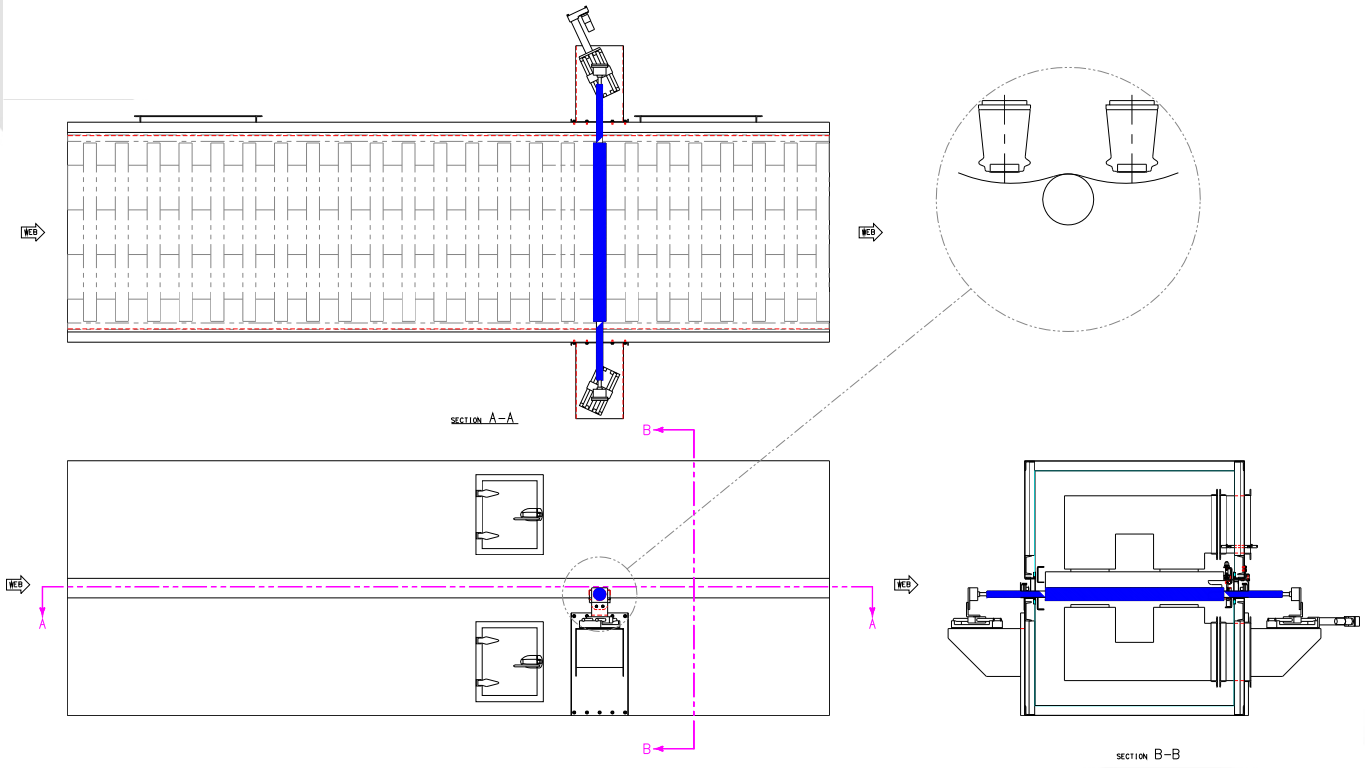
- **Technology Solutions**
  - **TD and MD IR sensor arrays provide feedback for maintaining uniform heat transfer**
    - **➔Heat transfer = Time, Temperature and Turbulence**
    - **➔Dryer zoning gives further adjustment flexibility**
  - **Internal dryer plenums, return air ductwork and nozzle headers can be insulated to minimize heat loss when tight temperature control tolerances are required**

Webs that Change Form During the Drying Process (independent of mechanical control)

- Application Challenges
  - Extensible films can cause web handling issues
  - Coatings can be sensitive to air flow
  - Entering materials can be dimensionally non-uniform
  - For some webs, hygroscopic effects can result in dimensional instability (curl, swelling, sheet growth etc)

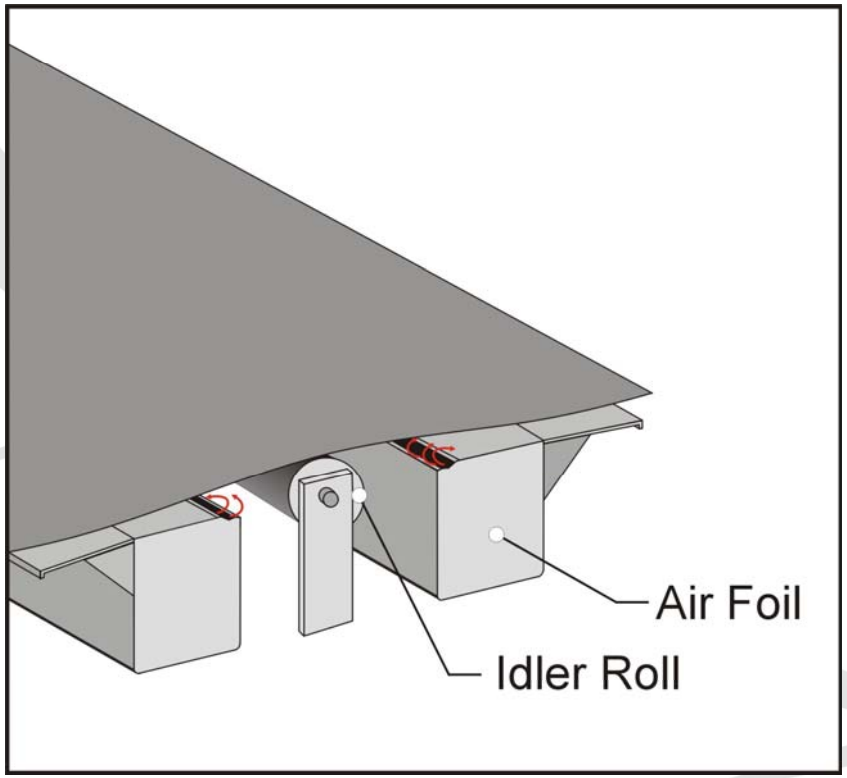
Webs that Change Form During the Drying Process (independent of mechanical control)

- **Technology Solutions**
  - **Dryer length must be increased to handle extensible films**



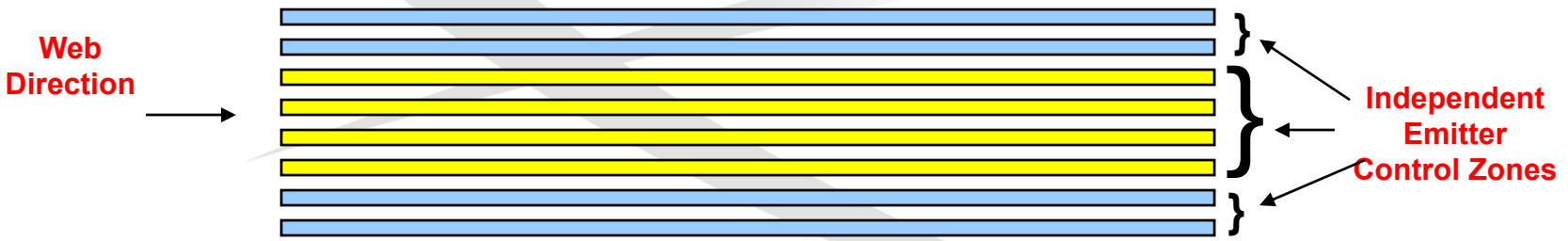
Webs that Change Form During the Drying Process (independent of mechanical control)

- **Technology Solutions**
  - **Unique nozzle configurations for webs that exhibit extensible mechanical behavior**



Webs that Change Form During the Drying Process (independent of mechanical control)

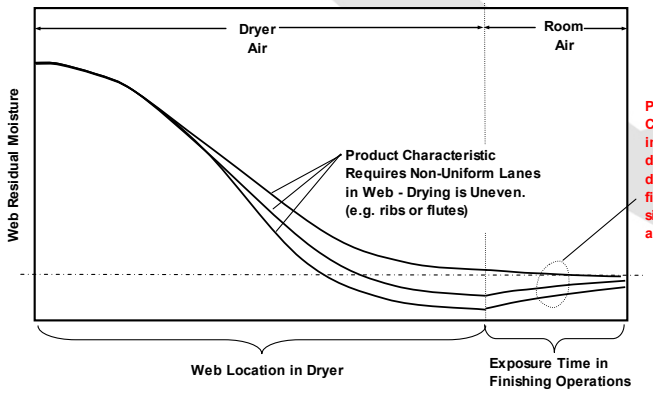
- **Technology Solutions**
  - **For webs requiring tight TM temperature control, MD IR emitter arrays can be used to allow for cross machine temperature profiling**



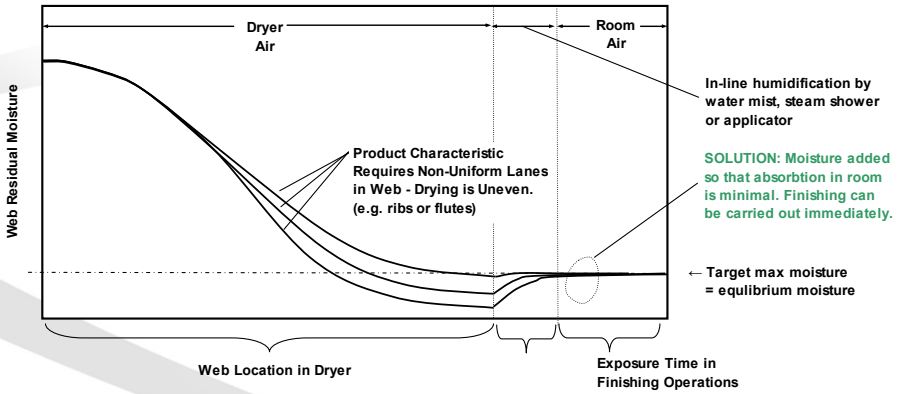
Webs that Change Form During the Drying Process (independent of mechanical control)

- **Technology Solutions**
  - **Certain hygroscopic substrates may require remoisturization to eliminate or minimize dimensional instability**

Hygroscopic Behavior of a Non-uniform Web Product
Case 1: Dry in Oven and Finish without Conditioning



Hygroscopic Behavior of a Non-uniform Web Product
Case 2: Dry in Oven and Finish after Conditioning



Webs/Non-Webs Dried on Carrier Webs or Belts

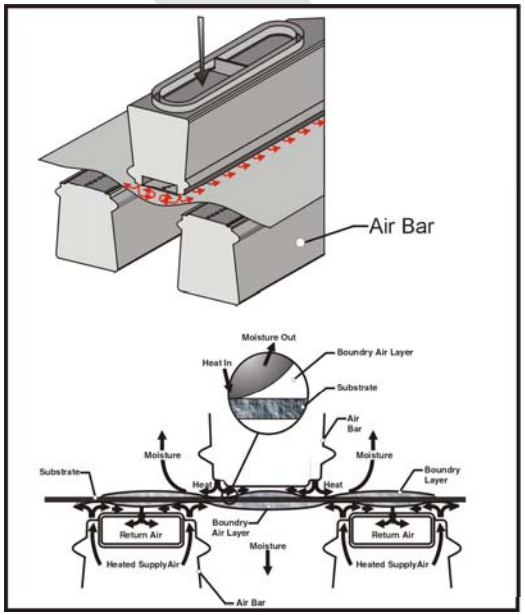
- Application Challenges
  - Controlling the rate and duration of chemical reactions to achieve specific performance
  - Controlling dimensional stability
  - Managing drying rates and dryer humidity

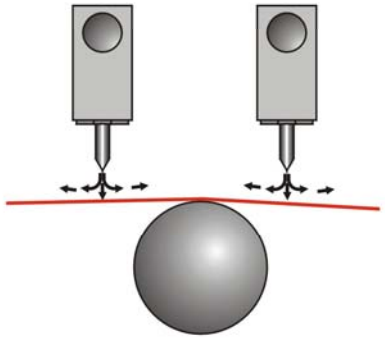
Webs/Non-Webs Dried on Carrier Webs or Belts

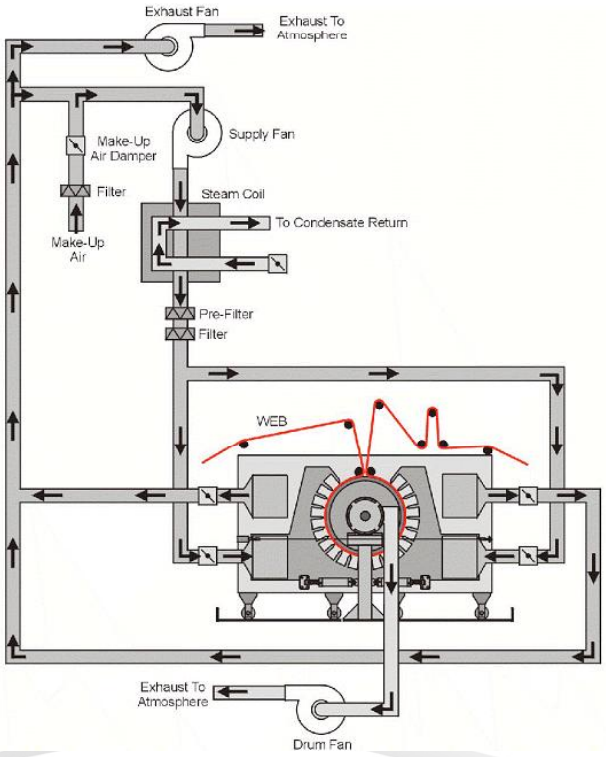
- Technology Solutions
  - High accuracy solvent concentration or humidity sensors can be positioned inside the drying chamber and MUA ductwork
  - Dehumidification of process MUA may be necessary
  - Clean room construction inside and outside of the dryer is often a requirement for FDA regulated processes where cleanability is a requirement

Webs/Non-Webs Dried on Carrier Webs or Belts

- **Technology Solutions**
  - **For some webs that are prone to hygroscopic effects that create curl, adding curvature to the web path may be necessary**

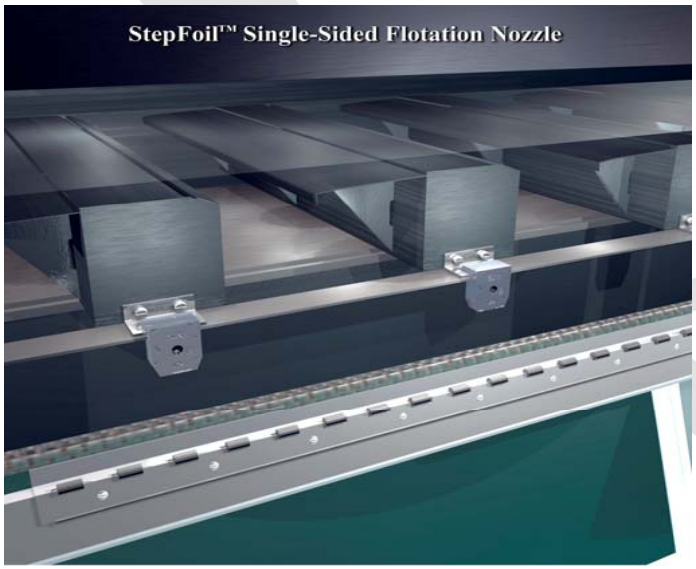


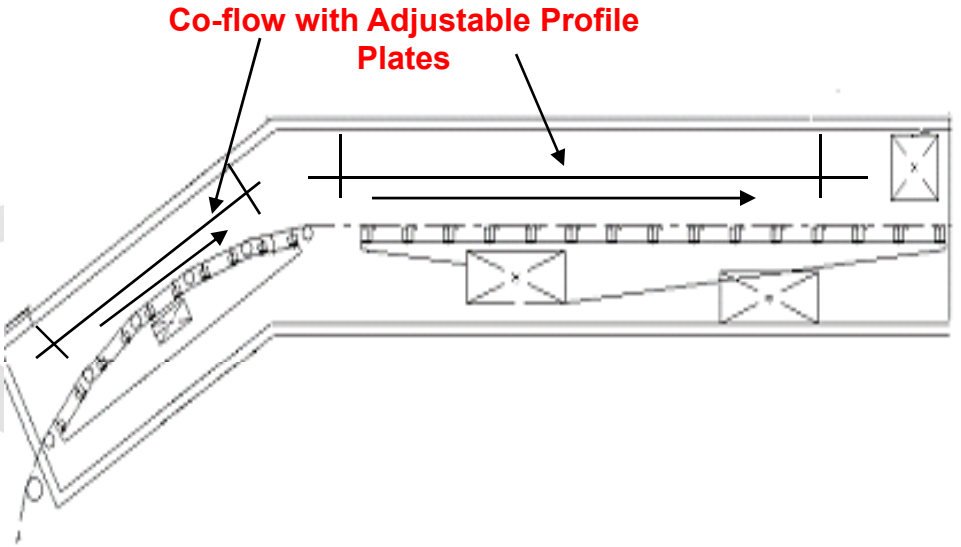




Webs/Non-Webs Dried on Carrier Webs or Belts

- **Technology Solutions**
  - **Precise control of airflow and impingement may be necessary to prevent active coatings from being upset or redistributed**





Webs that are Two-Side Coated

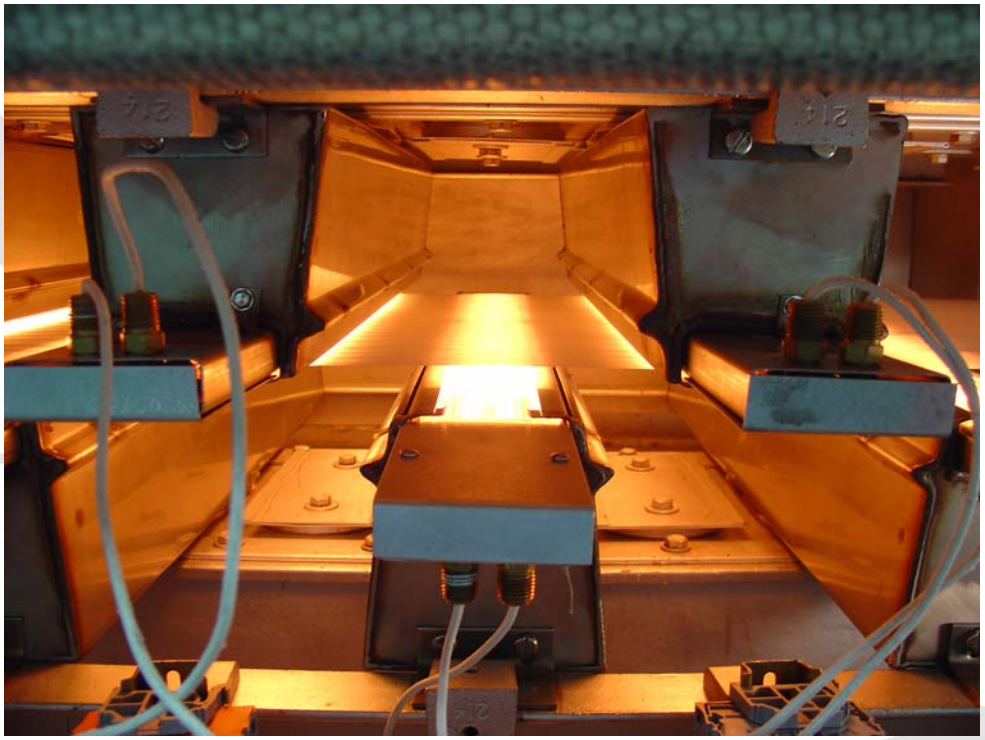
- Application Challenges
  - Thick coatings applied to thin substrate must often be dried slowly due to diffusion limitations
  - Some end products must have extremely low residual solvent content (<0.5%)
  - Recirculation air humidity can create product defects or impede drying
  - Large variations in coat weights common in digital printing applications require a wide range of drying capacity

Webs that are Two-Side Coated

- **Technology Solution**
  - **Long dryers with multiple zones are often used to maximize throughput while controlling drying rates zone-by-zone in accordance with diffusion limits**
  - **Continuous monitoring of web temperature or moisture along with Statistical Process Control methods can help sustain meeting difficult end moisture targets**
  - **Dryer humidity/solvent controls are sometimes necessary to meet low residual requirements in temperature sensitive products, especially in later zones**

Webs that are Two-Side Coated

- **Technology Solution**
  - **Combination air flotation/IR air bars can be used to expand heat transfer capability in a modular fashion to cover a wide drying range**



Webs with Active Coatings Controlled in Part by The Drying Process

- **Application Challenges**
  - **Defining process parameters is often a matter of empirical testing**
  - **Repeatability is critical since slight changes in thermal air management can result in undesirable changes in product performance**
  - **FDA regulation often guide equipment construction methods**

Webs with Active Coatings Controlled in Part by The Drying Process

- **Technology Solution**
  - **Clean room construction for cleanability and to minimize contamination**
  - **Vibration dampening of fans, flanges and support structure may be needed for vibration sensitive coatings**
  - **Activated coatings often require a controlled temperature and vapor pressure environment to maximize the functionality (e.g. pore structure and chemical activity) of the active layer**

Summary

- Emerging market are creating shifts in demand
  - Satisfying rapid increases in demand
  - Shifts in range of performance
  - Cost reduction to meet economic viability of new products
  - Generation of completely new products
- Joint product development or lab trials common
  - Design, development, testing, and optimization are the challenges of the day

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Thank You