Forced Air Convection Drying...

What is State of the Art?
Evolution of Convection Drying

- Natural convection (heat flows to cold)
- Hot air convection ovens
  - Hot boxes give way to forced air convection (higher heat transfer)
- Forced air convection drying has been in wide use in the printing and converting industries for more than a century
- Web support methods
  - Drag bars
  - Idler rolls
  - Opposed nozzles (+ high tension)
  - Sinusoidal Flotation since late ‘60s
The American Heritage® Dictionary of the English Language, Fourth Edition defines “State of the Art” as:

“The highest level of development, as of a device, technique, or scientific field, achieved at a particular time.”
Expanded Definition

For the printing and converting industry, SOTA forced convection drying is more about...

the synthesis and application of existing drying methods and technologies into process specific solutions.

than...

new hardware or software advancements.
Web Handling

Roll Support Technology

Effective, single-side coating or print drying at relatively low cost

- Typical dryer configuration
  - Live shaft idler rolls, driven by web contact or…
  - Driven or tendency driven rolls for sensitive webs
  - Arched roll path (2-5° wrap)
  - Chrome-plated steel or aluminum alloy roll construction depending on temperature, web width, line speed etc.
Web Handling

Roll Support Technology

Typical Tendency Driven Arched Roll Support Dryer Configuration
SOTA – Web Handling

**SOTA roll support dryer features**

- Flat-path roll configurations

- Impingement induced
- Airfoil draw
- Direct vacuum draw
SOTA – Web Handling

**SOTA roll support dryer features**

- Low inertia roll construction

Extruded rolls versus plugged ends help to reduce mass
SOTA – Web Handling

SOTA roll support dryer features

- Individual servo-motor driven idler rolls for more precise control of drive speed (e.g. for applications involving extensible webs)

- Lightweight, low deflection, carbon-fiber composite rolls (generally for operating temperatures less than 200° F). Particularly useful for extremely wide webs and in high-speed applications.

- Solid-lube bearings for high temperature applications or PTFE sleeve type bearings for clean-room applications where graphite could create particulate dust.
Web Handling

Air Flotation Technology

Non-contact web handling for two-sided coating and print drying and for sensitive webs

- Typical dryer configuration
  - Alternating, top and bottom side Coanda air bars or…
  - Single-side (normally beneath the web) airfoils
  - Sinusoidal wave pattern in a flat web path
Web Handling

Air Flotation Technology

Two-sided air flotation

The “Coanda” effect
Web Handling

Air Flotation Technology

Single-sided air flotation
SOTA – Web Handling

**SOTA flotation dryer features**

- Application specific nozzle types
SOTA – Web Handling

**SOTA flotation dryer features**

- High heat transfer nozzle configuration
SOTA – Web Handling

**SOTA flotation dryer features**

- Mid-dryer steering
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SOTA flotation dryer features

- Advanced airfoil designs
- Dual slot design
- Adjustable wing design
SOTA – Web Handling

SOTA flotation dryer features

- Accumulator dryers
Air Handling

Air Handling Components

- Fans
- Plenums
- Air distribution headers
- Nozzles/air bars
- Interconnecting ductwork
SOTA - Air Handling

- Remote Air Handling Systems

Cross-machine exhaust header

Tapered, finger-style air supply header

Adequate Exhaust Relief Area

Tapered supply air distribution duct

Air distribution uniformity is critical to both heat transfer and web handling
SOTA - Air Handling

- Integrated Air Handling Systems

Supply Air

Make-Up-Air

Return Air

Exhaust Air
SOTA - Air Handling

- Unique Quiet Zone Configurations

Single-side web support with co-flow or counter-flow above the web

Single-side web support with retractable header with dilution air bars
SOTA - Air Handling

- Plug-style fans and multi-blade dampers

Low profile fans save space

Multi-blade dampers for more finite volume control
SOTA - Air Handling

- Other Air Handling Features
  - Spark resistant fans
  - Individually dampered nozzles
  - Automated air supply header retraction
  - Computer modeling (Computational Fluid Dynamics)
  - Tapered (cross-machine direction) nozzles for end fed designs
Heat Sources

**Commonly Used Heat Sources**

- Direct and semi-indirect gas fired burners
- Thermal oil, water or steam coils
- Air to air heat exchangers
- Electrical resistance coils
SOTA - Heat Sources

- Dryers with integrated pollution controls
SOTA - Heat Sources

- Closed-loop heat recovery systems
- Modular gas train components
- Low Nox burners
- Advanced thermal fluids
Control Systems

**Commonly Used Controls**

- Relay logic with discrete temperature controllers
- Manual dampers
- Fixed speed fans
- Flame safeguards
- Pressure indicators
SOTA - Control Systems

- PLC or PC based systems with
  - Pressure transmitters
  - RTD temperature probes
  - Automated dampers
  - Variable Speed Fans
  - Web temperature, humidity, LEL sensors
  - Temperature compensating web guiding sensors
SOTA - Control Systems

Recipe control through PLC improves repeatability
### SOTA - Control Systems

Fault indication and logging facilitate maintenance and troubleshooting.

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Fault indication and logging facilitate maintenance and troubleshooting.
SOTA - Control Systems

Reactive Control – Web temperature sensor controlling burner
SOTA - Control Systems

Reactive Control – Web moisture sensor controlling burner
SOTA - Control Systems

Reactive Control – Humidity sensor controlling exhaust rate
SOTA - Control Systems

- Other SOTA controls
  - Data logging
  - Fan and bearing temperature & vibration monitoring
  - Modem service support and program downloads
  - PLC announced maintenance schedules
Misc. SOTA Design Features

- Dryer enclosure retraction systems
Misc. SOTA Design Features

- Removable nozzles
- Clean room construction techniques
  - Continuous seam welded construction (robotic)
  - Ground and polished welds
- IR/convection hybrids
- Computer modeling software for sizing and performance prediction
Summary

- The State of *your* art is as important as the State of *the* art when it comes to forced convection air drying technology.

- Engineering *process knowledge should drive* the application of available convection drying *technology* to meet your specific process needs.
MEGTEC Systems

Thank You
BACK TO LIST