Beyond the Barriers of Performance Through Sound™

Spectra HE™
Heat and Mass Transfer Technology

AIMCAL Presentation
Briefly about the company:

- 1996
- US based
- Initially Pulse Combustion
  - Paper processing
  - Water Heating
  - Industrial Boilers
  - Heavy Drying and Curing
- Latest Ultrasonic Mass Transfer
- Patents
  - US 4 with 1 pending
  - International 1 pending
HTI has created a line of products that use acoustic pulsations for mass transfer (heating, cooling, drying) using electric and pneumatic means.

The Spectra HE™ Ultra Drying System has been successfully applied to:

- Converting Industry
- Paper Processing
- Resins and Films
- Printed Electronics
- Food Processing
Technology Advantages:

- Advanced Heat and Mass Transfer Rates (2-4 times faster) = Increased Line Speed
- Less energy required (50-75% less energy)
- Less plant air (1/3 to ½ when compared with standard systems)
- Comparable or lower process air temperature (statistically 75 F/40°C lower)
- Low in maintenance
- Shorter footprint
- Less scrap material
Acoustic VS Standard Mode Of Heat and Mass Transfer

Acoustic Mode

- Hot Airflow onto pan of Dry Ice
- Same airflow and air temperature

Standard - Steady State Mode
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• See it for yourself:

![Image of ice cubes]
Theoretically, one can describe the processes occurred in our dryer by the various derivations of Navier-Stokes equation below:

\[ \rho \left( \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla p + \nabla \cdot \mathbf{T} + \mathbf{f}, \]

Where \( \mathbf{V} \) is the flow velocity, \( \rho \) is the fluid density, \( p \) is the pressure, \( \mathbf{T} \) is the deviatory stress tensor, and \( \mathbf{f} \) represents body forces (per unit volume) acting on the fluid and \( \nabla \) is the del operator.
Here is our solution to this equation: a dog whistle.
Process Management System (PMS) controls following variables to optimize the function of the acoustic module:

1) Temperature
2) Volume of Supply Air
3) Acoustic Energy
4) Web Speed
Effect of Sound on Smoke in Sealed Box (No Air is Mechanically Introduced)

Time 0:00 seconds

Time 1:00 second

Time 2:00 seconds

Time 3:00 seconds
• Here is what happens with a solvent when things are right:
The acoustic booster section consists of the following:

- One or more drying/curing sections or zones
- Exhaust (if needed)
- Control panel
- Electric Heater
- Regenerative Blower
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Photo of a single drying station for 26” (660 mm) wide web.
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• These photos show a 50” (1.27m) long dryer – replacement of a 56ft (17.36m) long traditional dryer for heavy coating applications
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- This dryer fully replaced a 56ft (17.36m) long dryer at maximum loads and speeds with 13% of the energy if compared with existing dryer.
A. Cold Seal Adhesives:

*Goal – improve line speeds to recover efficiencies*

<table>
<thead>
<tr>
<th></th>
<th>Dryer Length</th>
<th>Line Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current System</td>
<td>40 ft (12 m)</td>
<td>400 fps (120 m/min)</td>
</tr>
<tr>
<td>Acoustic Energy</td>
<td>26” (0.66m)</td>
<td>1300 fps (400 m/min)</td>
</tr>
</tbody>
</table>

- No “intrusion” into main oven/dryer section was needed
- Increase in line speed 900 fps
- Effectively tripled asset output
B. Rotogravure Printing on Metalized Substrates:

*Goal – replace solvent inks with water based inks at the solvent line speeds*

<table>
<thead>
<tr>
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<th>Line Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current System</td>
<td>40 ft (12.4 m)</td>
<td>110 fpm (34.1 m/min)</td>
</tr>
<tr>
<td>Acoustic Energy</td>
<td>4 ft (1.24m)</td>
<td>750 fpm (232.5 m/min)</td>
</tr>
</tbody>
</table>

- No “intrusion” into main oven/dryer section was needed
- Increase in line speed 640 fpm almost 7 times
- ROI on ink savings alone
## Acoustic System Case Studies

### C. Heavy Coatings, Edible Films

**Goal – to Double the Throughput**

Heavy coating - up to 2 mils, water based coating(s), 50-60% solids

<table>
<thead>
<tr>
<th></th>
<th>Dryer Length</th>
<th>Energy Consumption</th>
<th>Line Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current System</strong></td>
<td>210 ft (65.1m)</td>
<td>1.2 MW</td>
<td>20 fpm (6.2m/min)</td>
</tr>
<tr>
<td><strong>Acoustic Energy</strong></td>
<td>25 ft (7.75m)</td>
<td>0.3 MW</td>
<td>40 fpm (12.4m/min)</td>
</tr>
</tbody>
</table>

- Smaller Foot Print (88% less)
- Increase in speed (100%)
- Decrease in energy consumption by 75%
- Improved surface properties

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D. Moisture Control, Paper Tempering

*Goal – eliminate variability to optimize run speed and quality of print*

Paper based flexible packaging structure; 5-7% residual moisture in board; loss of one color deck on press

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<th>Dryer Length</th>
<th>Line Speed</th>
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</thead>
<tbody>
<tr>
<td>Current System</td>
<td>Entire color station</td>
<td>500 fpm (152 m/min)</td>
</tr>
<tr>
<td>Acoustic Energy</td>
<td>16” (0.4 m)</td>
<td>1,000 fpm (305 m/min)</td>
</tr>
</tbody>
</table>

- Increase in speed (100%)
- Restore press to full color station capability
- Moisture control achieved at 3% constant
Acoustic System Case Studies

E. PSA Material

*Goal – boost line speed to maximum of press*

5.15 g/m² dry weight; 35% solids; unable to dry at press speed

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<th>Line Speed</th>
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<tbody>
<tr>
<td>Current System</td>
<td>19 ft (m)</td>
<td>800 fpm (244 m/min)</td>
</tr>
<tr>
<td>Acoustic Energy</td>
<td>18 in (0.45 m)</td>
<td>1,000 fpm (304 m/min)</td>
</tr>
</tbody>
</table>

- Increase in speed (25%) with spare capacity
- Total of 57 kW for solution
F. Pattern Water Based Adhesive

*Goal – boost line speed to maximum of press; lower energy consumption*

3.25 g/m² dry weight; 40% solids; IR station + traditional dryer

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<thead>
<tr>
<th></th>
<th>Dryer Length</th>
<th>Power (installed)</th>
<th>Line Speed</th>
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<tbody>
<tr>
<td>Current System</td>
<td>24 in (0.6 in)</td>
<td>75 kW</td>
<td>500 fpm (152 m/min)</td>
</tr>
<tr>
<td>Acoustic Energy</td>
<td>24 in (0.6 m)</td>
<td>40 kW</td>
<td>650 fpm (198 m/min)</td>
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</tbody>
</table>

- Increase in speed (30%)
- Elimination of IR system (20% energy reduction)
- Improved finished properties of material
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• If tube is your process, and a confetti is a boundary layer, this is what our technology does to the boundary layer on a micro scale:
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Typical project sequence.

- Presentation
- Design Basics, Product Samples
- Budgetary Estimate
- Customer Paid Trials at Our Facility (costs creditable towards production scale PO)
- Preparation of the proposal
- Execution of the contract
Thank You.

We welcome the opportunity to fully discuss your application under complete confidentiality.

For more information please contact us at 770-804-9309, or by email at gplaynik@heattechnologiesinc.com