Optimized Cross Direction Control of Weight and Porosity

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Introduction

• One actuator affects multiple sheet properties
• Multiple actuators affect one sheet property
  - Slice lip → weight, moisture & caliper
• Cross Direction Multivariable Predictive Control
  - Optimal coordination of multiple actuators affecting multiple sheet properties
• Porosity & Basis Weight are highly coupled
  - Sack grades
  - Coated base stock
  - Cigarette papers
• Before 2005 no reliable on-line CD sensor available
• Cigarette paper manufacturer implements both
  - CD-MPC
  - Scanning on-line porosity measurement
Porosity Sensor

- Measurement of airflow correlates to sheet porosity
- Utilizes contact vacuum and measurement vacuum
  - Grade independent measurements result
Multivariable Process Identification

<table>
<thead>
<tr>
<th>Dry Weight</th>
<th>Porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain = 0.0102 gm^{-2}/µm</td>
<td>Gain = 0.0408 Coresta/µm</td>
</tr>
<tr>
<td>Width = 196 mm</td>
<td>Width = 154 mm</td>
</tr>
<tr>
<td>Attenuation = 1.20</td>
<td>Attenuation = 1.20</td>
</tr>
<tr>
<td>Divergence = 0.00</td>
<td>Divergence = 0.30</td>
</tr>
<tr>
<td>Time Constant = 24 s</td>
<td>Time Constant = 36 s</td>
</tr>
<tr>
<td>Time Delay = 26 s</td>
<td>Time Delay = 26 s</td>
</tr>
</tbody>
</table>
Multivariable Tuner
Performance Prediction
Control Scenario Results

**Basis Weight (g/m²)** | Traditional 2σ/%Proc. | CD-MPC 2σ/%Proc. | Delta
---|---|---|---
24 | 0.49 2.10% | 0.56 2.37% | 14%
25 | 0.27 1.11% | 0.29 1.19% | 7%
26 | 0.21 0.86% | 0.23 0.93% | 10%

**Porosity (Coresta)** | Traditional 2σ/%Proc. | CD-MPC 2σ/%Proc. | Delta
---|---|---|---
30 | 1.04 2.94% | 0.77 2.25% | -26%
45 | 1.22 2.42% | 0.84 1.79% | -25%
80 | 1.19 1.48% | 0.93 1.21% | -22%
Conclusions

• Porosity critical grades benefit from
  - Scanning porosity measurement
  - Cross Direction Multivariable Predictive Control (CD-MPC)

• Optimization of Dry Weight and Porosity achieved
  - Utilizing a single actuator – the slice lip

• Documented improvements over traditional control

• Benefits available for all porosity sensitive grades