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Innovative Drying Methods for the Paper Industry
High Capacity Gas-Fired Drum Dryer

Energy Solution Center
Technology and Market Assessment Forum
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Brooklyn, NY
Drum Drying

- Paper
- Food
- Textile
- Pharmaceutical
- Chemicals

The first effort was devoted to Papermaking
Paper Drying

\[ Q = U \cdot A \cdot (T_s - T_p) \]

\[ M = m \cdot A \cdot (P_s - P_a) \]
To increase the production capacity the dryer-limited paper mill has to extend the building and/or upgrade the boiler facility.
Gas-Fired Drum Dryer

Brief development history

- 2000 - initial meetings with GTI
  - Patented design
  - Application selection
- 2003-2004 - first phase at WMU pilot plant
  - Pilot-scale unit
  - Western Michigan University Pilot Paper Plant
- 2006-2007 - full-scale diameter test rig
  - Full-scale single section
  - Showcase for papermakers
- 2009 – installation of full size commercial unit
A standard steam heated cast iron dryer cylinder is replaced by a cylinder which is heated by a gas ribbon burner. The net effect is a higher surface temperature which results in more drying capacity in the same space.

One gas fired paper dryer = 2-3 steam heated dryers
Why a Gas-Fired Dryer?

- One gas-fired drum is expected to replace 2-3 conventional steam-heated cans due to a much higher drying rate.
- Increase in production rate (10-20%) without extension of paper machine length or building.
- Elimination of ASME pressure vessel criteria and simplified combustion system reduces overall weight and maintenance of the system.
- Reduced demand for steam.
- Increased overall energy efficiency from 60-65% (steam) to 80-95% (gas-fired).
- Reduced emissions of nitrogen oxides (NO$_x$).
- Applicable to both new and retrofit applications.
GFPD Design Concept

- Combustion in cylindrical annulus
- Ribbon burner forms a flame sheet
- Advanced heat transfer enhancement
- Flue gas recuperation
- Flue gas recirculation into flame root

US Patent 6,877,979
HC-511 TRIPLE SLOT BURNER
Pilot-Scale Testing Layout
Low-Firing at WMU Pilot Plant

unlock the potential
Burner Inspection
Major Pilot-Scale Findings

> Drum surface temperature up to 500°F
  - Conventional steam-heated can is 350°F limited

- NOx emission is less than 50 vppm
  - Steam supply facility produces about 100 vppm

- High combustion stability in tested range

- Overall thermal efficiency is 70-75%
  - Conventional steam-heated can ~ 60-65%

- TAPPI drying rate at 450°F is 6-8 lbs/hr/ft²
  - WMU pilot-scale machine steam can ~ 1 lbs/hr/ft²
Full-Scale Drum Dryer Unit
Burner Unit
GFPD Burner in Operation

- Nominal firing rate per GFPD section is 1.2 MMBtu/hr
- Variable gaseous fuels (natural gas, propane, syngas, landfill gas, etc.)
- CO: 22-34 vppm
- NO\textsubscript{X}: 58-69 vppm
Air/Fuel Gas Control Skid
Flynn Combustion System

- System meets US and Canadian standards & is CE compliant
- electronic spark ignition & flame supervision
- combustion air pressure switch
- exhaust fan pressure switch
- high & low gas pressure switch
TAPPI Drying Rate

Typical Board Grade Drying Rate

Graph showing the relationship between Drum Surface Temperature, F, and Drying rate, lb/hr/ft², for Full-scale unit (GL&V) and Pilot-scale unit (WMU).
Major Full-Scale Findings

- Production rate increase: 10-20%
- Thermal efficiency: > 70%
- Overall efficiency
  (with internal flue gas recuperation): 80-85%
  (with flue gas using a PV system): 90-95%
- Energy savings (5% retrofit): $5 \times 10^{12}$ Btu
- Low NO$_X$ operation: < 50 vppm
- Emission credit (NOx): 700 ton/yr
- Various fuels used: gas/liquid
- Payback period: < 1 year (aided by reduced capital cost)
Marketing Strategy

- Paper
  - Paper mills making board grades (which tolerate the higher surface temperatures)
  - Machines that are currently limited in production due to steam availability

- Food
  - Contact major processors to determine requirements
Marketing Challenges

- Need a situation that it makes financial sense
- Traditional industry very cautious of new technology
Paper Industry Analysis

- 229 interviews by The Martec Group:
  - Paper = 45%
    (20 – 49 lbs/3000)
  - Paperboard = 55%
    (30 – 60 lbs/1000)
  - Range = 1 – 9 machines
  - Sum = 455 machines
Primary Bottlenecks

- 29% Dryer limited
- 23% Machine speed limited
- 15% Wet-end pump/former
- 14% Pulp limited
- 7% Press capacity
- 3% Market limited
- 3% Steam limited

RE: GRI-96/0087
Machine Capacity Increase

33% - Add drying capacity:
  - dryer cans - 20%;
  - IR dryers - 7%;
  - steam boxes - 6%

27% - Upgrading drive shaft
14% - Add/replace presses
14% - Upgrade wet-end pump/formers
12% - Improve drainage
  9% - Increase pulp capacity/supply
  7% - Add new/better machines

Sum is greater than 100% due to more than one response
Competitive Advantage

- Team members experience
- Relatively small, flexible companies
Case Study

- ConAgra Foods
- Project was justified by reduction of property
- Two drums replaced by one
Machine Configuration
Results

- Product quality improved substantially
- Increased production even with one drum
- Close down of dormant property
What Do We Want?

- To commercialize the technology 
  [we need co-funding for marketing and showcasing]
- Identification of customers
Contact Us

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