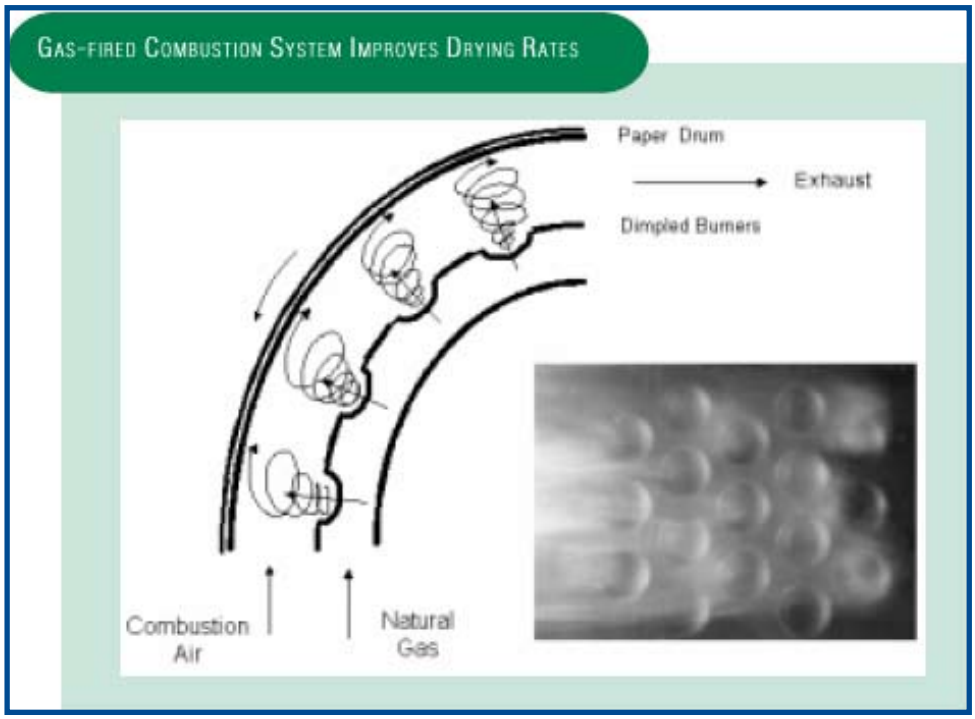
# Laboratory Development of High-capacity, Gas-fired Paper Dryer

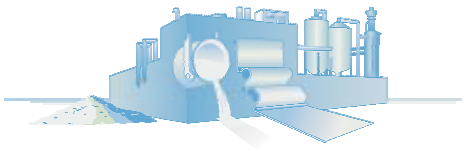
## Novel Combustion System Can Increase the Efficiency of the Drying Process

Paper drying is the most temperature-critical and energy and capital-intensive aspect of papermaking. In an effort to improve traditional drying systems, the Gas Technology Institute (GTI) is developing an innovative, new approach to drying paper that can significantly increase efficiency. The technology proposed by GTI is a natural gas-fired system that uses small dimples or cavities for combustion in a cylinder dryer. This innovative approach replaces current steam dryers, whose productivity is limited by drying capacity. By improving drying efficiency, this process can increase paper machine speeds and thus improve production rates.

GTI's objective is to design the natural gas-fired process to be more thermally efficient. Because of its higher heat transfer rate, the combustion system can increase the temperature reached by steam dryers. With drum temperatures of over 600°F, this process achieves drying rates that are significantly higher than those attained by the conventional system. High heat transfer rates also lower flame temperature in the dryer, substantially cutting $NO_x$ emissions.




*Gas-fired paper dryer dimple combustion concept.*



## Benefits for Our Industry and Our Nation

- Minimized steam consumption
- Increased efficiency
- Decreased specific energy consumption
- Reduced $NO_x$ emissions
- Higher drum temperatures
- Increased drying capacity
- Quick installation times
- Lower initial capital investment

## Applications in Our Nation's Industry

The process improves the conventional drying process of paper and paperboard. This gas-fired dryer can be installed in new or existing equipment. Other potential applications include preheating, hot pressing, incremental drying, moisture profiling, and hot calendering.

## Project Description

**Goal:** Provide experimental confirmation of the technical and economic feasibility of the dimple combustion concept for retrofits and new installations.

This natural gas-fired cylinder dryer involves combusting natural gas and combustion air in small dimples or cavities. Natural gas is injected into the dimples, while combustion air is supplied from the outside and normal to the dimples. The air flow creates vortices within each dimple, resulting in highly stable mini flames and uniform drum surface temperatures. The dryer efficiency is high because diffusion firing allows high levels of heat recovery to preheat combustion air.

This two-phase project began with bench-scale laboratory testing. GTI used stationary dimpled elements to define air and gas velocities and specifications for cavity diameter, depth, pitch, and patterns. During the second phase, researchers built a pilot-scale dryer drum which was installed and evaluated at a pilot paper dryer site by project partners.

## Results

Two concepts were investigated in the laboratory, one with combustion taking place inside the dimples, and one with the combustion outside the dimples. The latter approach was found to be better, and it led to the design and testing of a prototype gas-fired paper-dryer (GFPD) drum. The new approach was evaluated in laboratory and pilot-scale testing at the Western Michigan University Paper Pilot Plant. Drum surface temperatures of more than 400ºF were reached with linerboard (basis weight 126 pounds/3000 square feet) production and resulted in a 4-5 times increase in drying rate over a conventional steam-heated drying drum. Successful GFPD development and commercialization will provide large energy savings to the paper industry and increase paper production rates from dryer-limited (space- or steam-limited) paper machines by an estimated 10 to 20%, resulting in significant capital costs savings for both retrofits and new capacity.

## Project Partners

Boise Cascade Corporation
Boise, ID

Eclipse Combustion
Rockford, IL

GL&V/Black Clawson-Kennedy
Hudson Falls, NY

Gas Technology Institute
Des Plaines, IL

## For additional information, please contact

Drew Ronneberg, Ph.D.
Industrial Technologies Program
Phone: (202) 586-0205
Fax: (202) 586-9234
E-mail: Drew.Ronneberg@ee.doe.gov

Harry Kurek, Manager
Gas Technology Institute
Des Plaines, IL 60018
Phone: (847) 768-0527
Fax: (847) 768-0600
E-mail: harry.kurek@gastechnology.org

## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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