Alternative Commercial Laundry Systems

Poised for Big Energy Savings

Mary Horsey
Associate Director
Technology Assessment, E Source

Utility Energy Forum, 2015
A New Dawn for Commercial Laundry Efficiency
New Technologies on the Rise...

Liquid carbon dioxide (CO₂)

And an old technology is being revived

Ozone

Courtesy: Scott A. Miller
Liquid CO$_2$
What’s Liquid CO\(_2\)?

- **Solvent properties of CO\(_2\):**
  - Lower viscosity and surface tension
  - Improved small-pore penetration
  - Cleans better and more quickly

<table>
<thead>
<tr>
<th>Gas at room temperature</th>
<th>Solid at low temperature</th>
<th>Liquid at higher pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonation</td>
<td>Dry ice</td>
<td>Liquid</td>
</tr>
</tbody>
</table>

Courtesy (left to right): Scott A. Miller, Mr. Thomas, and Michael Melgar
How the Process Works

Particulates and organic wastes (wastes used as bio-diesel blends)

Clean and dry

Courtesy: CO2Nexus
## Comparing Apples to Apples

<table>
<thead>
<tr>
<th>Baseline Standard Commercial System</th>
<th>CO2 System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Washer</strong></td>
<td><strong>Washer, compressor, and pumps</strong></td>
</tr>
<tr>
<td>Equipment</td>
<td>Equipment</td>
</tr>
<tr>
<td>Electricity (ongoing)</td>
<td>Electricity (ongoing)</td>
</tr>
<tr>
<td><strong>Water for wash (ongoing)</strong></td>
<td><strong>CO2 (one-time)</strong></td>
</tr>
<tr>
<td><strong>Water treatment</strong></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>Chemicals (ongoing)</td>
<td></td>
</tr>
<tr>
<td>Pump energy (ongoing)</td>
<td></td>
</tr>
<tr>
<td><strong>Water heating (natural gas)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Detergents (ongoing)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Water for rinse (ongoing)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dryer</strong></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>Electricity (ongoing)</td>
<td></td>
</tr>
<tr>
<td>Natural gas (ongoing)</td>
<td></td>
</tr>
</tbody>
</table>
# Liquid CO₂ Savings

## Annual process consumption

<table>
<thead>
<tr>
<th></th>
<th>Water-based system</th>
<th>CO₂-based system</th>
<th>Percentage reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (gallons)</td>
<td>4 million</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>Electric energy (MWh)</td>
<td>444</td>
<td>200</td>
<td>33%</td>
</tr>
<tr>
<td>Natural gas energy (MWh)</td>
<td>667</td>
<td>300</td>
<td>22%</td>
</tr>
<tr>
<td>Chemicals (pounds)</td>
<td>30,000 (disposed of in municipal water system)</td>
<td>9,000</td>
<td>70%</td>
</tr>
<tr>
<td>Garment life</td>
<td>50+ cycles</td>
<td>2 to 3 times longer life</td>
<td>NA</td>
</tr>
</tbody>
</table>

Note: Based on 1.2 million pounds of garments throughput per year.
Economics and Applications

- Simple payback period target of 2 to 4 years
  - Laundry-as-a-service: $/lb basis
  - Application- or market-specific
  - Water/energy costs vary geographically

- Applications
  - Hospitality
  - Upstream textile processing
  - Coated fabrics and garments
  - Oil and gas
  - Healthcare
  - Dry cleaning
Non-Energy Benefits

- CO₂ is recycled
- Clothes come out dry
- No secondary waste stream
- Short cycle times (approximately 20 minutes)
- High throughput
- Increased fabric/garment life
- No shrinkage or color bleeding
- Cleans a wide variety of fabrics
- Non-toxic, non-hazardous, non-flammable, and inexpensive

Source: MS Clipart
Demonstration Project

- Cleanroom garment field test
  - CEC PIER project
  - Aramark Cleaning Services, Los Angeles
  - Testing completed March 2014

Results

**Cleanroom Requirements**
- Classification based on air particulates
- Static-charge control
- Minimal biological contamination

**CO₂ System Advantages**
- 60% fewer particles
- Reduced static buildup
- 25% less bioburden
Polymer Beads
How Polymer Beads Clean and Work

- Polymer beads:
  - Spheroidal
  - The size of BBs
  - 1:2 mass ratio of laundry to beads
  - Expand with moisture
  - Polarized with special additive

- The Process:
  - Beads enter drum of specially made machine
  - Polarizing additive added
  - Agitate with fabrics
  - Beads lift and absorb stains
  - Beads exit drum for reuse
  - No treatment of beads necessary
Why Polymer Bead Is Better

- One-quarter of the water
- Heat
- Half the detergent
- Less time
- Reduced drying*

Courtesy: Liberty Utilities

Source: MS Clipart
Liberty Utilities Laundry Study

Procedure

- Two machines
  - Milnor (baseline)
  - Xeros (polymer bead)
- Three types of fabrics
  - Bath towels
  - White linens
  - Colored linens
- Same loads
  - 60 pounds
- Measured
  - Water
  - Therms
  - Run time
  - Electricity
# Big Savings

<table>
<thead>
<tr>
<th>Per load</th>
<th>Milnor (baseline)</th>
<th>Xeros (polymer bead)</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (minutes)</td>
<td>54 to 78</td>
<td>50 to 51</td>
<td>4 to 26</td>
</tr>
<tr>
<td>Water (gallons)</td>
<td>134 to 156</td>
<td>35 to 37</td>
<td>80%</td>
</tr>
<tr>
<td>Therms</td>
<td>1.02 to 1.59</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>Electricity</td>
<td>2 kWh</td>
<td>3 kWh</td>
<td>−4,600 kWh(^a)</td>
</tr>
</tbody>
</table>

Notes: kWh = kilowatt-hours.
\(^a\) total additional electricity use in a year (compared to baseline).

Source: MS Clipart
Non-Energy Benefits

- Gentler on fabrics
- No sorting colors
- Improved cleaning
- No bleach
Economics

Total system cost: $56,000

Incentives from Liberty Utilities, National Grid, Unitil, Public Service of New Hampshire, NSTAR, and New Hampshire

- **New construction**
  - 75% incremental cost ($25,612)
- **Retrofit**
  - 50% cost ($28,000)

Source: MS Clipart
Economics (cont.)

Approximate simple payback periods

With incentive = 5 years
Without incentive = 10 years

With incentive = 5 years
Without incentive = 10 years

Source: MS Clipart
OZONE
How Does Ozone Clean?

- Chemically reacts with soil molecules
- Breaks soils into smaller molecules
- Water-soluble soils released and removed via agitation
How the Process Works

- New or existing washer
- Ozone produced in generator
- Injected into cold water supply
- Ozone is reduced to oxygen (O₂) during wash process
## Field Test Results: % Savings

<table>
<thead>
<tr>
<th></th>
<th>PNNL/Navigant</th>
<th>PNNL/Navigant</th>
<th>PG&amp;E</th>
<th>Santa Barbara County</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charleston Place Hotel</strong></td>
<td>65%</td>
<td>63%</td>
<td>66%</td>
<td>88%</td>
</tr>
<tr>
<td><strong>Rogerson House Asstd Living</strong></td>
<td>+ 1.5 kWh/load</td>
<td>+ 38 kWh/month</td>
<td>3.5%</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td>3.5%</td>
<td>n/a</td>
<td>19%</td>
<td>31%</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>15%</td>
<td>+19%</td>
<td>31%</td>
<td>19%</td>
</tr>
</tbody>
</table>
Economics

Ozone System Costs
Simple Payback Period

Charleston House
- $42,200
- 2.8 years

Hilton Garden Inn
- $14,000
- 7.5 months

Source: MS Clipart
Applications

Hospitality
Food Service
Healthcare
Laboratories
Cleanrooms
Non-Energy Benefits and Concerns

- **Benefits**
  - Increased garment life
  - Improved effluent quality
  - Reduced:
    - Water use
    - Chemical use
    - Cycle time
    - Drying time

- **Concerns**
  - Toxic gas code requirements
  - British Columbia requires:
    - Special piping
    - Eye-wash station

Source: MS Clipart
Resources

Liquid CO₂

Demonstration of a Carbon Dioxide–Based Industrial Laundry Machine (PDF), California Energy Commission (2012)

Polymer Bead

Xeros Laundry Technical Assessment Study (PDF), Liberty Utilities (2014)

Ozone


Project Test Report: Santa Barbara County Jail Ozone Laundry Detergent (PDF), Southern California Gas Co. (2011)
Resources

Ozone

For More Information

Mary Horsey
Associate Director
Technology Assessment Service, E Source
303-345-9160  mary_horsey@esource.com

Questions?