Controlled Atmosphere Stunning for Poultry Processing

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North American Meat Institute
Animal Care & Handling Conference
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Alternative Stunning Methods

• Why are we talking about this?
  ▫ Consumer pressure?
  ▫ Activist pressure?
  ▫ Expert opinions?
  ▫ Regulations?
  ▫ Improved welfare?
  ▫ Improved meat quality?
Controlled Atmosphere Stunning Commitments

- Perdue Farms
- Pilot Programs/Product Lines
  - Tyson
  - Wayne Farms
- McDonalds by 2024
- Global Animal Partnership
  - 150 Company Commitments
WATT/Rennier Poultry Confidence Index Survey - end of 2017

• “By the year 2024, what percentage of the U.S. industry’s total broiler slaughter will be via atmosphere stunning (CAS)?”

<table>
<thead>
<tr>
<th>How Much CAS</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>2%</td>
</tr>
<tr>
<td>1-9%</td>
<td>4%</td>
</tr>
<tr>
<td>10-24%</td>
<td>30%</td>
</tr>
<tr>
<td>25-49%</td>
<td>32%</td>
</tr>
<tr>
<td>50-75%</td>
<td>19%</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>12%</td>
</tr>
</tbody>
</table>

WATTAgNet.com March 1, 2018
European Commission  
Directorate General for Health and Consumers  

Study on various methods of stunning for poultry  

Framework Contract for evaluation and evaluation related services - Lot 3: Food Chain  

Final report  

Submitted by:  

Food Chain Evaluation Consortium (FCEC)  
Civic Consulting - Agra CEAS Consulting-  
Arcadia International - Van Dijk Management Consultants  

Project leader: Agra CEAS Consulting  

Reported December 2012  

Potential Costs

<table>
<thead>
<tr>
<th>Factors (12,000 bph)</th>
<th>Electrical</th>
<th>CAS</th>
<th>LAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Cost of Installation</td>
<td>$144,000</td>
<td>$1,573,000</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Maintenance (% of installation cost)</td>
<td>3.45%</td>
<td>6.90%</td>
<td>2.40%</td>
</tr>
<tr>
<td>Reception/Hanging Labor</td>
<td>97 hours/day</td>
<td>90 hours/day</td>
<td>90 hours/day</td>
</tr>
<tr>
<td>Water for Stunning/Cleaning</td>
<td>2,378 gal/day</td>
<td>925 gal/day</td>
<td>925 gal/day</td>
</tr>
<tr>
<td>Electricity</td>
<td>5.2 kwh/day</td>
<td>127 kwh/day</td>
<td>1136 kwh/day</td>
</tr>
<tr>
<td>Gas Used</td>
<td>n/a</td>
<td>6,834 lbs/day</td>
<td>n/a</td>
</tr>
<tr>
<td>Other Labor</td>
<td>3 hours/day</td>
<td>5 hours/day</td>
<td>5 hours/day</td>
</tr>
<tr>
<td>Average cost per bird</td>
<td>$0.0288</td>
<td>$0.0413</td>
<td>$0.0312</td>
</tr>
</tbody>
</table>
# Main Drivers for CAS Use

<table>
<thead>
<tr>
<th>Main Drivers</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working conditions</td>
<td>Bird handling</td>
</tr>
<tr>
<td>Mechanization</td>
<td>Reduced labor cost</td>
</tr>
<tr>
<td>Quality/Revenue</td>
<td>Improvement over high voltage stunning</td>
</tr>
<tr>
<td>Access to capital</td>
<td>Larger integrators</td>
</tr>
<tr>
<td>Bird throughput</td>
<td>Larger numbers = less cost/lb</td>
</tr>
<tr>
<td>Animal Welfare/Consumer Demands</td>
<td>Markets, labeling, perceptions</td>
</tr>
</tbody>
</table>
## Main Barriers for CAS Use

<table>
<thead>
<tr>
<th>Main Barriers</th>
<th>Out of 17 members</th>
</tr>
</thead>
<tbody>
<tr>
<td>High investment costs</td>
<td>76%</td>
</tr>
<tr>
<td>Insufficient capital for investment</td>
<td>41%</td>
</tr>
<tr>
<td>Space issues for installation</td>
<td>35%</td>
</tr>
<tr>
<td>Planning requirements</td>
<td>18%</td>
</tr>
<tr>
<td>No market premium for CAS meat</td>
<td>35%</td>
</tr>
<tr>
<td>No/limited cost savings</td>
<td>18%</td>
</tr>
<tr>
<td>Lack of experience with CAS</td>
<td>29%</td>
</tr>
<tr>
<td>Other (Halal, gas storage, technical failure)</td>
<td>29%</td>
</tr>
</tbody>
</table>
Controlled Atmosphere Stunning

- Not "one size fits all"
- A variety of systems to choose from
- Ongoing system design improvements
Controlled Atmosphere Stunning

- Multi-phasic Systems
  - Typically 2-5 phases

<table>
<thead>
<tr>
<th>Induction</th>
<th>Transition</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induce unconsciousness Suppressed ECG and EEG</td>
<td>Unconscious Slow breathing</td>
<td>Unconscious No respiratory response Irreversible stun</td>
</tr>
</tbody>
</table>
Controlled Atmosphere Stunning

- **Gas Systems**
  - Hypercapnic (carbon dioxide)
  - Hypercapnic/hyperoxygenic (carbon dioxide and oxygen)
  - Anoxic (Argon, Nitrogen, etc.)

- **Pressure Systems**
  - Low atmosphere pressure stunning (no gas)
Controlled Atmosphere Stunning

- System types
  1. Linear
  2. Chamber
  3. Underground
- Transport module use
  - Dump-type
  - Drawer-type
- Transfer of birds to shackles
System Types

1. Linear
   - Induction
   - Transition
   - Completion

2. Chamber
   - Induction
   - Transition
   - Completion

3. Underground
Transport Modules

Dump-type example
Pros: Already in use
Cons: Filling and dumping

Drawer-type example
Pros: Ease of filling and no dumping
Cons: Capital investment
Transfer of Birds to Shackles

1. Dump from coop – prior to stun
2. Dump from coop – following stun
3. Shacked from drawer
Examples of Available Systems
- Two-stage CO₂
- Conveyor
- Stun in transport modules
- Dump after stun

www.humaneaire.com
Straight line, modular setup for all capacities

- Multi-stage CO₂
- O₂ added during induction
- Conveyor
- Dump before stun

www.marel.com
- Five-stage CO₂
- O₂ added during induction
- Conveyor
- Stun in drawers
- Shackled from drawer

www.baader.com
Conveyor, Stun in Drawers
- Four-Five-stage CO₂
- Chamber
- Stun in transport modules
- Dump after stun

www.meyn.com
Containers entering stunning unit

Tilting unit
• Multi-stage CO₂
• Underground
• Stun in drawers
• Shackled from drawer

www.baader.com
Underground, Stun in Drawers
Underground, Stun in Drawers
Underground, Stun in Drawers
Underground, Stun in Drawers
Controlled Atmosphere Stunning With added gasses - CO\textsubscript{2} or CO\textsubscript{2}/O\textsubscript{2}

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unconscious when shackled</td>
<td>• More expensive</td>
</tr>
<tr>
<td>• Consistent stun regardless of bird variability</td>
<td>▫ Initial cost</td>
</tr>
<tr>
<td>• Potential for improved meat quality (hemorrhaging)</td>
<td>▫ Gas costs</td>
</tr>
<tr>
<td>• Potential for minimizing broken wings and leg bruising</td>
<td>• Larger footprint</td>
</tr>
<tr>
<td>• Broilers cannot recover</td>
<td>• Length of time to unconsciousness</td>
</tr>
<tr>
<td>▫ Will not recover consciousness</td>
<td>▫ Induction phase</td>
</tr>
<tr>
<td>• Broilers cannot recover</td>
<td>• Broilers cannot recover</td>
</tr>
<tr>
<td></td>
<td>▫ No ventilation reflex</td>
</tr>
<tr>
<td></td>
<td>• Broilers cannot recover</td>
</tr>
<tr>
<td></td>
<td>▫ Will not recover consciousness</td>
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Low Atmosphere Pressure Stunning

- LAPS
- Stun in whole module
- Slow decrease of atmospheric pressure until loss of consciousness

www.LAPSinfo.com
Low Atmosphere Pressure Stunning
Controlled Atmosphere Stunning
Low Atmosphere Pressure Stunning

- Jet Aircraft: 30,000 ft (33,000 ft occasionally)
- Light Aircraft: 10,000 ft
- Canada goose: 3280 ft
- Songbirds: 4,000 ft
- Most ducks & geese: 7,000 ft
- Bald eagle: 10,000 ft
- Bar-headed goose: 29,500 ft
- Some cranes and swans: 33,000 ft
## Controlled Atmosphere Stunning

### Low Atmosphere Pressure Stunning

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<td>• More expensive</td>
</tr>
<tr>
<td>• Consistent stun regardless of bird variability</td>
<td>▫ Initial cost</td>
</tr>
<tr>
<td>• Potential for improved meat quality</td>
<td>• Not widely adopted</td>
</tr>
<tr>
<td>• Potential for minimizing broken wings and leg bruising</td>
<td>• Larger footprint</td>
</tr>
<tr>
<td>• No recurring gas cost</td>
<td>• Length of time to unconsciousness</td>
</tr>
<tr>
<td>• EU approved</td>
<td>▫ Induction phase</td>
</tr>
<tr>
<td>• Broilers cannot recover</td>
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</tr>
<tr>
<td>▫ Will not recover consciousness</td>
<td>▫ No ventilation reflex</td>
</tr>
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* extension

* AUBURN

Poultry Science
How do these alternative stunning systems apply to Halal slaughter?

- ESMA defines standards
- Middle East imports ~86% chicken consumption
How do these alternative stunning systems apply to Halal slaughter?

- Breathing vs. Heartbeat
- What does it mean to be alive?
Breathing vs. Heartbeat

- Breathing
  - Rhythmic motor output

- Heartbeat
  - Electrical impulses independent of the brain
  - Will continue to beat until oxygen is depleted
CAS - Carbon Dioxide for Halal Example Broiler Stunning Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Halal</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction CO\textsubscript{2}</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Transition CO\textsubscript{2}</td>
<td>55%</td>
<td>74%</td>
</tr>
<tr>
<td>Completion CO\textsubscript{2}</td>
<td>75%</td>
<td>89%</td>
</tr>
<tr>
<td>Total stun time</td>
<td>4.5-6 minutes</td>
<td>6-8 minutes</td>
</tr>
<tr>
<td>Time to neck cut</td>
<td>&lt;45 seconds</td>
<td>~ 100 seconds</td>
</tr>
</tbody>
</table>
Approximation of CO$_2$ vs. Time
How do they know the bird is alive?

- No respiratory reflex
- Heartbeat test
  - 5 birds per load (~7,000 birds)
  - Conducted between stun and neck cut
  - Place hand on neck area
  - Feel for presence of heartbeat (pulse)
Low Atmosphere Pressure Stunning

Fig. 5. Example traces showing characteristic ECG activity. A: 6 s trace excerpt showing bradycardia and arrhythmia (arrow indicates onset, 52 s into LAPS, Broiler 332); x-axis large tick marks are 0.5 s. B: 1 s trace excerpts showing characteristic appearance of the ECG at different points of the LAPS cycle (a) 1–2 s (awake/conscious); (b) 58–59 s (unconscious); (c) 162–163 s (isoelectric EEG); and (d) 278–279 s (end of LAPS cycle, isoelectric EEG); x-axis large tick marks are 1 s.

Topics to Address

- As more CAS systems are installed, more questions arise.
  - Ambient/bird temperature effects
  - Relative humidity effects
  - Time between exit CAS and knife
    - How long is too long?
  - Line stops
    - Any welfare issue?
    - Quality issues?
  - Carcass and meat quality
  - CO$_2$ emissions
Controlled Atmosphere Stunning

• Much to consider
• Should you switch from electrical to CAS?
  ▫ Dependent on customer base
• If so, what type of system will best suit your needs?
  ▫ Space available
  ▫ Initial costs
  ▫ Long term costs
  ▫ Long term planning and goals
• Many CAS options available to suit a variety of needs.
Thank you!

Contact:
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