Gas stunning of poultry: Gas mixtures; Equipment: alternatives, adjustments and maintenance

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Gas mixtures approved in the EU

1. Carbon dioxide (CO2) in two phases: exposure to **less than 40%** to induce unconsciousness and then to higher concentrations
   – hypercapnia

2. Carbon dioxide (no more than 30%) in association with inert gases (nitrogen, argon)
   – Hypercapnic hypoxia

3. Inert gases
   – anoxia

- **Slaughter**, depopulation and other situations.
High concentrations of CO2

• Not approved for slaughter of poultry

• Approved only for depopulation and other situations
  – Created opportunity for innovation and development
  – More choice for the industry
Equipment

- EU Regulation 1099/2009: gas mixtures 2 and 3 may be used in **pits**, **bags**, **tunnels**, **containers** or in buildings previously sealed
Already covered topics

- Specific gravity of gases
- Properties of CO2
- Properties of inert gases
Effect of inhalation of CO$_2$

• Carbon dioxide induces breathlessness
• Inhalation of carbon dioxide is distressing and painful
• Pain and breathlessness activate same brain regions

How to measure pain or breathlessness in animals?
  – No verbal communication
Intrapulmonary chemoreceptors

Vertebrate animals have chemical receptors in their lungs (Intrapulmonary chemoreceptors, IPCs)

Acutely sensitive to carbon dioxide but insensitive to hypoxia / anoxia
Stimulation of IPC depresses respiration and the rate and extent depends upon the inhaled concentration of carbon dioxide
Inhalation of carbon dioxide leads to stimulation of central (brain) and peripheral (e.g. arterial) chemoreceptors

The effect of carbon dioxide on IPC is independent of the effects on central and arterial chemoreceptors, and pH of blood
Welfare significance (3)

IPC stimulation

↓

Depression of breathing

↓

Apnoea in animals = breathlessness / feeling of suffocation in humans?
Aversion testing in turkeys

Do not avoid anoxia created using argon or nitrogen

Avoid high concentrations of carbon dioxide
Aversion to gas mixtures
Inference

Induction of unconsciousness with hypoxia / anoxia is non-aversive

Carbon dioxide induces breathlessness

Inhalation of carbon dioxide is distressing and painful

Time to loss of consciousness – duration of suffering can be up to 45 seconds
Other view point

• Carbon dioxide stunning at 40% is better than electrical water bath stunning
  – Hanging up-side-down (inversion)
  – Stressful shackling (up to one minute)
  – Poorly designed and maintained WB
  – Pre-stun shocks
  – Ineffective stunning
  – Low stunning currents
  – Recovery of consciousness
Welfare advantage

Eliminate uncrating, hence avoid pre-slaughter handling induced fear, anxiety, distress, suffering or pain in conscious birds

Eliminate problems inherent to multiple bird water bath electrical stunning
Other advantages of gas stunning

• Automated gas concentrations & exposure time less prone to human error
• Irreversible stunning prevents chances of recovery of consciousness
Equipment
Gas stunning systems

- Anglia Autoflow
- Linco
- Meyn
- Stork
Linco controlled atmosphere stunning system

Cross-section through CAS stunning unit
Financial Justification and Payback

- Simulation done, in a small scale, at an American poultry slaughter house.

- By moving from Containers + Water Bath to Drawer system + CO2 stunning, they would improve the amount of “A Grade” meat by 8,4 M. Lbs (3,8 M Kg) in one year.

- Considering 0,5$/lbs delta for A Grade meat vs B grade => ≈4M$ / year profit improvement (< 1 year payback).

- Payback period for our CO₂ Stunning System is normally < 2 years.
Multi stage CO$_2$ stunning

For stunning of poultry
Meyn Praxair multi stage CO₂ stunning

• CO₂ in 5 stages:

• Stages 1 to 4 are below 40% to induce unconsciousness

• Stage 5 above 40% to induce deep irreversible stun.

• Humidity and temperature are within comfort zone during cycle,

• Measured at 4 different spots in the container the concentration is for every bird the same treatment (ch1-4)
Meyn Praxair multi stage CO$_2$ stunning

- Claimed Improvements versus existing systems:
  - Live handling at the plant is completely eliminated.
  - Reduction in wing damage (bruises).
  - No increase in wing breakage (unique feature).
  - Improved yield and quality of all final products.
  - Improved yield in deboning as a result of excellent carcass quality.
  - Suitable for different arrival systems and high capacity’s.
Test results: Effects on major breast fillets

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<th></th>
<th>Perfect</th>
<th>Medium</th>
<th>Severe</th>
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<tr>
<td><strong>HF @ 200 mAmps</strong></td>
<td>42 %</td>
<td>49 %</td>
<td>9 %</td>
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<tr>
<td><strong>CO₂ Stunning</strong></td>
<td>87%</td>
<td>12 %</td>
<td>1 %</td>
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(Wouter Veerkamp, 2015)
Test results: Effects on minor breast fillets

<table>
<thead>
<tr>
<th></th>
<th>Perfect</th>
<th>Medium</th>
<th>Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF @ 200 mAmps</td>
<td>32 %</td>
<td>48 %</td>
<td>20 %</td>
</tr>
<tr>
<td>CO$_2$ Stunning</td>
<td>96 %</td>
<td>4 %</td>
<td>0 %</td>
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(Wouter Veerkamp, 2015)
Stork CAS SmoothFlow

CAS SmoothFlow

Controlled atmosphere stunning
Stork CAS SmoothFlow

- 5 equal sections, each with its own programmable controlled atmosphere.
- In the induction phase the broilers are stunned ≤40% CO₂.
- In the first 3 sections the level of carbon dioxide and oxygen is controlled.
- The last two sections CO₂ only.
- The total exposure time is 5 minutes.
Alternative?

• Gas stunners are designed and constructed to accommodate manufacturers’ own brand of crates / draws

• Slaughterhouses using other types of crates or draws, regardless of throughput rates, are left out?
Adjustments

• Manufacturers’ instruction for effective use
  – Should provide details of adjustments needed for bird type, e.g. breeder V broiler, exposure time

• Standard operating procedures
Maintenance

• Manufacturers instructions for setting up
• Care and maintenance of live bird handling systems
  – e.g. signs wing damage or crushed heads
• Care and maintenance of crates, drawers, modules
• Routine inspection and record keeping
Gas stunning poultry
Identifying and correcting management failures

13:30 – 14:30 hrs
FBO’s responsibilities

• Checks on condition of birds at the time of arrival and prioritising slaughter
• Stocking density in crates – do not over load
• Checks transport crates / modules to make sure they do not jam inside the chamber
• Checks on supply of gas
• Calibration of gas monitors
• Back up stunner
Training of staff to recognise system failures

• Define roles and responsibilities
• Identify lack of knowledge or skills
• Identify need for training and evaluation
• Certificate of competence and retraining
• Regular internal auditing to identify problems and sources
• Positive interaction between welfare officer, VO and FBO
Gas stunning poultry
Global trends
Critical control points

14:30 – 16:00 hrs
Global trends

• Preferred method of stunning poultry for many retailers and welfare assured programs
• Some religious authorities have accepted gas stunning
• Small and medium slaughterhouses feel left out
Trend in EU

Large slaughterhouses in the EU are moving towards gas stunning - **2012 data**:

Germany: 60% of broilers and 40% of turkeys
UK: 36% of broilers (65% of broilers in 2016) and 95% of turkeys
Italy: 30% of broilers and 20% of turkeys
Netherlands: 22% of broilers
Finland: 90% of broilers
Austria 65% of broilers
Sweden 35% of broilers
Belgium: 25% of broilers
Forecast for USA

As part of the quarterly WATT/Rennier Poultry Confidence Index survey conducted at the end of 2017, respondents in the industry were polled on how they feel about the future of gas stunning in broiler processing.

The question was: “By the year 2024, what percentage of the U.S. industry’s total broiler slaughter will be via atmosphere stunning (CAS)

Most respondents said between 10 to 49 percent of the industry will be using the method by 2024.

Future perspective

• Global Animal Partnership (GAP) does not require the use of controlled atmosphere stunning. However, a July 2017 broiler welfare commitment – “Joint Animal Protection Organization Statement on Broiler Chicken Welfare Issues” – co-signed by the Humane Society of the United States, Compassion in World Farming and other activist groups does ask for food companies to require its chicken suppliers to use CAS by 2024.
Critical control point (1)

- Bird type – free range V intensively raised
- Stocking density in crates
- Design of crates – perforated V non-perforated floor
- Entry and passage of crates or birds through the system
  - No bunching or grouping of birds
- Gas concentrations monitored and maintained during exposure
  - Visible and audible alarm systems
- Calibration of gas monitors
- Duration of exposure adequate to prevent return of consciousness
  - Maintain records of recovery of consciousness
Critical control points (2)

- Interval between end of exposure to gas and bleeding should be appropriate and adequate to prevent recovery of consciousness.
- Neck cutting interval and blood vessels cut in simple stunning methods.
Critical control point (3)

- Detection of dead-on-arrival (DOA)
  - Ante-mortem detection and removal possible
- Stages of detection post exposure to gas mixture:
  - At the time of shackling
    - Remove birds that are cold or in rigor
  - During bleeding
    - Sign of poor or no bleeding
  - After scalding
    - Remove red skins
  - After plucking
    - Remove poorly plucked carcass
Meat Quality
Factors affecting blood loss

• birds stunned or killed
• blood vessels cut
• interval between stun/kill and neck cutting
• bleed-out time
• amount of blood retained in visceral organs
• effect of stunning methods on vascular resistance and smooth muscle tone?
Carcase and meat quality implications of gas stunning

• Wing flapping occurring during gas stunning are similar to those occurring during flight - twitch contractions in breast muscles

• These contractions do not induce haemorrhaging in muscles or broken bones in carcases
Carcase and meat quality implications of electrical stunning

- Low frequency (<125 Hz) electrical stunning will induce contraction which will persist for the entire duration of current application.
- The force of contraction in white breast muscles will be the maximum - super contraction.
- These results in breast muscle haemorrhaging and broken bones.
Rate of rigor development

• direct effect, muscular activity occurring during stunning e.g. anoxia, hypercapnia and certain electrical stunning parameters

• indirect effect, muscular activity occurring during bleeding e.g. high current, high frequency electrical stunning
Rate of rigor development

Within in electrical stunning:

- frequency of current
- waveform of current
- peak-to-peak voltage
- applied current per bird
- stun duration?
Rate of rigor development

Within gas stunning

• residual oxygen concentration

• carbon dioxide level at a given residual oxygen concentration

• rate of induction of unconsciousness and thus time to onset and duration of convulsions
Rate of rigor development

Electrical stunning broilers

- 5 mA per bird was delivered for 10 s with 11 Volts, 500 Hz pulsed DC
- 125 mA per bird was delivered for 5 s with (150 Volts) 50 Hz sine wave AC
Rate of rigor development in broilers

pH 15 min post mortem
Carcase appearance defects

Mainly induced by the massaging of residual blood in the superficial blood vessels by the plucker fingers

- Pre slaughter handling
- Stunning method
- Efficiency of bleeding
- Severity of plucking
Gas mixture Vs Electrical stunning in broilers

Muscle haem... Broken bones

- 30% CO2 + 60% Ar
- Electrical
Texture of breast meat

Main factors affecting texture:

• rate of rigor development
• carcase chilling rate
• filleting time post mortem
• interactions
Thank you