CO$_2$: Everything You Always Wanted to Know
(But Were Afraid to Ask)
Attendees will learn how to anticipate and recognize the hazard of carbon dioxide in various brewery operations, manage that hazard and apply practical methods of control that can be employed in breweries of all sizes.
Houston brewery cited by OSHA for CO2 exposure to employees

Employment which were free from recognized hazards that were causing or likely to cause death or serious physical harm to employees on January 9, 2014, employees were exposed to carbon dioxide at the following concentrations:
What is CO$_2$?

- Colorless
- Odorless
- Tasteless
- Heavier than air
4 % Floor Level

0.5 % Breathing Zone

2 % 18” off Floor
It’s Toxicity and your bodily response

- Drowsiness/Fatigue
- Decreased physical response
- Fresh air makes everything good again
- Pushes out oxygen
- That’s why we use in brewing
- Increased heart rate
- Shortness of breath
- Dizziness/Headache
Terminology and Exposure limits

- **TWA** = Time Weighted Average (8 hour)
- **PEL** = Permissible Exposure Limit (OSHA)
- **STEL** = Short Term Exposure Limit (OSHA)
- **IDLH** = Immediately Dangerous to Life and Health

- 100,000 ppm = 10%
- 10,000 ppm = 1%
- 5,000 ppm = 0.5% OSHA
- 1,000 ppm = 0.1%
Common levels and bodily response

➢ 0.04% fresh outside air
➢ 0.15% average indoor air
➢ 0.5% OSHA PEL for 8 hours
➢ 3.0% OSHA STEL for 15 minutes
➢ 4.0% IDLH (immediately dangerous)
➢ 8.0% Unconsciousness
➢ 20.0% Death
SAFETY DATA SHEET

Carbon Dioxide

Section 1. Identification

GHS product identifier: Carbon Dioxide
Chemical name: Carbon dioxide
Other means of identification: Carbonic, Carbon Dioxide, Carbonic Anhydride
Product use: Synthetic/Analytical chemistry.
Synonym: Carbonic, Carbon Dioxide, Carbonic Anhydride
SDS #: 001013
Supplier's details: Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation): 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status: This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture: GASES UNDER PRESSURE - Liquefied gas
Simple asphyxiating.
GHS label elements: 
Hazard pictograms: ♂
Transition into Locations
Locations

- Receiving and storage
- Lab
- Brew house
- Cellar
- Packaging
- Pub
- Small low spaces
Cellar
Packaging
“A 48 year old bartender went into the basement after closing the bar where she was allegedly overcome by leaking carbon dioxide. She was found unresponsive at 7:00 a.m. EMS was called and she was taken to the hospital where she died.”
Before we talk about specific controls

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We need to talk about a concept used to control any hazard
Control at the source
Pathways and Controls

Picture your favorite brewer here…
Controls Methods for CO$_2$

Detection
Evacuation
Exhaustion
Administrative
PPE

You will need a combination of methods; one single method will not work.
Detection
Detection – Sensor Technology

- Color Detector tubes
- Nondispersive Infrared (NDIR)
Detection – Classification

➢ Portable (Hand Held)
  • Job/Task specific
  • Personal monitoring

➢ Fixed location
  • Stand alone single station
  • Multi point
  • Breathing zone and Floor level
  • Can be connected to ventilation system, warning systems
  • Preventative maintenance (calibration)

➢ Preventive maintenance (calibration)
Detection

Evacuation
Best Control = Evacuation
Evacuation
Remove the CO$_2$ before it leaves the vessel and gets into the work environment
Evacuation

- Most effective engineering control
- Series of pipes or hoses that take the gas from fermentation vessels directly outside
- Foam traps
- Pressure relief
Evacuation

Tank → Foam Trap → Wall

Water and Foam

CO₂ outside
Foam Traps
CAUTION

No Standing

CO₂ Discharge

> 5%

2 - 5%
Evacuation - Pro/Con

- Cost
- Cross contamination
- Home made or highly engineered
- Foam trap
- Discharge point
Detection
Evacuation
Exhaust
Exhaust Ventilation
Removing the CO₂ after it enters the work environment
Exhaust - Ventilation

- Drawing air out of a space
- Less effective engineering control
- Sustainable
- General or Localized
- Must be designed for the operation
Exhaust System Design

HOOD → DUCT → STACK → FA → N
Local Exhaust - Ventilation

- Limited application
- Most effective exhaust
- Cost
- Engineered system
- Tied with detection/automatic
General Exhaust - Ventilation

- Wider application
- Must draw air from floor level
- Large volumes of air
- Lower Cost vs. local exhaust
- Engineered system – Balanced system
- Tied with detection
Exhaust - Ventilation

- Effective engineering control
- Drawing air out of a space
- Sustainable – local better
- Must be designed for the operation
- Required for open top fermentation
Detection
Evacuation
Exhaust
Dilution
Administrative
PPE
Dilution

“Dilution is the solution to pollution”
Dilution

- Least effective engineering control
- Adding air (or space) to lower exposure
- Detection is critical
Dilution

- In small operations within large spaces and detection system it can functional
- Fans just blow it around
- Standard HVAC systems/units are not designed to control CO$_2$ from brewing
Administrative
Must be part of any other control method
Administrative

- Policy, SOP
- Manual ventilation
- Job rotation or Work / Rest Cycles
- EAP – Emergency Action Plan
- Education
- PM needed for equipment, detection, ventilation, evacuation systems
PPE – Personal Protective Equipment

Least effective of any Control
PPE

• No “real” PPE for CO$_2$
• Least effective of any Control

“WARNING! A half-mask or full-face air-purifying (or cartridge) respirator can not be used in an oxygen deficient environment nor can they protect against carbon dioxide asphyxiation.”  NIOSH
Attendees will learn how to anticipate and recognize the hazard of carbon dioxide in various brewery operations, manage that hazard and apply practical methods of control that can be employed in breweries of all sizes.
What should I do when I get back to the brewery?

What should I do when I leave here?”

- Talk about it
- CO₂ Management
- “Yet” it is a journey
David Currier, CIH CSP  
Safety Manager  
Bell’s Brewery, Inc.  
Galesburg, MI  
dcurrier@bellsbeer.com