Portable CO_2/O_2 Monitoring In the Craft Brewing Industry

Florida Beer Company – Cape Canaveral, FL

- Regional Craft Brewery
- 40,000+ bbls/year
- Multiple brands (28 +)
- Focus on Craft Lagers
- Produce Cider & Soft Drinks
- Started brewing in new facility in 2013
- Purchased portable digital CO_2/O_2 meter
- Prior to purchase only checked CO_2/O_2 with older technology
- Lacked the ability to accurately monitor O_2 levels

Florida Beer Company Facility

Why Portable

- Market Expansion - Can we provide consistent products in distant markets?
- Accurate Data - Is our current equipment providing reliable results?
- Reducing Operator Error - Are all operators following the same procedures?
- Need Quick Reliable Results – Can we reduce operator time with reliable results?
- Justify Inline - Confirm critical process points for inline equipment

Decision to Trial Portable CO_2 / O_2 Meter

- Inconsistent shelf stability with no previous data
- Lack of operator S.O.P's to ensure measuring consistency
- Increase in production volume both bottling & racking
- New equipment purchased
- Verify that our processes are actually providing low O_2
  Verify that our CO_2 levels are accurate
- Need to pin point areas of concern for O_2 ingress
- Follow CO_2 & O_2 throughout the process to improve quality and process efficiency
- Provide expanding markets with quality driven, consistent products

Equipment Trialed

- Pentair Haffmans Model c-DGM CO_2 / O_2 Gehaltemeter plus ISD Piercer Accessory.
- CO_2 Range: 2-10 v/v
- O_2 Range: 0-2,000 ppb

TECHNICAL SPECIFICATIONS

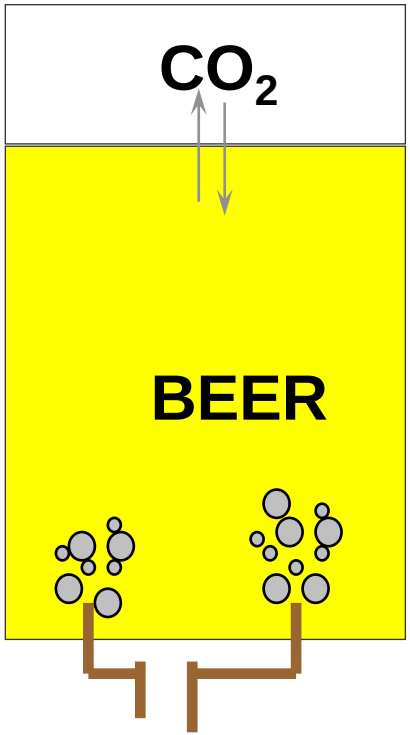
For O_2:	**DISSOLVED**	**GAS**
• Measuring range		
• LHO Coating	0.0 – 2,000 ppb	0.0 – 4.18%
• WLO Coating	0.0 – 45 ppm	0.0 – 100%
• Accuracy		
• LHO Coating*	+/- (1 ppb + 2% of m.v.)	0.002% ±2% of mv
• WLO Coating*	<5% of mv from 0.1 ppm	<5% of mv from 0.23%
* At 20 °C		
• Detect. limit	1 ppb	
• Response time	< 1 minute	
• Temperature range	-2 to 40 °C	

PRINCIPLE OF MEASUREMENT

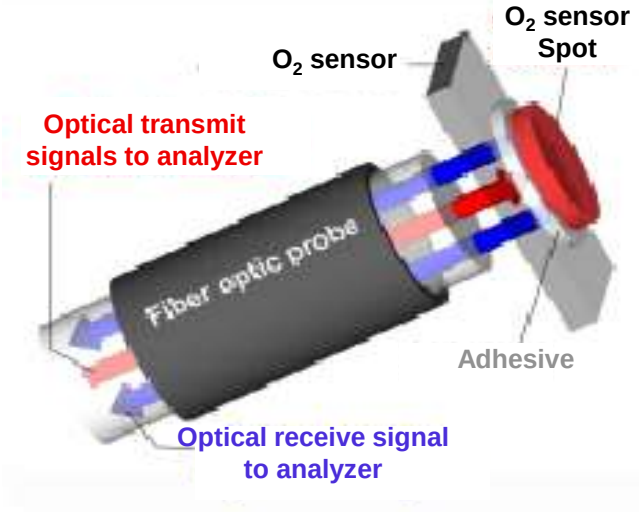
CO_2 Measuring Principle

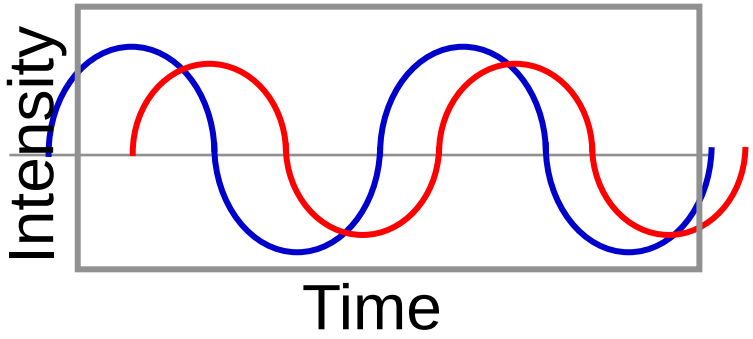
Based on Henry‘s law:

$CO_2 = P * f(t)$



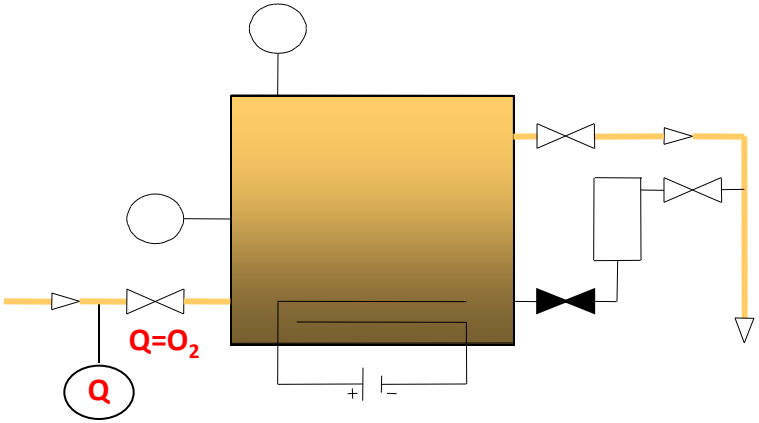
O_2 Measuring Principle



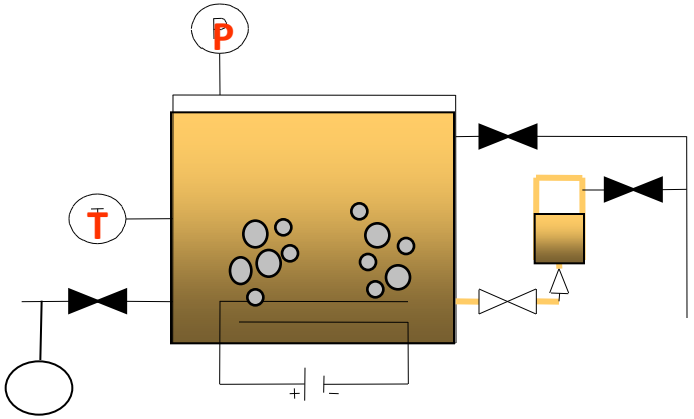


PRINCIPLE OF MEASUREMENT

OPERATING POSITIONS OF THE LEVER / VALVES



Sampling + Measuring O_2



Measuring CO_2

Main Areas of Concern
Bottles & Kegs

- Concerned about bottled & kegged product stability
- Desire 180 day shelf stable product
- Out of state distribution with unknown storage conditions
- Confirm minimum O_2 pickup during packaging process
- Are our processes working?

Main Areas of Concern
Centrifuge / Filtration

- Want to verify manufacturers claims
- New equipment in our process
- If levels are high can we adjust equipment or process to lower them?
- Are we maintaining low O_2 levels and not affecting product quality on the way to brite tank?

Main Areas of Concern
Transfer Pathways

- Are our S.O.P's working?
- Are we purging properly?
- Are we contributing to high levels of O_2 during transfers? If so, how?
- Are operators aware of significant changes in O_2 or CO2 levels during transfers?
- Can they catch these changes in time if an issue arises?

Main Areas of Concern
Brite Tanks

- Are we purging properly?
- Can we reduce CO_2 use during purge?
- Are we maintaining low O_2 levels from fermentation vessel, through filtration prior to packaging?
- Can we reduce the need for forced carbonation throughout the transfer process to improve quality & stability?

Outcome of the Trial

- Our processes needed to be re-evaluated and completely changed
- Our products had extremely high levels of O_2 which contributed to very short shelf stability and off-flavours associated with O_2 pickup
- It became apparent that a stronger S.O.P system was needed to make sure all operators are following protocol
- CO_2 levels in packaged product was inconsistent and out of limit in most cases
- Purging of pathways, brite tanks, filler and pasteuriser proved ineffective and in most cases wasteful of CO_2, time and energy

Outcome of the Trial (cont.)

- New equipment needed to be optimized regarding O_2 pickup
- We realised that our processes did not achieve the desired results which were leading to unstable product in the market, sensory based off-flavours (i.e., trans-noneal, staling, etc.) and potential brand suffering
- We needed to identify critical areas of potential O_2 ingress and correct them immediately
- The need for an accurate, repeatable portable O_2 / CO_2 monitoring device became evident

How did we accomplish the task ahead?

- Assembled a team made up of supervisors, key operators, QA/QA department and leads
- Went through the entire process from maturation in uni-tanks to bottled & racked product gathering data along the way
- Confirmed critical areas that needed to be addressed
- Confirmed recommended changes in process to eliminate or minimize O_2 pickup
- Updated and re-wrote S.O.P's to ensure minimal O_2 pickup
- Worked with manufactures to minimize O_2 pickup during filtration

Results

Within one week we managed to locate 5 main causes for elevated O_2 in final product:

1. Poor operator practices when hooking up hoses, connections or switching products from different vessels

2. Insufficient purging of pathways and vessels prior to filtration, transfers and packaging

3. Dry hopping method

4. Insufficient filler practices; mainly foam over at crowner

5. Lack of sufficient and available S.O.P's for processes

Results From Data

- O_2 levels dropped from 300-850ppb to 0-15ppb (brite tank)
- O_2 levels dropped from 100-400ppb to 2-40ppb (in bottles)
- Managed to reduce O_2 levels in brite tanks pre-product transfer from 5-15% to 0.3-0.5% total O_2
- Sensory analysis on bottle product improved and eliminated accelerated staling and off-flavours associated with high O_2 levels
- Able to keep all CO_2 levels within our desired range
- Able to correct issues within 48 hours of findings

OTHER APPLICATIONS

Brewhouse	• Monitoring the aeration of the wort prior to the fermentation
Fermentation/ Maturation	• Monitoring the CO_2 formation during the fermentation • Checking O_2 pickup during the fermentation • Monitoring the O_2pickup during the filtration • Monitoring the CO_2 content during the carbonation process
Packaging	• Monitoring O_2 pickup during the packaging process • Monitoring O_2 pickup post pasteurisation • Final in-process quality control
Laboratory	• Final product quality control check • Gas purity in terms of bulk gas storage (CO_2)

Portable vs. Inline Measurement

- Identical optical O_2 measurement technology also available in inline process instrument for continuous monitoring.
- Correlation to portable unit is good (same technology)
- Certain process applications make sense to put continuous monitoring versus portable grab sample with high O_2 alarm as the brewery grows (i.e., centrifuge, filter, filler pathway).
- In the process of justifying inline technology in our systems where we find the most probable cause of O_2 ingress for our processes
- Reduce operator labour while increasing system efficiency with inline equipment

Conclusions

- Use of portable digital CO_2 / O_2 meters drastically improved overall quality of beer
- Able to monitor and continuously check processes
- Results are accurate and repeatable
- Meter is reliable and durable to date
- Investment yielded immediate returns in process improvements, beer quality & shelf life
- Operation of unit is easy and training is minimal
- It is the most widely used piece of equipment in our facility
- Proved that S.O.P's are crucial to facility operations
- Provides means to continuously improve product quality

CHEERS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