Bottle Conditioning Like a Pro!

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Background

- Microbiologist
- QA Lab at Boulevard Brewing Co.
  - Production QA
  - Member of A.S.B.C.
  - Sensory Specialist, Beer Judge
- Consultant—Lab Science, Etc.
- K.C. Beer Pairing Examiner
- Homebrewer

What is Bottle Conditioning?

A secondary fermentation that takes place within the bottle, with the addition of yeast and fermentable sugar (also called "refermentation")

Reasons Lotsa Homebrewers Don't Like to Bottle

- 3. Getting the glass.
- 2. Too much work
- 1. Inconsistent & Unpredictable

Glass should be free!

- Recycle your own bottles!
- Just check with your local bar!
  - Everybody wants to be Green!
- Ask your friends to rinse & save their non-twist-off bottles (return them a bottle or two)

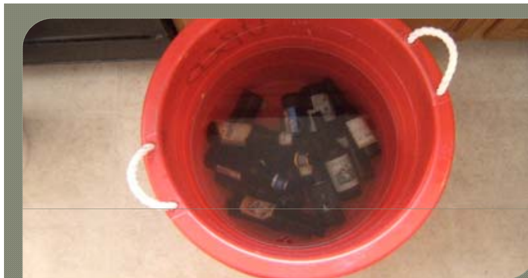
Too much work?!

- How much effort is put into brewing, and cleaning of equipment?!
  - Bottling is a job that can be broken down into separate tasks (you don't have to do it all at once!)
    - Label removal and washing
    - Sanitizing
    - Filling and crowning
    - Labelling

Relax, have a homebrew!

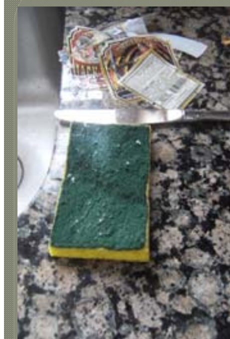
Keep It Simple, Stupid (K.I.S.S.)

Make It Easy On Yourself (M.I.E.O.Y.)



Label Removal & Washing

Soak your bottles in a tub overnight with a mild caustic solution such as P.B.W.



With a scrubbie and table-knife, labels and glue are easily removed at the kitchen sink

After soaking in a mild caustic cleaning solution overnight (such as P.B.W.), very little scrubbing will be necessary. Rinse them 3X, inspect for any residue. Then, just drain your bottles in the sink.

Rather than sanitizing with a no-rinse chemical, or in the dishwasher, you can really sterilize your bottles with dry heat in the oven and keep them there until you're all ready to bottle.

Don't break your back bottling!

Inconsistent & Unpredictable?

- There is not enough information available to homebrewers !
- It takes some measurements & calculations—but will give you a consistently good product!
- Optimum carbonation can be achieved with practice!

Top Ten Reasons to Bottle-Condition

- 10. It's "green"
- 9. It's cheap.
- 8. It doesn't require equipment space.
- 7. It's simple.
- 6. It's portable.
- 5. It's more sanitary.
- 4. It showcases your beer
- 3. It will produce appropriate CO_2 levels.

Top Three

- 3. It finishes up residuals.
- 2. It has a longer shelf-life.
- 1. It's the way to go for competition beers!

Craft Brewers Do It!

It isn't practical for a mega-brewer!

Commercial Bottle-Conditioning

- Belgian beers; Ommegang
- Sierra Nevada
- Boulevard Brewing Co.

Aspects for Commercial Brewers

- Consistency is top priority!
- Shelf-life extension is cost-effective
- Appearance is important.
- Storage and temperature requirements are major considerations
- Handling requirements are a factor
- Pasteurize vs. bottle conditioning

How they do it

- Sierra Nevada uses fermentation yeast and krausen
- Boulevard uses dry yeast and dextrose

The Belgians have done their research!

Articles in the past ten years:

1. Vanderhaegen, et al., 2002 "*Microbiological and biochemical aspects of refermentation*"
2. Van Landschoot, et al., 2003 "*Effect of pitching yeast preparation on the refermentation of beer in bottles*"
3. Derdelinckx, et al., 2004 "*Refermented beers: White and wheat beers, amber and dark beers, spiced and hoppy beers*"

Belgian beer findings

- In Belgium, about 10% of the total beer volume is carbonated by refermentation; or about 35% of the Belgian "special" beers
- There are two stages to refermentatin: Saturation (14 days) and Maturation

Saturation Stage

- Characterized by an increase of higher alcohols and esters, dependent on yeast multiplication.
- Taste judges find that refermentation improves beer aroma (verified by comparison of artificially injected CO_2 vs refermentation).

Saturation (cont'd)

The choice of yeast is important

- Easiest choice is to use the same yeast strain as used in primary fermentation
- Dry yeast strains were examined; two strains were selected for study: Safbrew S-33 and T-58
- Freshly propagated yeast produces better carbonation and "organoleptical" results—but only if available in the right quantity at the right moment!

Safbrew yeasts are available to homebrewers

Comparing yeast performance

Table 2: Characteristics of the beers refermented with pitching yeast of various preparation: foam stability (NIBEM-30), % yeast viability and turbidity in %.

Characteristics of the refermented beers	Pitching yeast preparation for refermentation				
	Harvested	Propagated on wort medium	Propagated on sucrose medium	Dried yeast Safbrew T-58	Dried yeast Safbrew S-33
Foam stability NIBEM-30 (s)	210 - 257	217 - 241	230 - 269	226	196
% Yeast viability					
– at bottling	72 - 94	99 - 100	99 - 100	84	80
– after 1 month	2 - 67	84 - 98	69 - 98	2	80
– after 3-4 months	0 - 45	41 - 80	51 - 93	0	71
Turbidity in %*	13.2 - 27.2	5.6 - 10.5	5.1 - 15.2	2.6	6.6
*(A-B/C-B) x 100	B = blank = beer turbidity at rest A = beer turbidity after turn-over movement C = maximal beer turbidity after shaking				

Quantities of yeast may be adjusted

- Usually, beers that are lighter in color (less than 12 EBC) are dosed with 100,000 cells/mL
- Beers that are darker (more than 35 EBC) or have ethanol levels above 7% v/v require 500,000 cells/mL

Commercial breweries do cell counts at the time of bottling and upon release

Ethanol Tolerance & Flocculation

- Problems can arise when non-ethanol tolerant yeast is selected for a strong beer.
- Flocculation varies among yeast strains, and is an important factor—involved in forming a solid sediment layer on the bottom of the bottle.

Yeast Fundamental:

- "Refermentation should increase the ethanol and the CO_2-content of the beer to an extent in accordance to the amount of added sugar."

To determine the amount of sugar to add--

$$A = 2B - (0.3C + D)$$

A = g/L fermentable sugar to reach saturation level B

B = final CO_2 (g/L) of beer expected

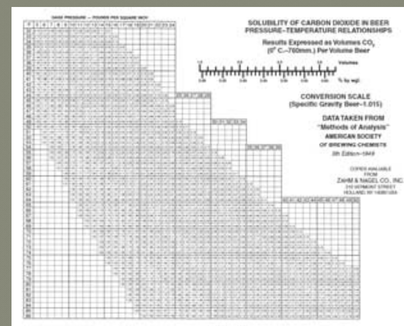
C = g/L fermentable sugar remaining in the beer before bottling; 0.3 factor used for maltotriose, which is not easily fermentable

D = g/L CO_2 remaining before bottling

Derdelinckx *et al.*, 1992

Commercial breweries check the CO_2 produced in bottle conditioning several times during the 14 day period.

Chart for determining volumes CO_2 from pressure & temperature



Three phases of aging

Similar to wine—

- Immaturity
- Maturity
  - Aldehydes are reduced to alcohols
- "Old" (Madeira wine, old Port wine)

Maturation Stage

- Aging and maturation of flavors is slower in refermented beers (*aging begins immediately with filtered and carbonated beers*)
  - Results of beers stored for a year demonstrated a universal reduction in levels of higher alcohols and esters
  - Bitterness decreases continuously, especially with larger amounts of yeast or dissolved oxygen.

Maturation (cont'd)

- Extremely important is the headspace oxygen; dissolved oxygen decrease is rapid in beers which contain yeast
  - Commercial brewers check the Total and DO frequently during bottling with an Orbisphere

Maturation (cont'd)

- The impact on flavor of autolyzed yeast should not be underestimated.
- Refermented beers with the lowest pitching rates lost less foam stability.
- Pitching rates can vary from 100,000 cells/mL to 1.5 million cells/mL

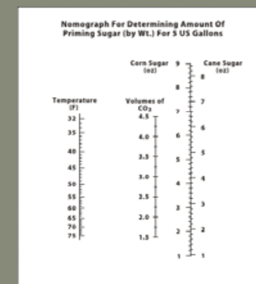
Most Critical Factor in achieving optimum CO_2:

- ***Residual fermentable sugar!***
- Breweries take careful measurements of Plato in the Bright Tanks.
- This determines the amount of sugar to dose.
- The beer style also affects the amount of sugar dosed.
- Yeast (cell counts) is less critical.

Empirical determinations

Through trials, extensive measurements, and meticulous records, breweries tweak their bottling regimes to achieve consistent results.

This has been the standard reference for homebrewers, but the final gravity factor is not included--



Most common problems with bottling are under- and over-carbonation

Under-carbonation

1. Amount of added sugar is too low, or not mixed in evenly, resulting in CO_2 < 5 g/L
2. Yeast is not active (most often happens with propagated yeast)
3. An imperfectly crowned bottle will leak CO_2

Over-carbonation ("gushing")

- Excess sugar added (in relation to final gravity); produces CO_2 > 9 g/L
- Contamination by other organisms that are able to ferment dextrins
- Gushing "inducers" such as molds (*Fusarium* and *Aspergillus*) or calcium oxalate crystals

Ways a homebrewer can imitate commercial practices

- Transfer from your secondary fermentation vessel to a bottling bucket, minimizing yeast carryover
- Take careful measurement of the final gravity of your beer, in the bottling bucket.
- Make judicious adjustments to the standard sugar dose, based upon the final gravity.
- To insure adequate yeast, add an amount of dry yeast to achieve 200,000 cells/mL.

Add yeast to the entire volume in the bottling bucket

- Prepare a suspension of dry yeast in 1 cup of water that is boiled and cooled to 80ºF; ¼ teaspoon (0.5 g) yields 200,000 cells/mL
- Stir gently into the bottling bucket with a sanitized non-wooden spoon.

Where to begin with sugar dosing?

Like with photography, you can "bracket" your sugar dosing and determine the concentration that produces the optimum carbonation for the beer style you are bottling.

Choose your sugar--

DEXTROSE

SUCROSE

Corn sugar Example

2/3 cup corn sugar = 86 grams
5 gallons beer = 19 L
Standard dose would be 4.5 g/L

To prepare 3 different concentrations, add sugar in three additions.

Decreasing volume produces increasing sugar concentration!

- Prepare 3 cups of sugar solution, from the standard amount (2/3 cup; 88 grams)—boiled and cooled.

Bottle in three stages

- For the first 12 bottles, add 15 oz of the priming solution to the full 5 gallons in the bottling bucket (3.0 g/L dose)
- After filling and crowning those, add 6 oz more of the priming solution to the bottling bucket and bottle 24 bottles (this concentration is the standard; 4.5 g/L)
- To the remainder, add 2.5 oz of the priming solution, and bottle the final 12 bottles. (6.0 g/L)

Use the same *priming solution volumes* for Sucrose additions

- You will start with 5/8 cup (130 grams) to make 3 cups of priming solution (it is denser)
- Use 15 oz, 6 oz, and 2.5 oz
  - (4.5 g/L, 6.8 g/L, 9.1 g/L)

This an "empirical" approach

- Not all of your bottles will have the carbonation you'd like—
- You will have a three levels of carbonation; pour to examine and taste
- Choose the g/L that you can refer to on your next batch

After crowning--

- Store the bottles in a room with a temperature of 70°F ± 5°F
- After 2 weeks, see how it pours!

How to record your CO_2 levels for future reference

- Lacking a Zahm & Nagel, pour into a beaker, 500 mL graduated cylinder, or pint glass.
- Photograph and/or measure the foam, or give them a score (0 to 5; 0 is no carbonation)

Carbonation continuum

Scores (Left to Right): 0, 1, 3,4

Modify & Tweak

These two examples produce sugar dosing and resulting carbonation that is ± 50%. You may want to modify this to ± 25%; or make more than three concentrations.

You do the math!

And, Finally…

Add labels to the best ones!

Or, don't—send them to competition!

Cheers!

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