Introduction

Transferring beer that has yet to reach its final gravity (as confirmed by a Fast Ferment Test[1]) into a keg to allow for natural carbonation through the use of a spunding valve is a natural choice for those employing Low O2 brewing methods. This style of carbonating, and subsequently serving, the beers produced with these methods serves to minimize and/or totally eliminate the presence of oxygen due to the scavenging effect of active yeast.

Where does that leave the bottler's though? What about brewers who keg and want the occasional bottle or contest entry? The commercially available alternatives include various counter-pressure bottle fillers, but their application seems to detract from the principles of keg spunding and O2 minimization.

The answer may very well be "Spunding in the Bottle", or taking beer directly off the fermentor into bottles for the purpose of natural carbonating them. Here the bottle supplants the keg as the serving vessel.

Please Note: While the theory and calculations presented here are well established and technically sound, I have not yet tested this method. A measure of conservatism should be taken into account until the variables (pressure, level of carbonation, flavor) contained in this method have been empirically analyzed.

The Method

1.) Determine your final level of apparent attenuation (and thus your final gravity) using a Fast Ferment Test.
2.) Determine the level of residual carbonation in the beer at time of transfer.
3.) Choose a desired level of final carbonation.
4.) Calculate the gravity at which to transfer the beer.

Fast Ferment Test

I won't go into the full explanation of the FFT here other than to state that the purpose is to take a sample of your wort and give it a herculean dose of yeast while allowing it to ferment completely. The gravity of this sample determines your limit of attenuation and gives you the lower limit of final extract. You can now use this as an input into your calculation of transfer gravity for bottle spunding. Here is the link to Braukaiser.com for the full article:

http://braukaiser.com/wiki/index.php?title=Fast_Ferment_Test

[1] http://braukaiser.com/wiki/index.php?title=Fast_Ferment_Test

Residual Carbonation

Most priming calculators (the one in my spreadsheet is no exception) have a common thread in terms of calculations: an article written by Michael Hall for Zymurgy in 1995, "Brew by the Numbers"[2]. The article is filled with interesting calculations of varying complexity but the one that will serve as most useful here is the following:

$$\text{CD}_{\text{Init}}\ (Vol.CO_2) = 3.0378 - (0.050062 * T) + (0.00026555 * T^2)$$

Where:

$$\text{CD}_{\text{Init}} = Residual\ Carbonation$$
$$T = Peak\ \ Temperature$$

With this value in hand we can now choose a desired level of carbonation.

Carbonation Potential of Remaining Extract

Kai established a sound baseline for the carbonation potential of remaining extract on his website[3]. The full derivation and calculation can be found there. Essentially he established the following guidelines:

$$\text{Each °P of additional fermentation yields 2 Vol. } CO_2$$
$$\text{Each S.G. point of additional fermentation yields 0.51 Vol. } CO_2$$

Calculating Transfer Gravity

With the equations and guidelines above we can now determine the gravity at which to transfer in order to obtain the desired level of carbonation in the bottle. Let's establish some variables and work through an example:

$$\boldsymbol{T = 45\ °F}$$

$$\text{CD}_{\text{Init}} = 3.0378 - (0.050062 * 45) + (0.00026555 * 45^2)$$

$$\text{CD}_{\text{Init}} = 1.323\ Vol.CO_2$$

$$\boldsymbol{Desired\ Carbonation = 2.8\ Vol.CO_2}$$

$$Carbonation\ Desired\ from\ Remaining\ Extract = \ Desired\ Carbonation - \text{CD}_{\text{Init}}$$

$$Carbonation\ Desired\ from\ Remaining\ Extract = 2.8 - 1.323 = 1.477\ Vol.CO_2$$

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[2] https://www.homebrewersassociation.org/attachments/0000/2497/Math_in_Mash_SummerZym95.pdf
[3] http://braukaiser.com/wiki/index.php?title=Accurately_Calculating_Sugar_Additions_for_Carbonation

$\boldsymbol{Starting\ Gravity\ (S.G.) = 1.049}$
$\boldsymbol{FFT\ AA\% = 82\%}$
$\boldsymbol{Final\ Gravity\ (S.G.) = 1.009}$

$$Transfer\ Gravity\ (S.G.) = \left(\left(\frac{\left(\frac{1.477}{0.51}\right)}{1000}\right) + 1\right) + 1.009$$

$$Transfer\ Gravity\ (S.G.) = 1.003 + 1.009 = 1.012$$

$$\text{T}ransfer\ Gravity\ (°P) = 259 - \left(\frac{259}{1.012}\right) = 3.07$$