
Brewing Efficiency
doug293cz

Efficiency - Why Should I Care?

- You must know your efficiency in order to know how much grain you need to use to hit a specific OG target at a particular wort volume
- Higher efficiency requires less grain for the same OG
  - Too much grain → OG over target
  - Too little grain → OG under target

What is Efficiency?

$$Efficiency = \frac{Amount\ Actually\ Obtained}{Maximum\ Amount\ Available}$$

- **Equation gives fractional efficiency**
- **Multiplying by 100 gives percent efficiency**

Efficiency Metrics

$$\text{Mash Efficiency} = \frac{\text{Extract in Boil Kettle}}{\text{Total Potential Extract}}$$

$$\text{Conversion Efficiency} = \frac{\text{Extract in Mash}}{\text{Total Potential Extract}}$$

$$\text{Lauter Efficiency} = \frac{\text{Extract in Boil Kettle}}{\text{Extract in Mash}}$$

$$\text{Mash Efficiency} = \text{Conversion Efficiency} \times \text{Lauter Efficiency}$$

$$\text{Brewhouse Efficiency} = \frac{\text{Extract in Fermenter}}{\text{Total Potential Extract}}$$

$$\text{Brewhouse Efficiency} = \text{Mash Efficiency} \times \frac{\text{Fermenter Volume}}{\text{Boil Kettle Volume}}$$

Grain Extract Potential

- Given on malt analysis sheets as percentage for fine grind, dry basis
  - Real malt typically contains ~4% moisture, so “as is” potential is ~96% of dry basis
  - Most brewing software does not correct for moisture
- SG potential is commonly used by homebrewers
  - SG that results from 1 lb making 1 gal of wort
  - SG potential = 1 + (%Potential * 46.2)/1000
  - 80% potential extract = 1.037 SG potential

Efficiency using Points

- Malt potential extract points/lb
  - Pts/lb = 1000 * (SG Potential – 1)
  - 1.037 potential = 37 pts/lb
- Potential points for each grain
  - Potential pts = Grain weight * pts/lb
  - 10 lb @ 1.037 = 370 pts
- Total potential pts = Sum of pts for all grains

Efficiency using Points

- Wort actual extract points/gal
  - Pts/gal = 1000 * (SG – 1)
  - 1.054 wort SG = 54 pts/gal
- Total actual wort points
  - Total wort pts = Wort volume * pts/gal
  - 5 gal @ 1.054 = 270 pts

Efficiency using Points

- **Mash efficiency example**
  - **10 lbs 2-row at 1.037 potential for 370 total potential pts**
  - **5 gal post boil at 1.054 SG for 270 total wort pts**
  - **Mash Eff = 270 / 370 = .73 or 73%**

Calculation Accuracy

- **Sources of error**
  - **Grain weight errors**
  - **Grain moisture content errors**
  - **Grain extract potential errors**
  - **SG measurement errors**
  - **Volume measurement errors**
- **Efficiency calculations are only accurate to ±3% - 4%**
- **Sanity check: total pre-boil points should equal total post-biol points**
  - **Pre-boil vol * pts/gal = post-boil vol * pts/gal ?**

Recipe Scaling

- Target is 5.5 gal post-boil @ OG of 1.065
- Grain bill has average 35 pts/lb
- Typical mash efficiency = 72%
- Target pts = 5.5 * 65 = 357.5
- Potential pts needed = 357.5 / 0.72 = 496.5
- Grain needed = 496.5 / 35 = 14.2 lb

What Affects Efficiency

- **Conversion efficiency affected by:**
  - **Crush size - Larger grits take longer to convert completely**
  - **Mash time & temp**
- **Lauter efficiency affected by:**
  - **Sparge method – fly, batch, none**
  - **Grain absorption rate (batch)**
  - **Undrainable MLT volume (batch)**
- **Brewhouse efficiency affected by:**
  - **Everything above**
  - **Volume left behind in boil kettle**

Effect of Grain Bill Size

- **Larger grain bills reduce lauter efficiency**