




THE ART OF FERMENTATION

Silicon Valley Sudzers

Jim Williams



Brewers do NOT make
beer – Yeast makes beer
and brewers feed and
care for them!

Jim Williams

Agenda

- Overview
- Pitching rate
- Wort preparation
- Temperature control
- Summary

Overview

- Fermentation management is the second most important thing in brewing. Good fermentation management includes:
 - Sufficient yeast
 - Sufficient nutrients
 - Optimal conditions (temperature)
 - Appropriate time

Important Terms

- Pitching rate (million cells / milliliter of wort / deg. plato)
- Flocculation (strong, medium, low)
- Lag Time (6-36 hours)
- Apparent Attenuation (60%-90%)

Fermentation Phases

- Lag phase
 - 0-15 hours (Chris White – Yeast book)
 - Cells uptake nutrients
 - Requires maximum oxygen uptake
- Exponential growth
 - 4 hours to 4 days
 - Krausen develops
- Stationary phase
 - 3-10 days
 - Yeast cleans up byproducts of fermentation

Yeast Types

- Dry yeast
 - Approximately 8-14 billion cells/gram
 - Always hydrate according to manufacturer
 - Limited types
- Liquid (typically 100 billion cells when fresh)
 - White Labs
 - Wyeast

This yeast is famous for its clean flavors, balance and ability to be used in almost any style ale. It accentuates the hop flavors and is extremely versatile.

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Play Audio Description of WLP001 California Ale Yeast »

Chris White, president of White Labs, discusses the company's strains.

STYLE PERFORMANCE LISTING

A listing of how this style ranks amongst different brew styles, on a scale from 0 to 4.

Style	Rating	Style	Rating
American Style Cream Ale	4	American Style Wheat Ale	4
Fruit Beer	2	Herbs & Spice Beer	4
Specialty Beers	4	Specialty Honey Ales	4
Smoke Flavored Beer	4	Golden Ale Canadian Style Ale	4
German Style Kolsch	2	Classic English Style Pale Ale	2
English Style India Pale Ale	1	American Style Pale Ale	4
American Style India Pale Ale	4	American Style Amber	4
English Style Bitter	2	English Style ESB	2
Scottish Style Ale	2	Irish Style Red Ale	2
English Style Brown Ale	2	American Style Brown Ale	4
German Style Brown and Dusseldorf Altbier	2	Robust Porter	2
Brown Porter	2	Classic Irish Style Dry Stout	2
Foreign Style Stout	2	Sweet Stout	1
Oatmeal Stout	2	English Old Ale English & American Strong Ale	4
Barley Wine Strong Ale	4	Strong Scotch Ale	2
Imperial Stout	2	Imperial IPA	4

REVIEWS

CHARACTERISTICS

Attenuation

73-80%

Flocculation

Medium

Optimum Ferment Temp.

68-73°F (20-23°C)

Alcohol Tolerance

High

MiniFerment Data

As-is Diacetyl

27.18ppb

Total Diacetyl

78.12ppb

As-is 2,3-Pentanedione

N/A

Total 2,3-Pentanedione

8.61ppb

Ethanol

4.825%ABV

Acetaldehyde

14.005ppm

Ethyl Acetate

17.46ppm

Isoamyl Acetate

N/A

1-Propanol

37.23ppm

Isoamyl Alcohol

90.185ppm

NOTES:

Final Gravity: 2.8 P Hours it takes to get to 50 percent attenuation: 40

A super clean, super-fast fermenting strain. A low ester-producing strain that results in a balanced, neutral flavor and aroma profile. Alcohol-tolerant and very versatile for a wide variety of styles. Similar to California Ale Yeast WLP001 but it generally ferments faster.

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CHARACTERISTICS

Attenuation

76-83% +

Flocculation

Medium to High

Optimum Ferment Temp.

65-68°F (18-20°C)

Alcohol Tolerance

High

Pitch Rate

- Million cells / Milliliter of wort / Degree plato
 - Minimum : 0.35 (ale only, fresh yeast only)
 - Middle of the road Pro Brewer 0.75 (ale)
 - Pro Brewer 1.00 (high gravity ale)
 - Pro Brewer 1.50 (minimum for lager)
 - Pro Brewer 2.0 (high gravity lager)
- Create starter – see
 - <http://www.howtobrew.com/section1/chapter6-5.html>
 - Use Stirplate with a foil cap
 - Add tsp of yeast nutrient (fermaid K)
 - Plan extra day to cold crash and decant
 - Consider small step up starter on brew day
 - Starter at fermentation temperatures for lagers



Determining Pitching Rate

- Pitching rate calculator
 - <http://www.brewersfriend.com/yeast-pitch-rate-and-starter-calculator/>
 - Has Kai Troester's stirplate calculations
- I typically use 1-1.20 billion cells/ milliliter for IPAs and greater for lagers and big beers
- Make adjustment for beers with a significant profile of ester or phenolic characteristics

Yeast Pitch Rate:

Units: ☒ US - Gallons / oz
☐ Metric - Liters / g

Sugar Scale: ☒ Gravity (1.000)
☐ Plato °P

Wort Gravity (OG): (1.000)

Wort Volume: Gallons

Target Pitch Rate: (million cells / ml / degree plato)

Yeast Type:

Liquid Packs: (packs/vials)

Mfg Date: (yyyy/mm/dd)
Date yeast pack was made.

Viability: **Yeast is 58 days old, the viability is estimated at 59%.**

Cells Available: **59 billion cells**
Pitch Rate As-Is: **0.14M cells / mL / °P**
Target Pitch Rate Cells: **408 billion cells**
Difference: **-349 billion cells**
Needs starter (see below), or more yeast.

Typically use 1

Typically 1 month or determine with use-by-date – self-life

Part 2: Make a starter if required, supports up to 3 step-ups.

Yeast Starter - Up To 3 Step-Ups:

Starting Yeast Count: (Billion Cells)

Enter the number of cells you are starting with, or click the 'grab from above' button if you set up your yeast in the previous section.

Starter - Step 1:

Starter Size (L) Gravity (1.000) Growth Model and Aeration

Braukaiser - Stirplate

DME Required: **10.9 oz, 308.1 g**
Growth Rate: **1.4**
Initial Cells Per Extract (B/g): 0.19

Ending Cell Count: **490 billion cells**
Resulting Pitch Rate: **1.20M cells / mL / °P**
Starter meets desired pitching rate!

Starter - Step 2: ☐
Starter - Step 3: ☐

Use Braukaiser stirplate formula
AKA Kai Troester

Wort Preparation

- Add 1 TBSP of yeast nutrient to boil
- Second dose of yeast nutrient 2 days into fermentation
- Yeast require oxygen for optimal propagation
 - 1.055 requires 8-10 ppm of O₂ (Yeast book)
 - >1.055 requires perhaps 14 ppm
- When using large amounts of simple sugars
 - Add 50% during fermentation

Wort Aeration

- Adding oxygen
 - Shaking 5 gallons for 5 minutes provides 2.7 ppm
 - 30 seconds O₂ at 1 LPM provides 5.1 ppm
 - 60 seconds O₂ at 1 LPM provides 9.2 ppm
 - 120 seconds O₂ at 1 LPM provides 14 ppm
- 90 seconds for average beers, 120 seconds for high gravity and lagers
- Second ½ dose 12 hours after pitching for high gravity beers

Adding Oxygen



Temperature Control

- High fermentation temperatures leads to:
 - Yeast death
 - Off-flavors
 - Mutation
- WLP001 fermentation at 66 and 75 yields 7.98 ppm acetaldehyde versus 152 ppm
- First 3-4 days are most important for temperature control
- Optimal temperature varies for different stages of fermentation
 - Diacetyl rest
 - Lagering
- Control wort temperature NOT ambient temperature
- Sometimes so called off flavors are the point! Understand your fermentation.

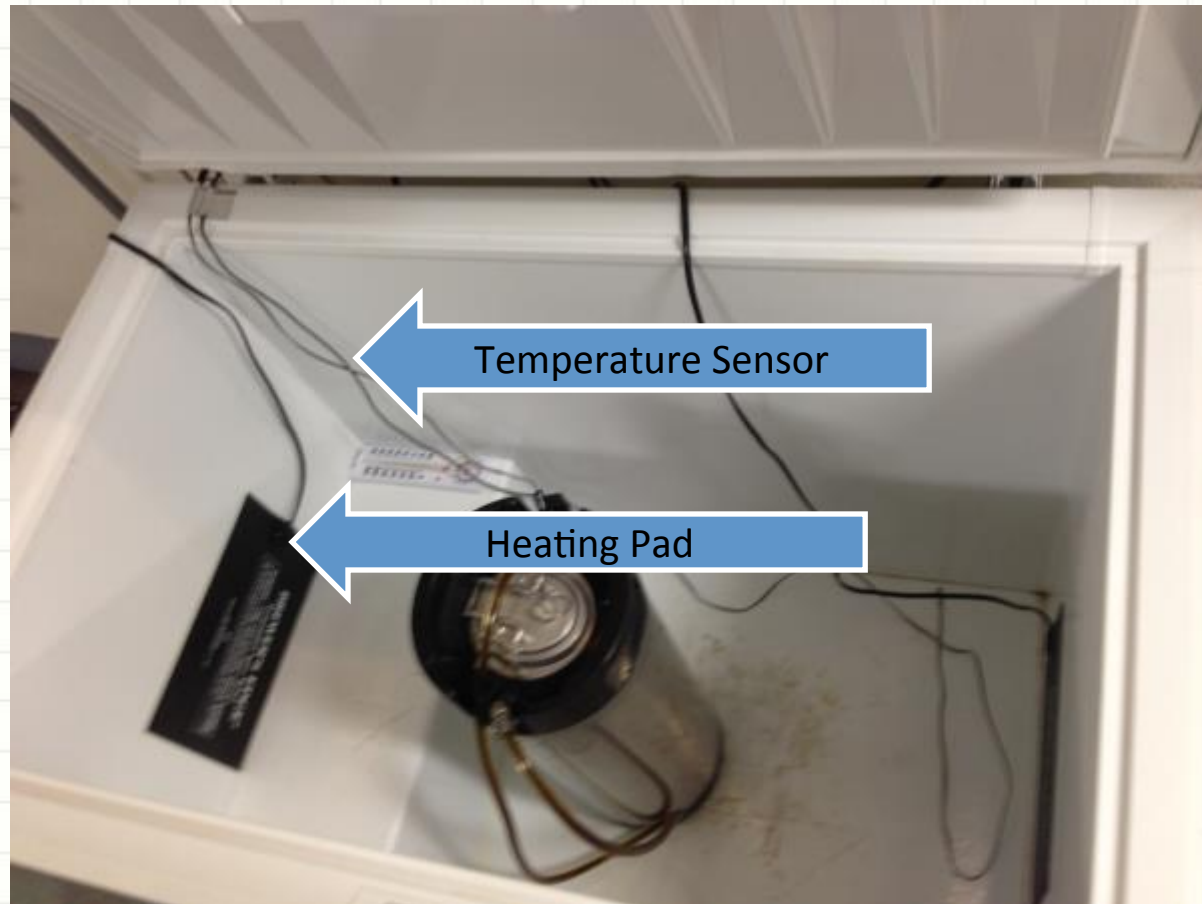
Temperature Control



Morebeer Fermentation Bag



Fermentation Chamber



Fermenter with thermowell

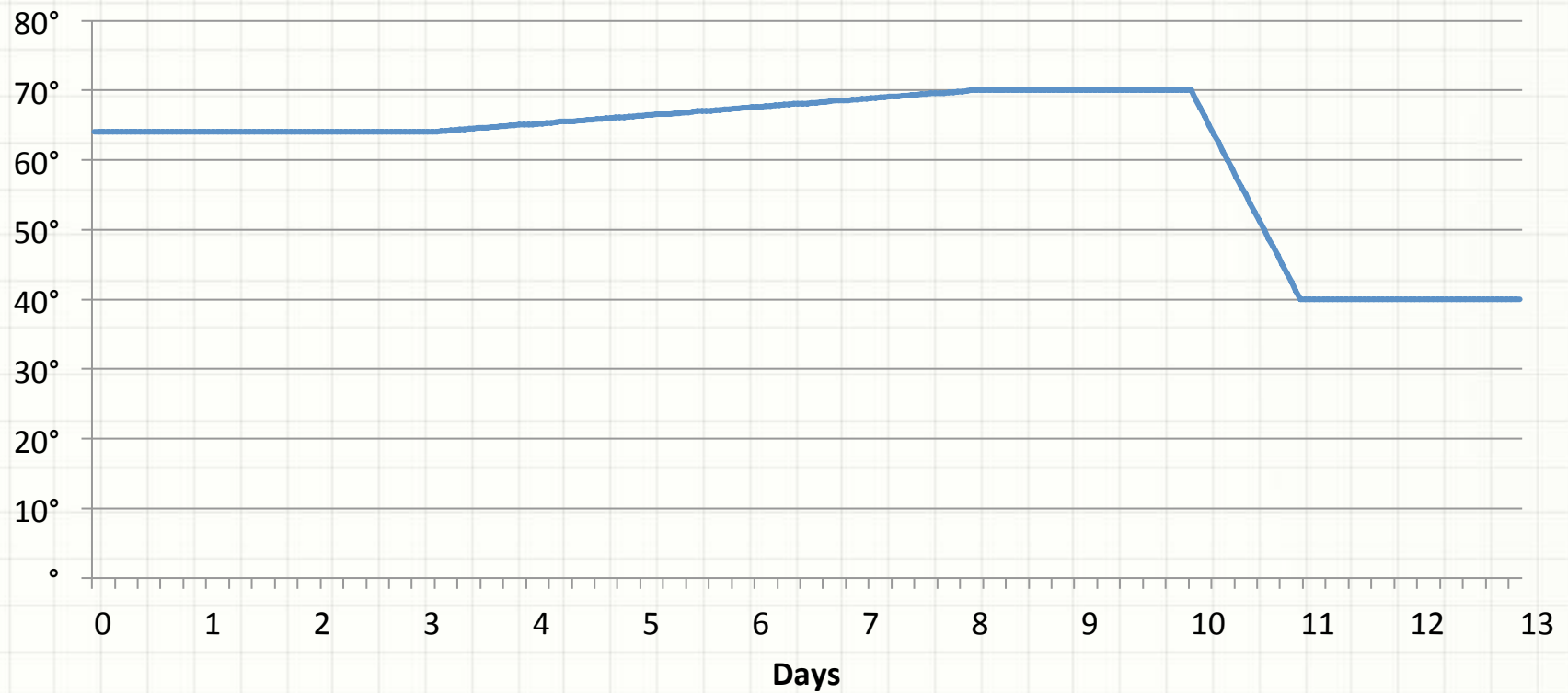


2-stage temperature controllers

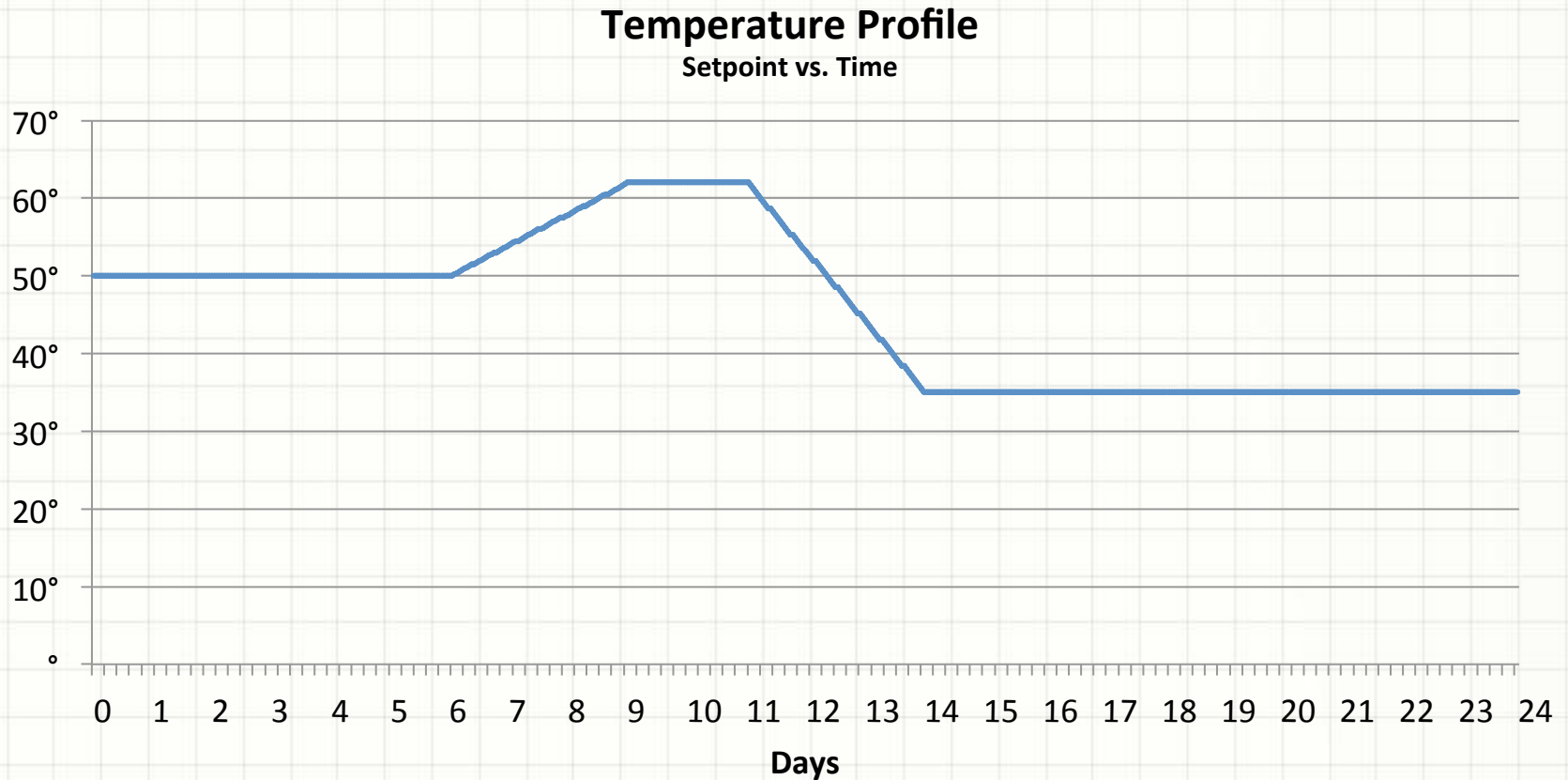


Temperature profile of WLP090

Temperature Profile
Setpoint vs. Time




Temperature profile of lager yeast






Extras: Beerbug





Hefeweisen

brew started: Jun. 21, '14 1:43pm
by: [Jim Williams](#)
where: Sunnyvale, California, USA
type: German Wheat

recipe specs.	O.G:	F.G:	ABV:
edit	1.052 1.051	1.014 1.013	4.8% 5.2%

[recipe notes](#) Water and stuff

[directions](#) no directions set

[ingredients](#) no ingredients set

[user notes](#)

Facebook for
your beer



Summary

- Make starters with a stirplate
- Provide sufficient oxygen
- Provide yeast nutrient
- Employ temperature control
 - Ferment on cold side for clean IPAs
- Know when the fermentation is complete
 - Clear
 - Stable gravity readings over 2 days
- Drink beer

Resources

- Starters
 - <http://www.howtobrew.com/section1/chapter6-5.html>
- Yeast propagation calculator
<http://www.brewersfriend.com/yeast-pitch-rate-and-starter-calculator/>
- Oxygen setup
www.williamsbrewing.com
- Yeast book



QUESTIONS?