# Craft Lager Fermentation Strategy and Management

Troy Casey

Brewer, AC Golden Brewing Company

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# Overview

- What is the AC Golden Brewing Company?
- Lager Fermentation Characteristics
- Fermentation Profiles
- Conclusions




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# Lager Fermentation Characteristics

# Lager Yeast

- Biggest difference between ale and lager
- Last ingredient to be added to the Reinheitsgebot, but the most important!
- If unfamiliar with lager yeast, use a yeast from a brewery with beer you like or respect
- When selecting a yeast, need to consider flocculation, temperature demand, and flavor characteristics

# Yeast Selection

- Most important aspect is flavor - does it taste good?
- Ester profile, sulphur production, temperature range and $SO_2$ are all somewhat strain specific
- Diacetyl production is not!
- Find a yeast that works for you under your conditions

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# One Yeast that we like…..

- Augustiner Lager yeast
  - Originated from the Munich Brewery
- Available through Brewing Science Institute
- Good flocculation
- Creates clean flavors - low sulphur production
- Very hearty, can be used at many different temperatures

# Lager and Ale Fermentations – What's Different?

# Wort Cooling

- Cool wort to at LEAST your primary fermenting temperature
  - Traditional to cool wort 1-2 °C below fermenting temperature, allowing yeast gentler start in fermentation
  - This creates a longer lag and growth phase, allowing the proper flavor contributions

# Aeration

- Oxygen is needed for formation of yeast cell walls, just like with ale yeast
- Low aeration rates slow down overall and start of fermentation, increase sulfur
- High aeration will increase yeast growth, altering beer flavor

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# Aeration

- If using pure oxygen, it's important to have some sort of direct measurement of wort oxygen level
- Absorption level changes with temperature, flow rate, and wort strength
- Gas flow meter is not enough for accurate injection!

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# Trub and Cold Break

- Traditional lager brewers will remove cold break, which they say contributes harsh characteristics, better yeast performance
- Centrifuge, filter, or floatation tank
  - 2-8 hours in floatation tank, with or without yeast, aerated during filling
  - Cold break will settle to top of tank, then skimmed or racked off
- Be careful of $SO_2$!

# Pitching Rates

- Consistency is key
- At least 1.2 million cells / ml / degree Plato
  - We pitch up to 1.5 million cells / ml / degree Plato
- Underpitching can cause delay in fermentation, under attenuation and altered flavor profile - The D!

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# Fermentation Temperature

- Most important consideration is yeast strain you are using
- Higher fermentation temperatures increase yeast growth, which speeds fermentation and increases diacetyl, esters and higher alcohols

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# Cold Fermentation

- Anywhere from 5-9 °C
- Less yeast growth
  - Increases esters, sulphur production
  - Less VDK production, but takes longer to reduce what is produced
- Longer primary, secondary fermentation
  - Probably at least a six week beer

# “Warm” Fermentation

- Anywhere from 10-13°C
- More yeast growth
  - More higher alcohols, hot character - very important when brewing high gravity lagers
- More esters released due to temperature, not yeast growth
- Shorter primary, secondary fermentation
  - VDK are produced, reduced faster
  - Lager beer can be ready in as little as three weeks

# VDK Control

- Ale yeast seem to create more VDK than lager yeast
- Need fresh, healthy yeast pitch to reduce VDK during fermentation
- Newly propagated yeast are not as apt to reduce VDK
- The more delicate the beer, the more the VDK will show through if the level is too high

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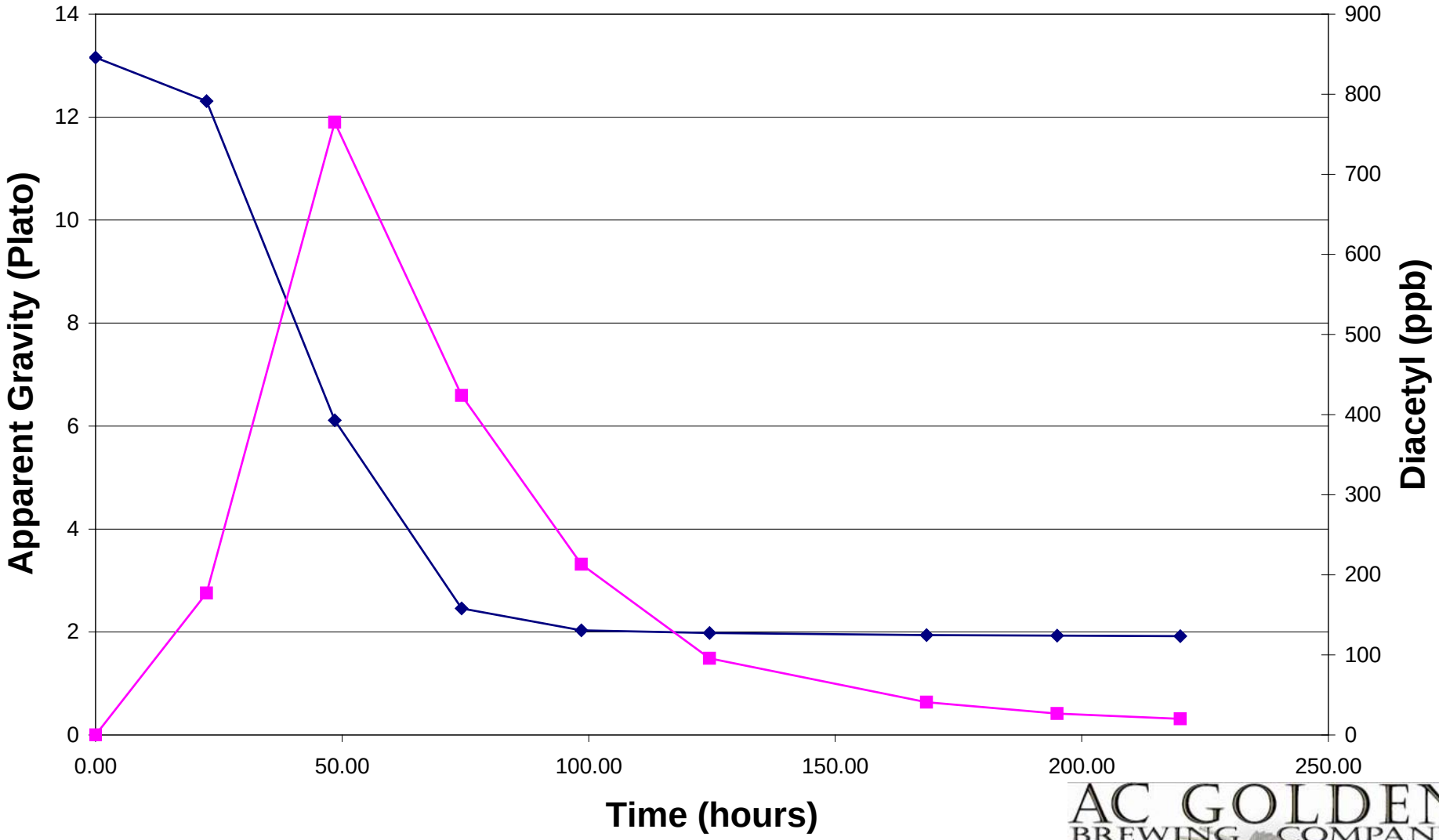
# Very Popular "American" Ale Yeast

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# How ACG Controls VDK

- Diacetyl rest - increase fermentation temperature 1-2 °C mid way through fermentation
  - Ramp at 50-60% of expected attenuation
  - Ensures yeast is still active in fermentation
  - Helps in forming the VDK so that it's available for yeast
  - Maintain increased temperature until VDK reduction complete

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# Maturation

- Once diacetyl level is acceptable, slowly crash fermenter or aging tank to near freezing levels
  - No more than 1 °C an hour, faster can shock yeast and release $H_2S$ (Brewing: Science and Technology, Briggs, Boulton, Brooks, Stevens)
  - Longer drop time is not necessary as the VDK has been fully reduced

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# Maturation

- After initial yeast crop and cooling the beer, it's important to periodically crop the break and yeast that settles out during aging
- The reason why will be instantly apparent
- This will make filtration days much shorter!

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# $SO_2$ in Lager Beer

- Created naturally by yeast during fermentation
- Created much more by lager yeast than ale
- Legal requirement that any beer must be labeled CONTAINS SULFITES if the $SO_2$ level exceeds 10 ppm
- The TTB has a lab in Washington to analyze $SO_2$

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# $SO_2$ in Lager Beer

- Great for flavor stability as $SO_2$ binds with oxygen and other staling compounds
- $SO_2$ is not volatile, so it can't be purged from beer like some other sulphur compounds
- The flavor threshold is 25 ppm, so taste is not an accurate measure
  - Burnt match and vitamin bottle are sensory descriptors
- Must be lab tested to determine concentration

# $SO_2$ Control

- Strain specific
- Easiest way is to make sure your yeast is as happy as possible
- All things that make yeast happy will help to control $SO_2$
  - Oxygen, wort trub, good pitch rate, nutritious wort, good storage conditions

# Yeast Handling

- We crop after attenuation is complete plus one day to allow for more yeast settling
- Still plenty of yeast in suspension for VDK reduction
- When saving yeast for repitching, store cold (1°C) at atmospheric pressure
- Use as soon as possible – lager yeast is delicate
- Before pitching, allow yeast to acclimate to wort temperature
- How many generations?
  - German brewers say 4-5, but depends on your process

# Fermentation Profiles

# First Yeast Pitch - What's Different?

- Higher fermentation temperature than planned for future fermentations
- About 2 PPM increase $O_2$ dose
- Warmer wort cooling

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# CBC #1 Parameters

- 20 bbl pitchable slurry for 8.5 bbls of 11 °Plato wort
  - 1.5 million cells/ml/Plato
- 12 ppm $O_2$
- Cooled wort to 10 °C
- Fermentation at 12.5 °C the whole way

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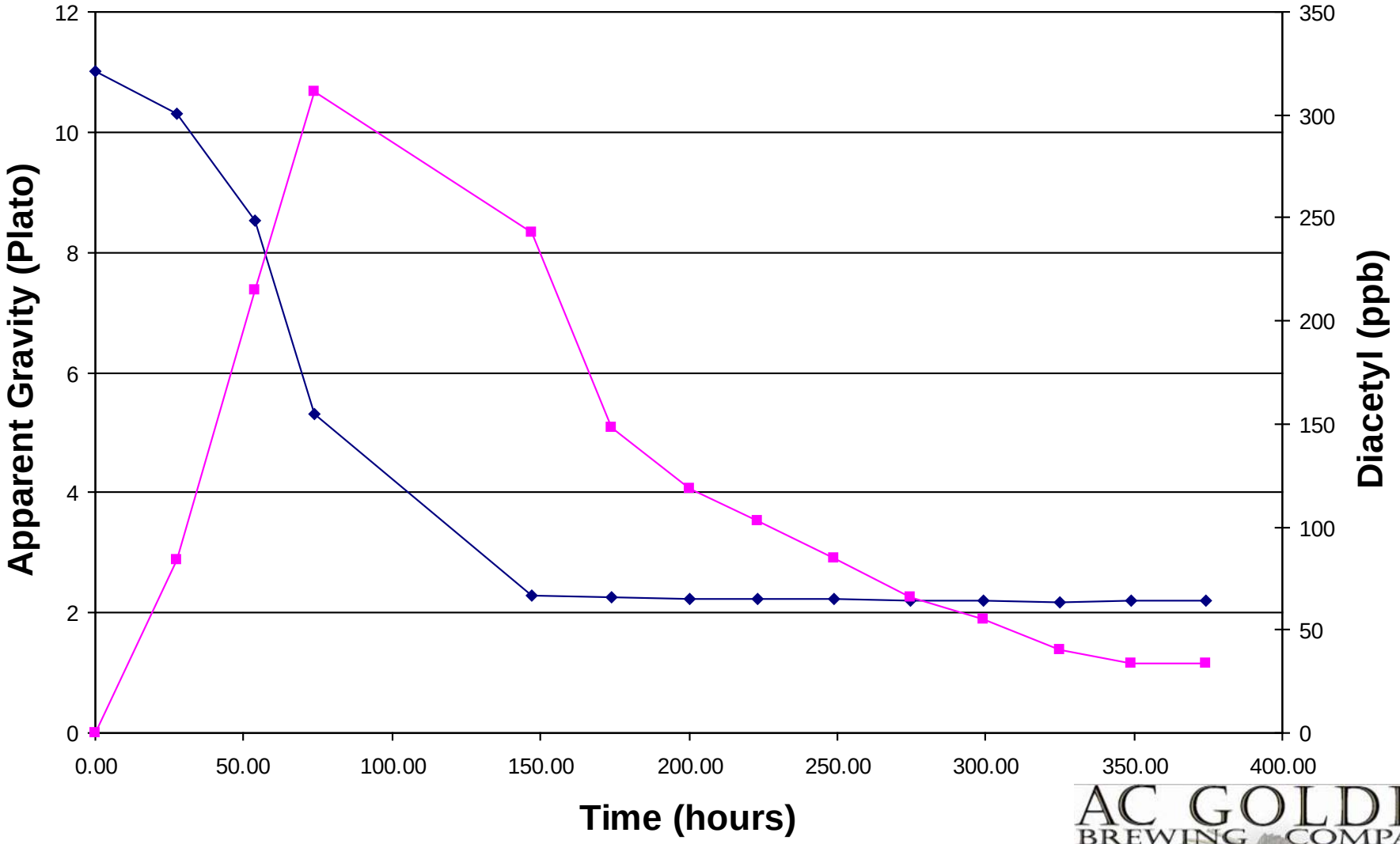
# CBC #1

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# CBC #2 Parameters

- 11 °Plato wort
- Pitched 1.5 million cells/ml/Plato
  - Needed all the yeast cropped from CBC#1
- 10 ppm $O_2$
- Cooled wort to 9 °C
- Fermented at 11 °C until 6 °Plato remaining, and allowed free rise to 12.5 °C

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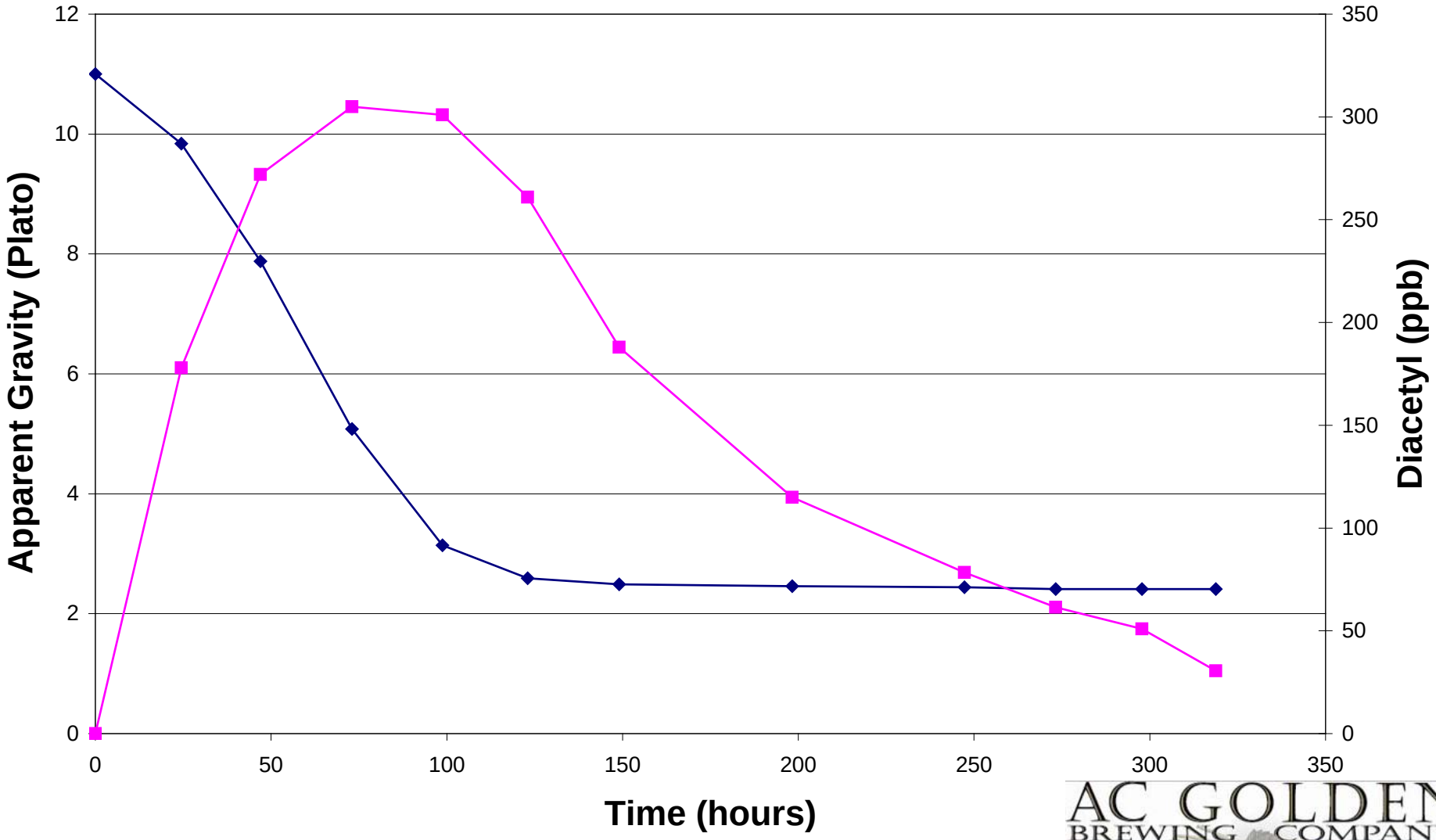
# CBC #2

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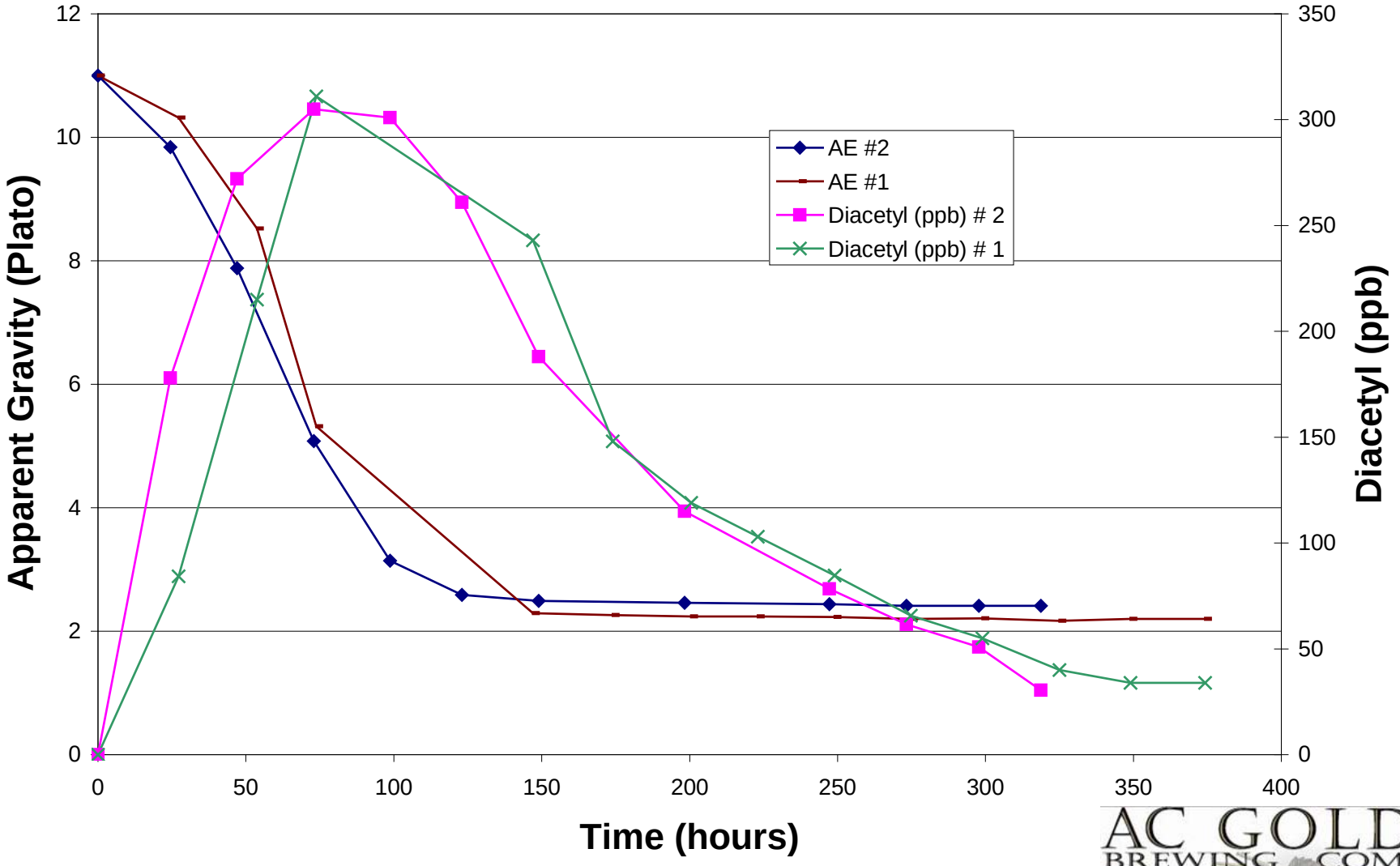
# CBC #1 vs CBC #2

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# CBC #3 and CBC #4

- Brewed our Dunkel and split the wort into two identical fermenters
- Same pitch rate of 1.5 mill cells/ml/Plato, 10 ppm $O_2$
- CBC #3 – ACG Traditional Fermentation
  - Cooled wort to 9 °C, fermented at 11 °C, free rise at 6 °Plato to 12.5 °C
- CBC #4 – Fermented at 18 °C
  - Cooled to 17 °C, no D rest

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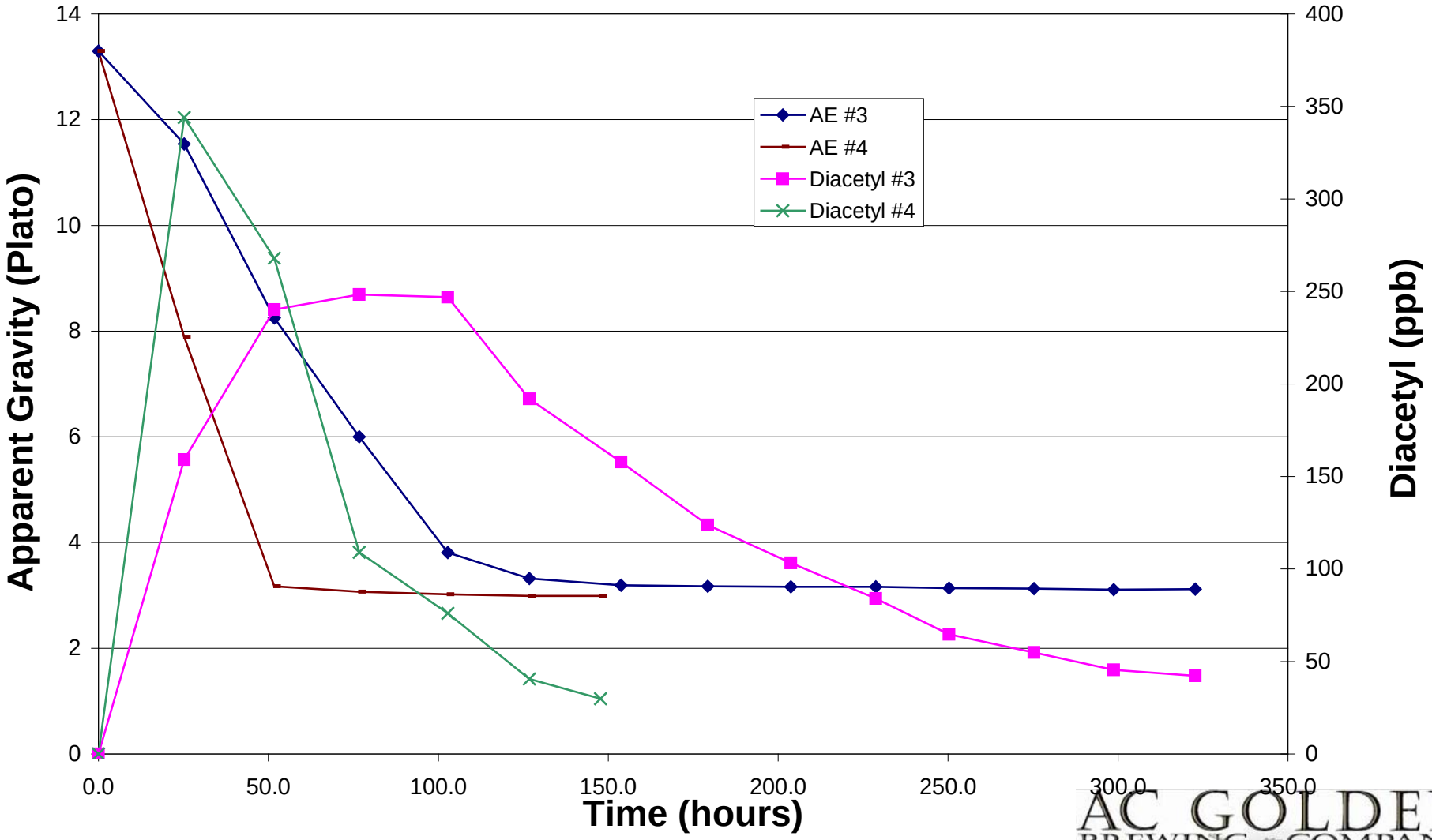
# CBC #3 vs CBC #4

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# How Do They Taste?

**CBC #3**

Cleaner all around

Balanced

Malt, hops show through better

Preferred 6-4

**CBC #4**

More esters, fruity

Yeasty

More sulphurs

Astringent

Harsh

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# CBC #5 and CBC #6

- Brewed a 12 °Plato beer and split the wort into two identical fermenters
- Same pitch rate of 1.5 mill cells/ml/Plato, same $O_2$
- CBC #5 – ACG Traditional Fermentation
  - Cooled wort to 9 °C, fermented at 11 °C, free rise at 6 °Plato to 12.5 °C
- CBC #6
  - Did a “reverse” D rest, and dropped beer to 7 °C at same Plato as above
  - Some brewers claim this helps with yeast flocculation and crop

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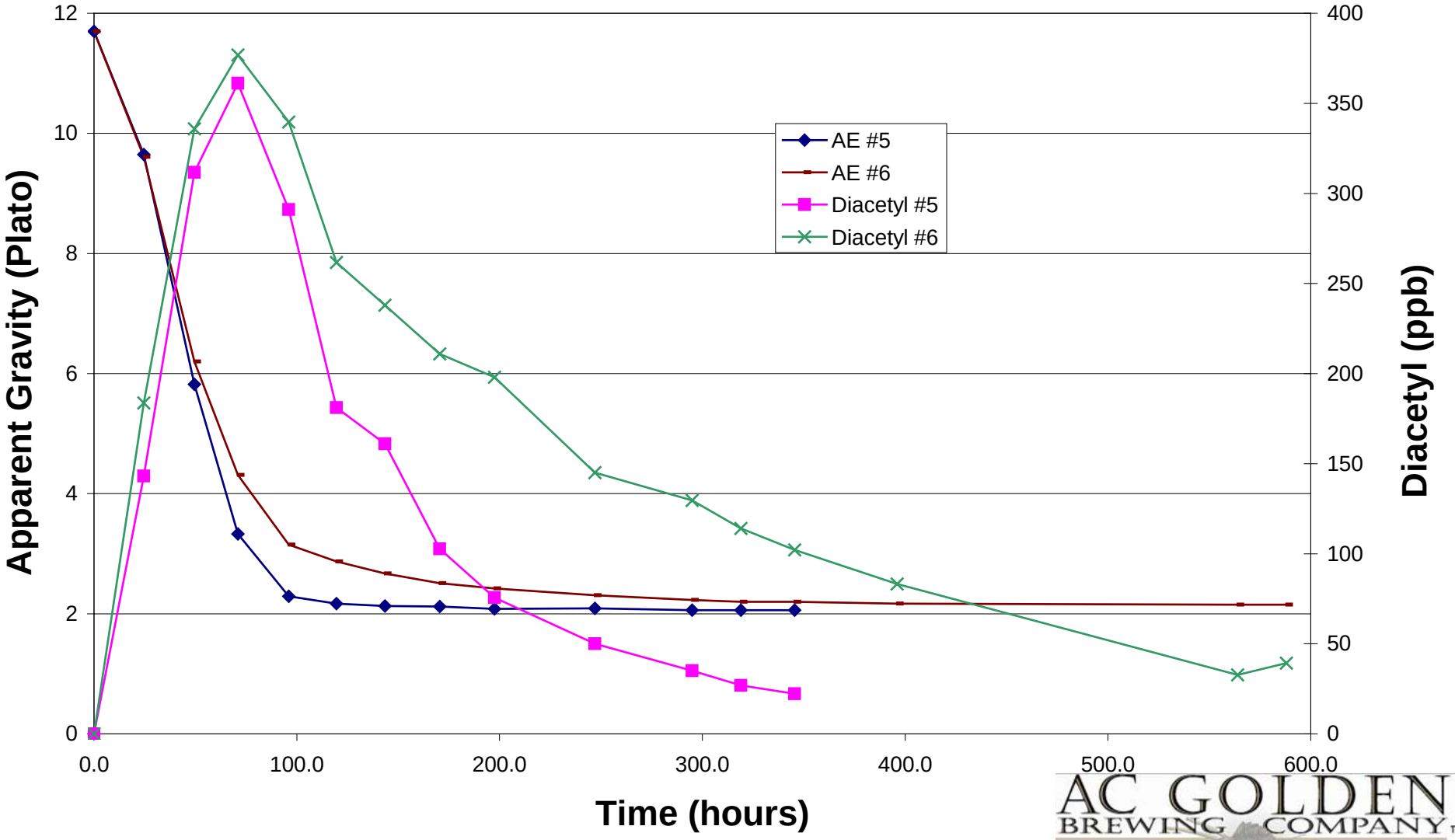
# CBC #5 vs CBC #6

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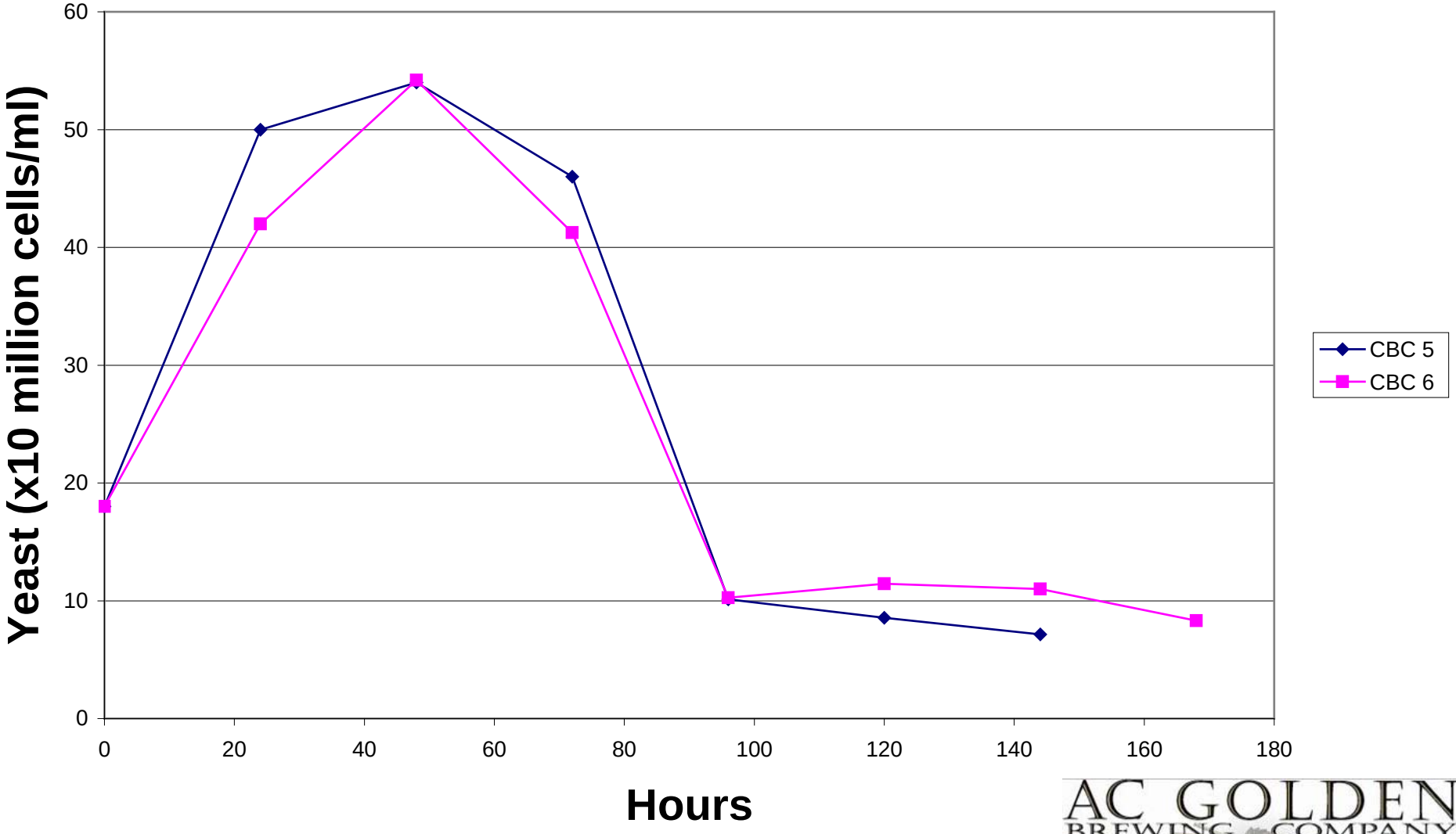
# CBC#5 and #6 Yeast in Suspension

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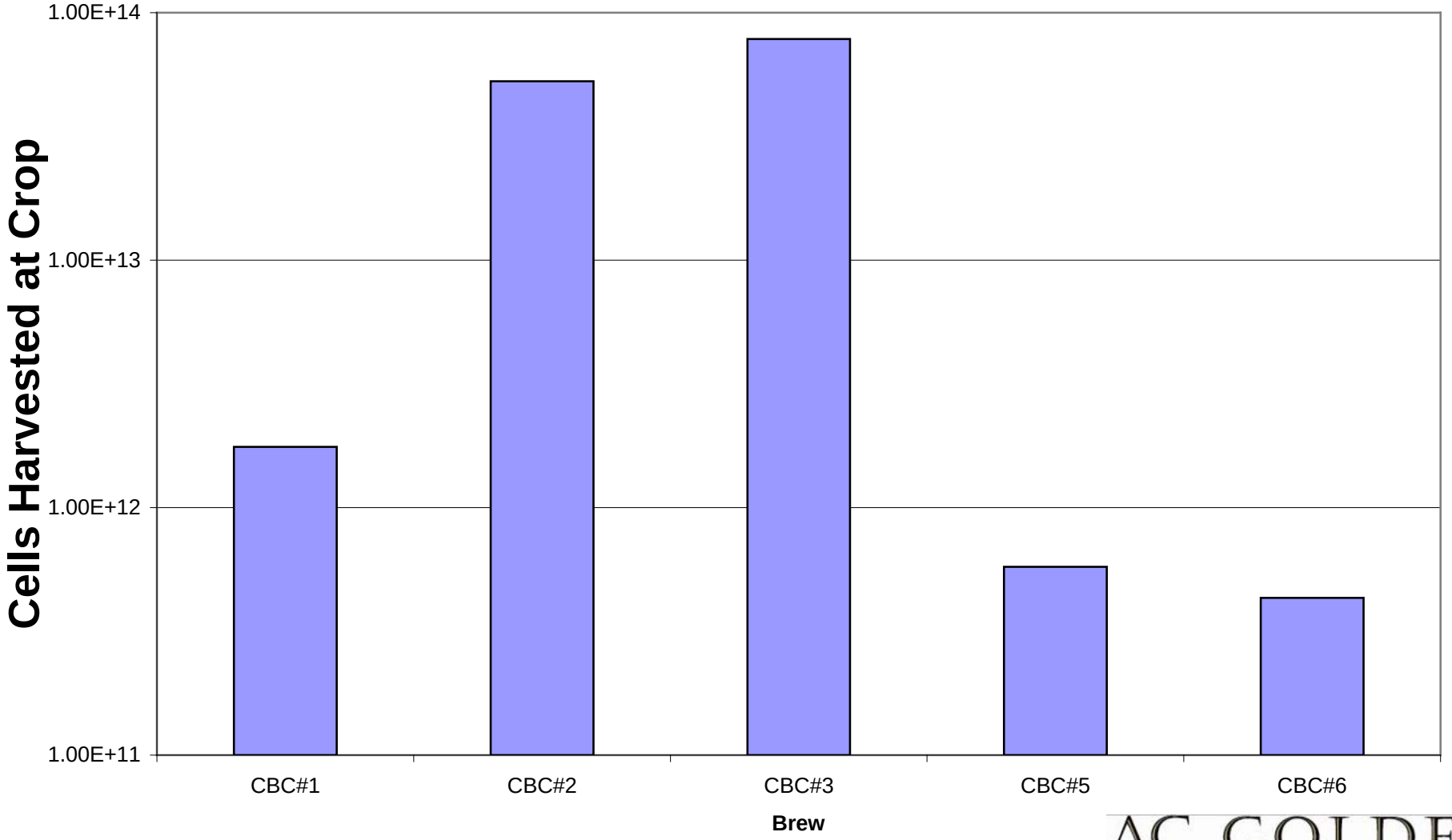
# Total Cells Harvested

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# $SO_2$ Results

- CBC #1 – 1.6 ppm
- CBC #2 – 3.8 ppm
- CBC #3 – 9.5 ppm
- CBC #4 – 0.1 ppm – ale-like temperatures!
- CBC #5 – 2.3 ppm
- CBC #6 – 4.8 ppm

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# Conclusions

# It’s All About the Yeast!

- Pitch the right amount of yeast and ferment at the right temperature
- By doing so you’ll get:
  - “Fast” fermentations
  - Great flavors
  - “Quick” tank turnover

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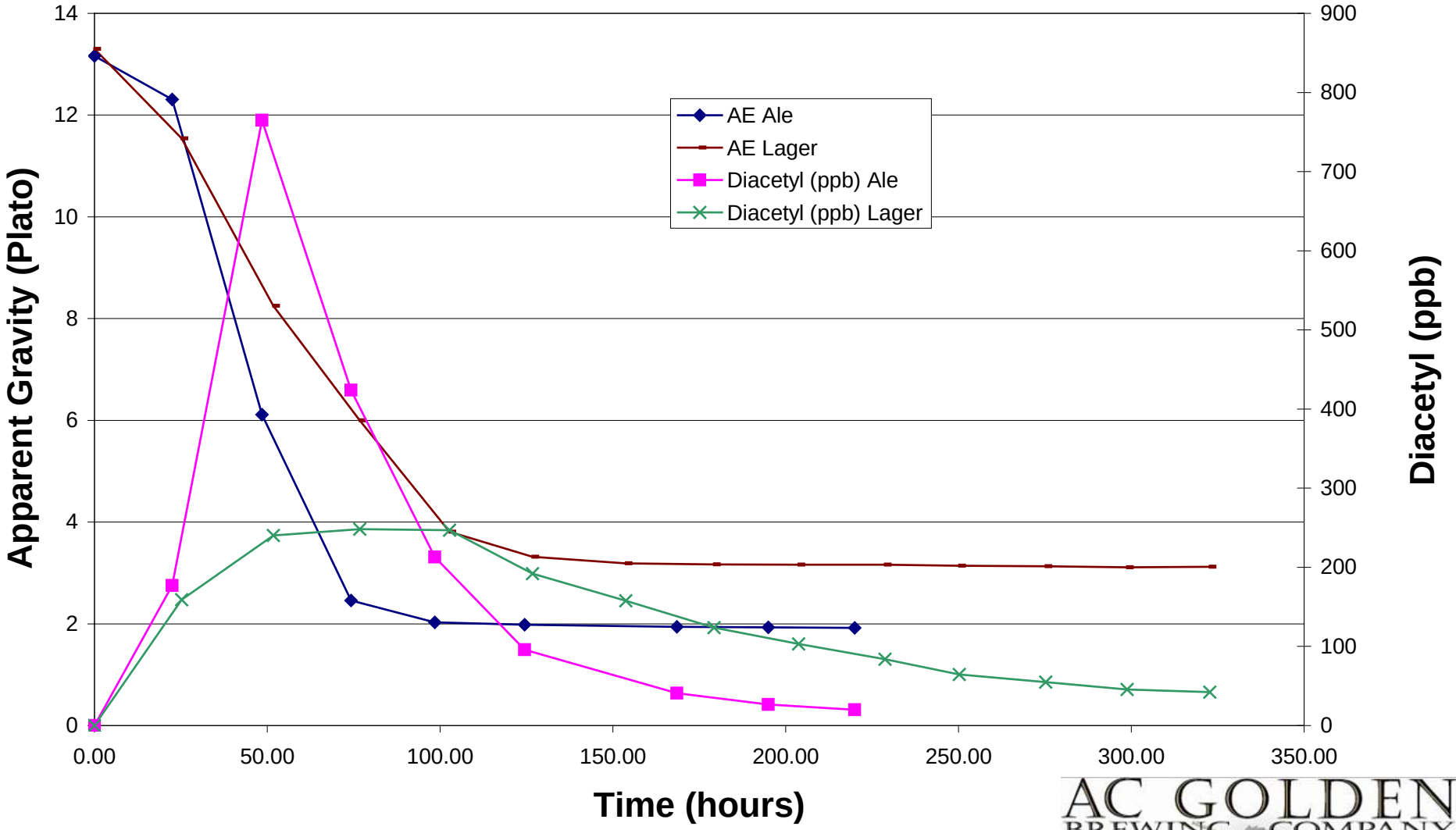
# Beware of the D!

- Allow plenty of time for the yeast to reduce the diacetyl
- Even if you really think it is all gone, double check!
  - Take a sample and put it in a hot water bath in the morning, and then take it out and chill it to taste at the end of the day to see if any remaining
  - This only works if you are sensitive to VDK

# Ale vs Lager Yeast Fermentation

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# Thanks for Sticking Around!

- The entire AC Golden brewing team
- Jenn Reffner and Steve Bosben in the MillerCoors QA lab for sample analysis
- All the brewers who have shared their lager brewing experience with me

**troy.casey@acgolden.com**

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