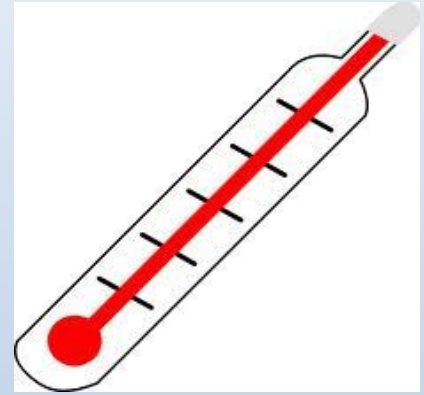
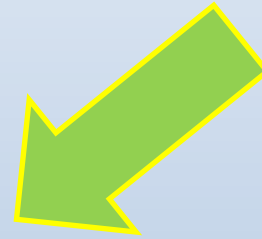
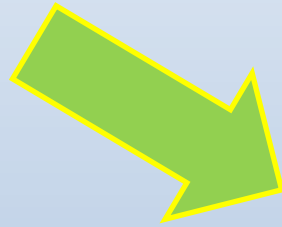


AGING BEER

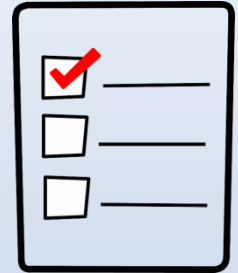


$$F(\text{beer sensory}) = f(\text{time}, \text{temperature})$$

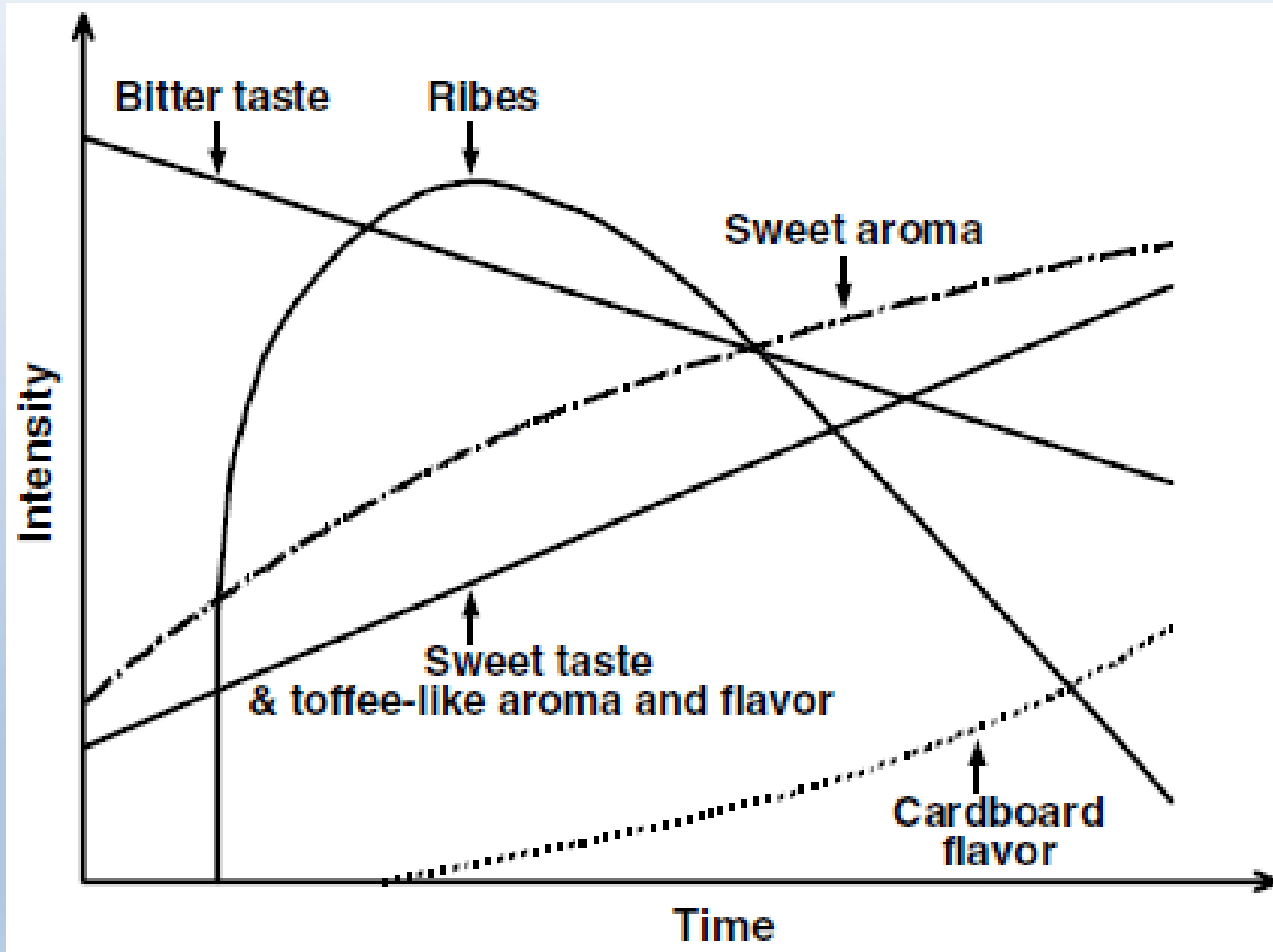
By Calvin Ninh

Relevant topics not covered

- Oxygen/oxidization
- Microbe contamination, off-flavors
- Microbe & colloidal stabilizing
 - Pasteurization, fining, filtering
- Additions, like sulfites & stabilizers
- Packaging: cans, bottles, caps, growlers, wax, corks, ect.



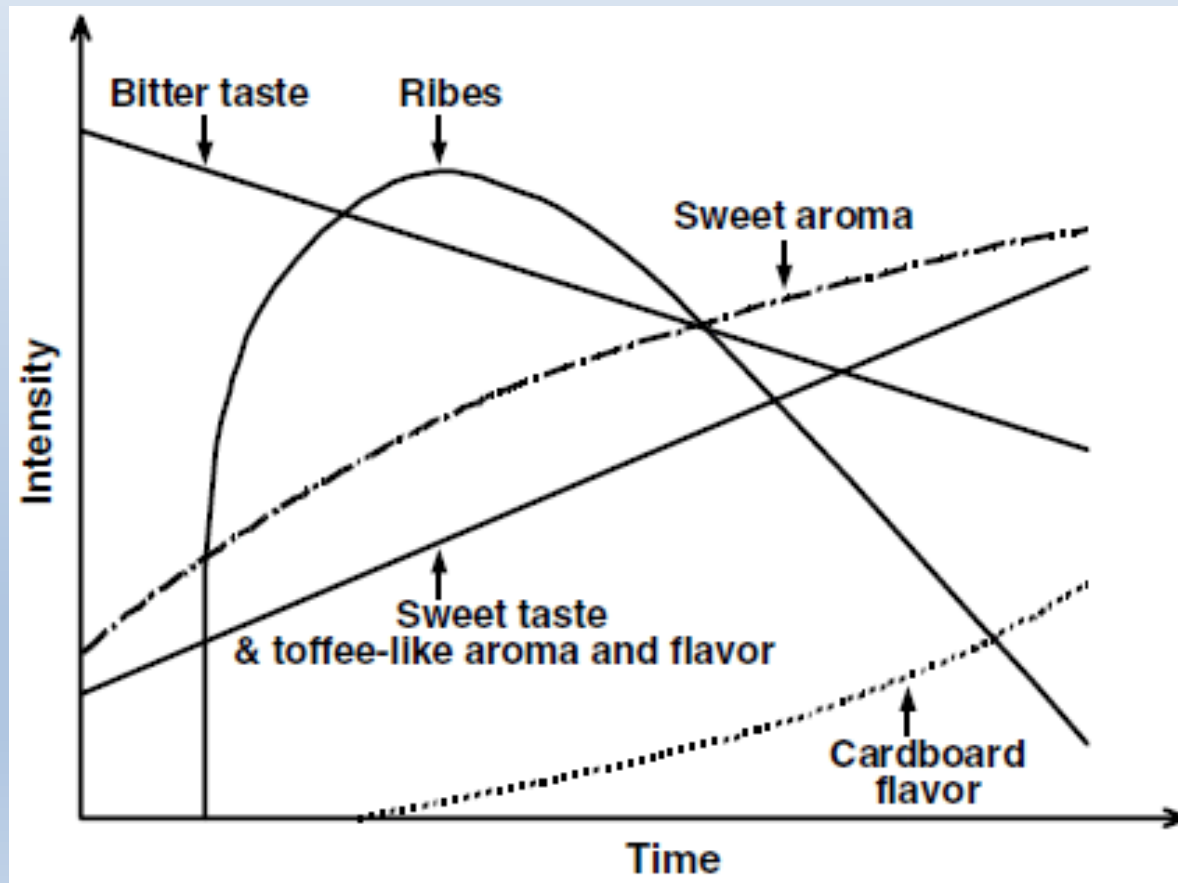
Theory



Dalgliesh, 1977. *Sensory Changes During Beer Aging*

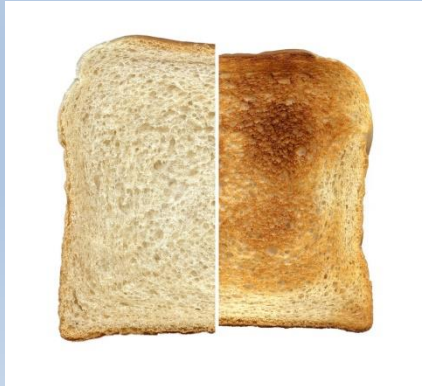
Beer tasting time!

- Time to drink & compare



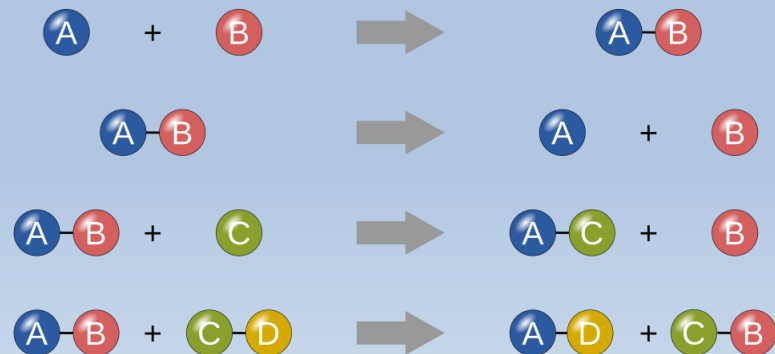
Sensory Notes

- O_2 seeps in \rightarrow E-2-Nonenal \rightarrow cardboard
- Ribes (certain hops) – “cat piss” over time
- Alpha-acids degrade
 - Balance = bitter vs. sweet?
- Note: brewhouse operations do not affect beer after it is packaged



What is Going On?

- Formation of aging carbonyls
 - Strecker degradation of stuff
- Breakdown of lipids
- Maillard reactions
- Breakdown of isohumulones (hops) → less bitter
- O₂ seeps in, free radical reactions



Arrhenius Equation

The diagram shows the Arrhenius Equation $k = Ae^{-\frac{E_A}{RT}}$ with red arrows pointing to each term and its definition:

- k : rate constant
- A : frequency factor or pre-exponential factor
- e : mathematical quantity, e
- E_A : activation energy
- R : the gas constant
- T : kelvin temperature

- Higher $T \rightarrow$ faster rate of reaction
 - Beer stored hotter gets “old” faster
- Other constants are relatively similar in beers

Forced Aging Timeline

[Approximation for an American lager (with an eagle involved on the label) that has been pasteurized. Tasting done by sensory professionals.]

Temperature (°C / °F)

- a) 0 / 32
- b) 10 / 50
- c) 20 / 68 (ambient)
- d) 30 / 86
- e) 35 / 95 (interpolated)
- f) 40 / 104
- g) 50 / 122
- h) 60 / 140

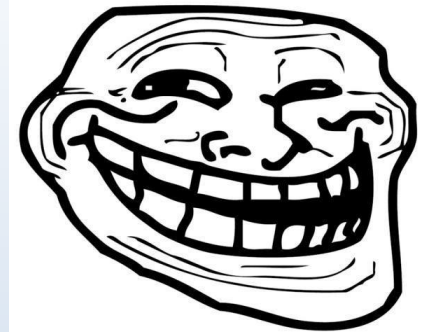
Days to Staling (stale = beyond expectations)

- a) (long time)
- b) 330
- c) 110
- d) 30 – 35
- e) 20 – 41 (interpolated)
- f) 10 – 12
- g) 3 – 4
- h) 1

As a ...

- Brewer: Find out what the beer is supposed to taste like & have it taste like that as long as possible
 - Your skills, establish expiration dates
- Shipper: Transport beer in refrigerated trucks
 - Why beer is best out of the bright tank
- Collector: Store beer as cold as possible
 - Freshness & aging beers systematically
- Customer: appeal
 - Fresh may not be best, whatever sells

Issues



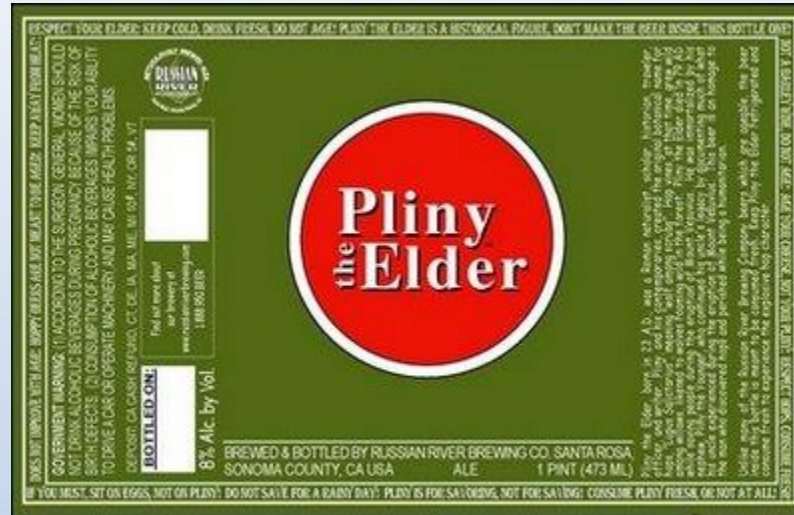
problem?

- Improper storage
 - Shipping/storing beer
 - Beer competitions (why you may not get a 50)
- Increasing temperatures and English casks
- Not drinking “fast enough” or cellaring
- Beer to beer & taster variations
 - Overall: judgement call

Real Life



(don't C&D me, bro)



Fresh is best

Well aged brew



Shipping Cold

- Expensive: NanoCool shippers

- <https://www.nanocool.com/products/universal-systems>

Easy as 1 – 2 – 3

Easily portable, NanoCool 2-8°C systems arrive ready to activate and ship. There's no need to freeze and condition gel packs (or worry about whether gel packs have been conditioned or packed correctly).



1. Open box, remove cooling engine and place silver foil side down on a flat surface. Push straight down on the activation button.



2. Notice the NanoCool logo turning blue between 30 seconds and 3 minutes indicating cooling has begun. Confirm by touching the surface of the cooling engine near the activation button.



3. Load product into the payload compartment, replace the cooling engine, close the box and tape shut prior to shipping.

- Basic: Foam shipping kit + ice packs

- https://www.uline.com/BL_2157/Insulated-Shipping-Kits?keywords=insulated+foam+shipping+kit



Extras

- Flavor Stability in Beer with Dr Charlie Bamforth - BeerSmith Podcast #74:
<https://www.youtube.com/watch?v=Fm2t5HrMcc>
- Cellaring beer:
 - <https://beerconnoisseur.com/articles/how-cellar-beer>
 - <https://beerandbrewing.com/8-tips-for-successful-cellaring/>
 - <https://www.beeradvocate.com/beer/101/store/>