

Foam



What is Beer Foam?

- CO₂ Bubbles surrounded by surface-active molecules, with...
 - low surface tension
 - high hydrophobicity
- These surface active molecules (mainly) include..
 - Proteins/Polypeptides
 - Iso-Alpha Acids



How is Foam Formed?

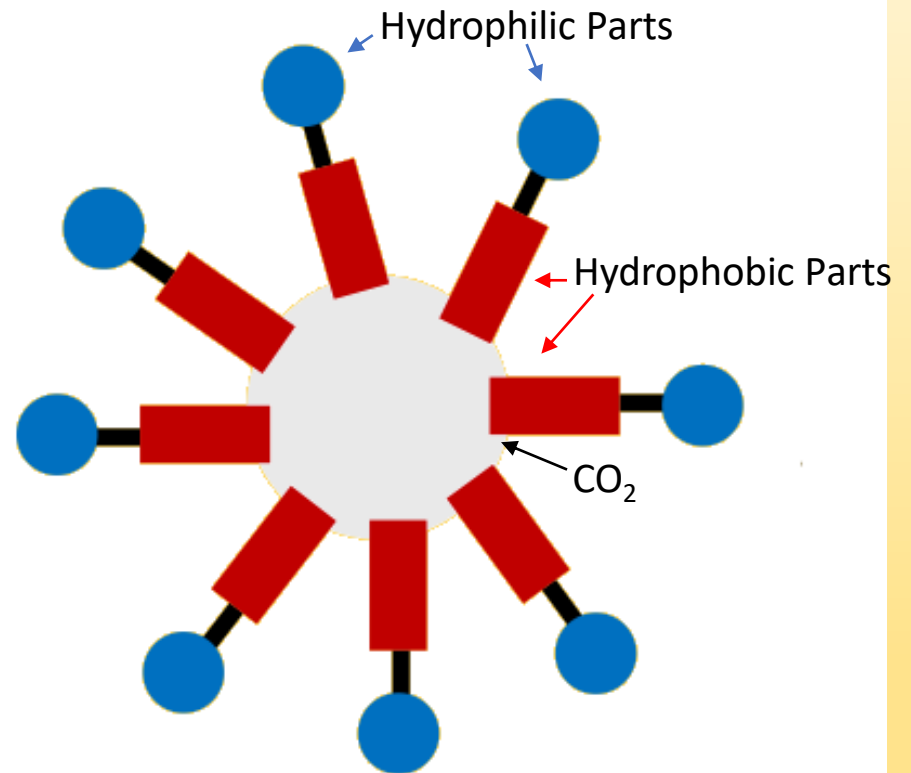
- Pressure Reduction
 - pouring beer
 - temperature increase
- CO₂ Condenses and Releases from Nucleation Sites
 - Glass flaws
 - Particles in Beer
- CO₂ Bubbles Rise, attracting the Surface Active Molecules
- Surface Active Molecules form Layer around the Bubble
 - Stabilizes the Bubble in the Liquid Beer



How is Foam Formed (cont.)?

The hydrophobic part of Surface Active Molecules interact with the CO₂ bubble.

The hydrophilic parts of Surface Active Molecules interact with each other, holding bubbles tightly together.



A single CO₂ bubble, with Surface Active Molecules



Foam Production vs Foam Retention

- Foam Production
 - Dissolved CO₂ Content
 - Amount of Nucleation Sites
 - Release of Pressure
 - Intensity of Pour
 - Faucet/Glass Temperature
- Foam Retention
 - Surface Active Molecules



Things that Enhance Foam Retention

from
Grains

- **Lipid Transfer Protein (LTP1)**
 - Boiling denatures and makes *more* effective
- **Protein Z**
- Polypeptides from hydrolysis of Hordein during Malting
- Melanoidins (from kilned malts)
 - Protect the foam from Lipids
- Isomerized Alpha Acids (from hops)
 - Bond with Polypeptides, strengthening stability
- Iron (good for foam, bad for flavor)



Things that Harm Foam Retention

- Alcohol
 - may reduce rigidity of surface active molecule layer
- Lipids
 - make surface layer *too* Hydrophobic and Rigid, compromising stability
- Fatty Acids
 - Interfere with foam positive proteins
- Detergents
 - on glassware or brewing/dispensing equipment
- Proteinase A
 - Enzyme secreted by yeast that degrades proteins
 - Stressed yeast make more
- Warm Beer Temperature
 - fine bubbles merge into larger bubbles and collapse



Practices for Good Foam

- Use Malt from Barley with high Nitrogen (protein) content
- Add Flaked/Malted Wheat or Flaked Barley (proteins)
- Avoid Over-Modified Malts (destroys proteins)
- Limit No/Low Protein Adjuncts (corn, rice, sugar)
- Avoid Protein Rests with well Modified Malts (destroys proteins)
- Use Caramel Malts & other Highly Kilned Malts (contain Melanoidins)
- Limit Use of Oats, Coconut, Coffee, Chocolate (fats/oils, i.e. lipids)
- Keep Most Kettle Trub Out of Fermenter (Fatty Acids)
- Make Bitter Beers (Iso-Alpha Acids)
- Adequate Yeast Health and Pitch Rates (avoid stress)
- Pasteurization (commercial breweries, denatures Proteinase A)
- Scrupulously Clean Equipment and Glassware
- Vorlauf (retains more Lipids in grain bed instead of kettle wort)

