Turbidity in Radler: from compound to final product

EBC symposium on beer-mix beverages
September 2014 – Vienna
To discuss

- Heineken’s interest in Radler products
- Production/composition of Radler products – interest in turbidity
- Turbidity – a particle’s journey from compound to final product
- Physical principles of (in)stability of turbidity in final product
Global introduction of Radler products by Heineken
Radler composition and production

- A Radler is comprised of:
  - Beer
  - Fruit compound (in– or excluding sugar/sweetener)
  - Dilution water

- Mixing of the different compounds – storage in bright beer tank – bottling – pasteurisation

- Most Radler products are turbid
  - Turbidity originates from fruit compound
  - Turbidity should be controlled
  - Turbidity should be stable
Examples of compound systems

- Several compound systems are in use:
  - Using different fruits and flavourings (e.g. lemon, lime, grapefruit …)
  - Using both clear and turbid juices
  - Using different stabilizer systems (e.g. gums)
  - In some occasions oils are applied (cloudifiers)
  - In- or excluding added sugars / sweeteners
  - Compounds deliver both flavour and turbidity

- Recipe of compound lies with the supplier – often not fully known by the brewer
Radler production (example)

1. Bright beer high ABV
2. Sugar syrup + Dilution water
3. Diluted & sweetened beer
4. Radler Compound
5. Static Mixer
6. Bright Beer Tank
7. Filler
8. Pasteur
Particle size analysis (light scattering) during Radler production: compound

- Mono-disperse distribution $\varnothing \sim 3–4$ um
After static mixer

- Both break-up and aggregation occurs
Final products (after pasteur)

- Tri-modal distribution of particle sizes
Effect of pasteurization - lab-scale trials

Left: non-pasteurised  right: pasteurised
Phase separation in IBC’s

No phase separation

Clear phase separation
Compound with clear phase separation—analysis of phases

- **LOWER phase:** <1 um particles
- **UPPER phase:** main peak 4–5 um, plus minor <1 um and ~50 um particles

After mixing in IBC: similar to upper phase, with higher contribution of <1 um particles
Analysis of compound (after mixing)

- IBC with clear phase separation
  - Small sub-micron particles absent
  - Cause unknown
  - Break of sub-micron particles appears to affect phase separation

- IBC without phase separation
  - Small sub-micron particles absent
  - Cause unknown
  - Break of sub-micron particles appears to affect phase separation
Summary observations on particle size: compound and Radler production

- Both break-up and aggregation processes occur during production
- Some break-up (and aggregation) already present in compound
- Aggregation can be induced by pasteurisation
- Effect on Radler (final product) stability to be established

- Intensity / type of changes is Radler-dependent
- Need to study on product–for–product basis
Physical principles governing stability of turbidity: rules of thumb

Particles < ~1 um
Subject to heat movement

Stable turbidity
(when inert)

Creaming if density of particle is lower than Radler matrix

Sedimentation if density of particle is higher than Radler matrix
Images of unstable Radlers

Turbidity settled to bottom

Radler is no longer turbid

Turbidity creamed to top
Microscopical analysis: sedimentation

- In the good Radler, particles are mostly dispersed
- In the sedimented Radler, aggregated particles are present
Microscopical analysis: creaming

- In the good Radler, particles are dispersed
- In the creamed Radler, aggregated particles are present
What is going on?

Aggregation of Radler compound particles leads to larger particles >> unstable turbidity
So, what matters?

- Size of particles
  - Final product

- Density of particles and Radler matrix

- Aggregation and dispersion forces
  - Inter-particle interactions (vdW’s forces, charge, hydrophobicity)
  - Stabilization forces
  - Reactions with beer matrix

- Physical properties of beer matrix (e.g. viscosity, yield stress)

- External factors: e.g. use of enzymes, storage conditions
Electrostatic and polymeric stabilization

**DLVO theory**
- Van der Waals attraction
- Electrostatic repulsion

**Potential energy**
- Potential barrier
- Minimum potential energy
- Repulsion
- Attraction

**Polymeric stabilization of colloids**
- Steric stabilization
- Depletion stabilization

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Before answering questions, I have one for you

- Currently, no EBC methods and standards for Radler/beer mixes exist regarding colour, turbidity, stability …

  - We lack a common language, in a fast growing category …

  - What to do ….??