# PROCESS CONTROL FOR BEER PHYSICAL STABILITY: CHILLPROOFING & TARGETING HAZE PROTEINS BY SILICA!

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**Timing of SHG addition**? Treat before diameter of "average" haze protein too large to enter pore? Add at ruh vs. fassing?

SHG with reduced permeability, e.g. **Lucilite** (+)

**Lower temperatures** increases capacity of SHG for sensitive proteins.

Most effective size range for SHG's is 3-12 nm ... if larger ppt foam proteins.

Non-uniform dosing of chillproofer (-). SHG must contact all beer!

SHG removes haze active proteins with high levels of proline (>30%) and glutamine (>30%).

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**Mechanism** is the **diffusion** of proteins from the beer to the surface of the SHG, then followed by **adsorption** to the hydrated silica gel surface and their penetration into the silica pores.

**"Stringy Floaters"**....consist of cysteine rich proteins (of the B3 fraction of 14-25 kDa hordeins) not removed by SHG treatment which in beers with high DO, high storage temps and high $SO_2$ lead to their formation.....suggest via formation of disulfide bridges.

**Siebert:** examined following:
a) One commonly used SHG milled to **mean particle sizes** of: 5.1, 9.1, 14.5, 20.6 and 24.4 um;
b) **Five independent SHG's, one a xerogel** with avg sizes of @ 9.5 um;
c) three **addition rates**: 150, 300 and 1,000 ppm
d) **Test methods:** Chapon alcohol cooling, SASPL, HA protein tests.

**Findings:**
i) **Alcohol and HA protein tests** in good agreement with forcing test….thus good predictability,
ii) **SASPL less** correlative with forcing,
iii) **SHG particle size** had no impact on HA protein or SASPL predictive test results,
iv) **Forcing test** indicated much better stability with the **lowest & highest** particles sizes...poorest with the intermediate sizes,
v) The **xerogel ineffectual** in removing protein or stabilizing beer!!

**Effect on Beer Physical Stability**

US Patent Appl. US 200501142258 A1: most SHGs are processed to be free of alkali metal salts, however this patent claims improved ability of SHG to remove haze forming proteins using silica xerogels with alkali metal (preferably sodium or potassium) or a mixture of 2 or more alkali metals, optionally with the addition of an alkaline earth metal or metals (preferably calcium or magnesium), preferably totaling 0.2-1.0 mmol/g at pH of a 10% aqueous slurry at least 8, and preferably between 8.5-10.5.

Select **grade of SHG** with best pore size distribution and surface hydroxyl activity i.e. "surface accessibility" is important! Use different grades for all-malt vs. high adjunct formulations.

**Handtmann's CSS**: "Combined Stabilization System"...use of porous X-linked 100-300 um agarose beads removes both polyphenols and > 45 kD haze specific proteins...regenerable in 2 hr CIP/SIP with 12% salt + 4% caustic. Can regenerate 500x, 1.5 year operational life. Hot water sterilizable in 30 minutes. Cost to operate @ 0.08-0.11 $US/hL (+)

**CCS**: beads produced by GE for use in harvesting proteins in pharmaceutical industry – now a brewing application used by Foster's & Heineken in Russian breweries; Tooheys & Lion Nathan in Australia and a Czech brewer. Beads are agarose – spacer – $NH_3$ structure, with length of spacer determining which proteins bind to $NH_3$. Contain $OH^-$ groups to bind PP's fraction too.

**CCS**: regenerable agarose bead ion exchangers (ammonia group with chloride as the counter ion) coupled to beads with spacers. Absorbs both tannins and proteins <106 daltons.

By changing SHG surface chemistry, can change selectivity of SHG for proteins e.g. ["free-silonol sites"].

**CB** states SHG with low permeability (filterability) obtain better stability, but should add in aging and use more DE in filtration….OR use increases amounts of high permeability (filterability) SHG in-line along with DE filter aid. Claim up to 2 years of stability possible with low permeability SHG!

Study of Xerogel vs. PVPP vs. SHG/PVP hybrid:
a) Xerogel also absorbs a portion of the anthocyanogen fraction, not just proteins, via non-specific adsorption.
b) other two fractions showed a much higher capacity to adsorb anthocyanogens & a greater selctivity for the species (mono, di or tri) adsorbed.
c) PVPP alone had a higher total anthocyanogen binding capacity than the PVP/silica hybrid.

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