117

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Innovation in beer clarification and stabilization using diatomaceous earth-based adsorbents

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ABSTRACT

With consumer habits driving demand for longer shelf life and better clarity of beer, chill haze reduction becomes critical. Haze reduction typically involves using diatomaceous earth (DE) in combination with silica gel. DE in combination with silica gel typically requires long hydration times and often results in reduced filtration efficiency due to fine silica gel particles clogging cake void spaces and ending the filtration cycle. This reduced filtration performance issue can be overcome by combining the functions of diatomaceous earth (filtration) and silica gel (cold stabilization) into one material; a DE-based adsorbent. By engineering the nano-structure of this filter aid to selectively adsorb haze-forming proteins, post-centrifuged beer can be filtered and highly stabilized (reduced chill haze) without sacrificing filtration performance. This poster presents studies which exhibit how the vast network of pore space within the DE-based adsorbent cake contributes to it's unique permeability and how the combination of permeability and high surface area of this engineered material contribute to significant chill haze reduction and filtration performance.

TECHNOLOGY

This DE-based adsorbent filter aid has been engineered to filter out large proteins via the complex inter/intra pore structure of DE while simultaneously and selectively adsorbing smaller chill-haze protein complexes which contribute to beer instability. The large pores help filter out permanent haze while the adsorptive surface on/within DE performs the chillproofing. Each gram of DE-based adsorbent can have between 65-140 m^2 of surface area with nano-pores carefully tuned in size for optimal chill-haze adsorption.

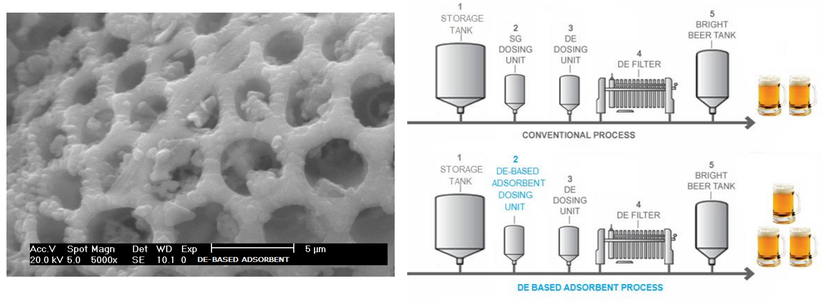

Figure 1. (Left) An SEM image of the surface of a DE-based adsorbent particle. (Right) A process diagram highlighting that a DE-based adsorbent can be used with existing filtration equipment and also result in more chillproofed barrels of beer per filtration cycle.

FILTRATION PERFORMANCE & CLARITY

Depending on the priority of a brewer, a compromise typically needs to be made between beer clarity/stability and beer throughput/yield. A DE-based adsorbent can be used to meet either of these needs. The table and graph below highlight typical physical properties and chillproofing data. The chillproofing data was collected by performing the Chapon (colloidal stability) test on raw post-centrifuged beer filtered with four types of DE-based adsorbent. Each type of product has a different combination of permeability and surface area.

DE-Based Adsorbent	Mid-Efficacy Low Permeability	High-Efficacy Low Permeability	Mid-Efficacy High Permeability	High-Efficacy High Permeability
TYPICAL PHYSICAL PROPERTIES				
Color	Buff	Buff	White to Off White	White to Off White
Appearance	Powder	Powder	Powder	Powder
Permeability (Darcy)	0.2	0.2	0.7	0.7
Density Wet (g/L)	360	360	360	360
Surface Area BET, m^2/g	65	140	65	140
Beer Soluble Iron (ASBC) ppm	25	25	25	25

Figure 2. Typical properties of DE-based adsorbent filter aids.

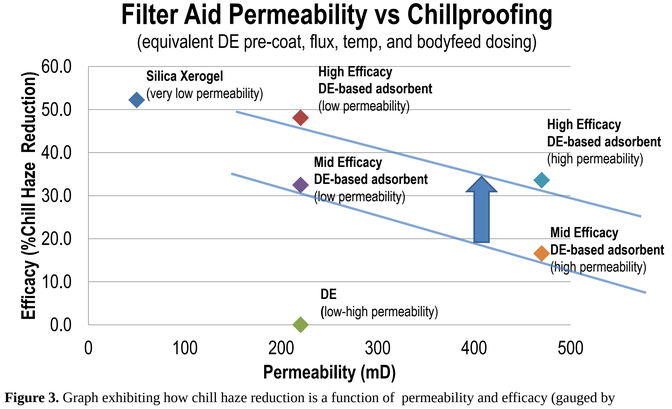

Figure 3. Graph exhibiting how chill haze reduction is a function of permeability and efficacy (gauged by surface area) of DE-based adsorbent.

PRESSURE RISE & STABLIZATION

Because DE-based adsorbents filter like DE, the filtration cycle experiences lower pressure rise. This means higher beer throughput and lower cost per barrel of beer than with a DE and silica combination system.

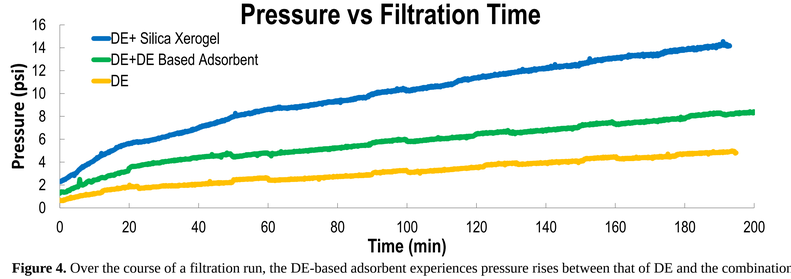

Figure 4. Over the course of a filtration run, the DE-based adsorbent experiences pressure rises between that of DE and the combination of DE and silica gel.

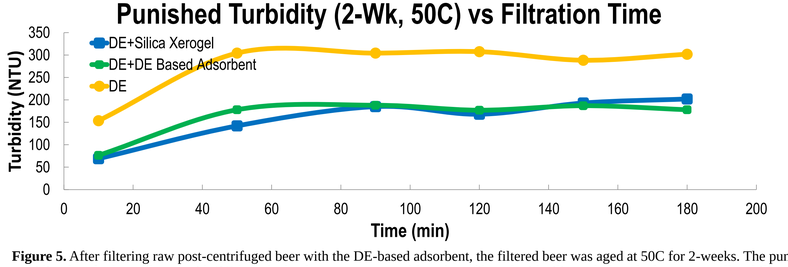

Figure 5. After filtering raw post-centrifuged beer with the DE-based adsorbent, the filtered beer was aged at 50C for 2-weeks. The punished turbidity data for beer filtered with DE-based adsorbent was comparable to beer filtered with silica gel, thus the beer was well stabilized.

CONCLUSIONS

- Lower permeabilities together with higher efficacies (as gauged by surface area) contribute to reduced chill haze.
- High efficacy DE adsorbent systems do not compromise on permeability/filtration performance.
- High efficacy DE adsorbent systems help decrease filter aid dosages significantly (by up to 50%).

IMERYS Filtration