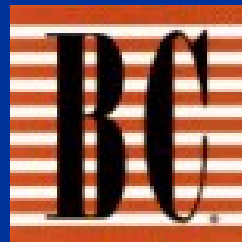


Cleaning and Sanitizing in the Brewery
MBAA Northern California
May 2, 2008
Sierra Nevada Brewing Co.
Chico, CA

Dana Johnson, BIRKO Corporation
Henderson, Colorado



Goals of this Presentation

- Why do we Clean?
- *How* do we Clean?
- Acid First/Acid Only Cleaning?
- Rising Chemical Prices – Why?
- Conclusion

Brewery Location/ Soil Composition:

- **Brewhouse :**
- Protein, starch, minerals, beerstone, hop oils, hop resins, fermentable sugars
- **Heat Exchanger:** Protein, starch, minerals, beerstone, hop oils, hop resins, fermentable sugars
- **Fermentation Tanks:** Protein, starch, minerals, beerstone, yeast
- **Maturation Tanks:**
- Protein, starch, minerals, beerstone, yeast
- **Bright Beer Tanks:** Beerstone, protein (unfiltered)

Chemical Cleaning Techniques Used in the Brewery

General Classifications:

- Hydrolysis
- Dissolution
- Displacement/Dispersion
- Emulsification
- Peptizing
- Chelation
- Back-Buffering

Hydrolysis

- Both caustics and acids use this approach.
- Breaks down soil with extreme pH.
- Extreme pH tend to be corrosive to soft metals like brass, copper, aluminum etc.
- When using caustic, the pH must remain above 12.5
- Keep the pH below 2 when using phosphoric, phosphoric/nitric blends.

Dissolution

- Here, we are simply dissolving the soil through whichever means work best. (Water, same or opposite pH).
- An example of dissolution is removing calcium deposits (hard water scale) with acid.

Displacement/Dispersion

- Alkaline, non-caustics products use displacement by suspending the soil in solution (primary fermenters, for example).
- This technique works extremely well in the “acid first” immediately followed by non-caustics alkaline detergent approach used in the brewhouse (mash/lautertun, brewkettle, heat exchanger).

Emulsification

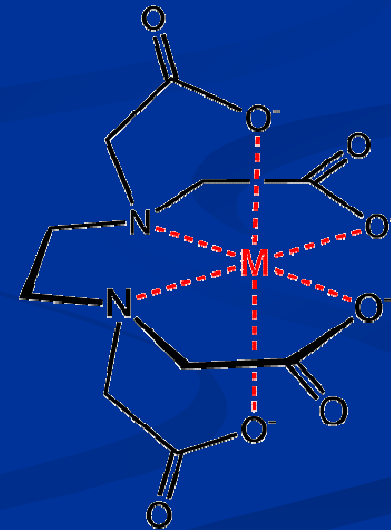
- Pulls the soil into the water and holds it there.
- Works well for greasy, oily types of soil through the use of surfactants, pH, solvents, etc.
- Critical Micelle Concentration (CMC) must be reached to effectively emulsify the soil.
- Allows the soil to then be sent to effluent.

Peptizing

- Definition: **Verb 1. peptize** – “disperse in a medium into a colloidal state”
- Further breaking down and suspending soil.
- Effective in recycled solutions to keep soil from re-depositing on the surface.
- Polyphosphates (STPP, TKPP) help peptize soil.

Chelation/Sequestration

- Chelators hold metal ions in suspension.
- Sodium gluconate used in “built caustic” solutions to chelate Fe hardness
- Citric is a chelator for iron
- EDTA uses chelation for metals with two or four bonding sites:



Conventional CIP

“Tried and true”.

- Rinse product out using ambient to warm water.
- CIP with 1-2 ounces of caustic blend per gallon of water (180 degree F. maximum temperature) for 15-30 minutes (or longer) depending on conditions.
- Rinse.
- CIP with 1-2 ounces of an acid cleaner per gallon per gallon of warm (120-140 degree F.) for 15-30 minutes to neutralize the caustic and finish cleaning.
- Rinse with ambient temperature water until the pH of the rinse water is neutral (same pH as the tap water coming in).

Mash Tun CIP (Traditional)

- The test was performed in the following manner:
- Caustic wash: 3% mixture of caustic and caustic additive— 40 minutes
- Caustic rinse cycle
- Acid wash: 3% nitric/phosphoric— 20 minutes
- Rinse

Mash Mixer Before



Mash Mixer After (Traditional) CIP



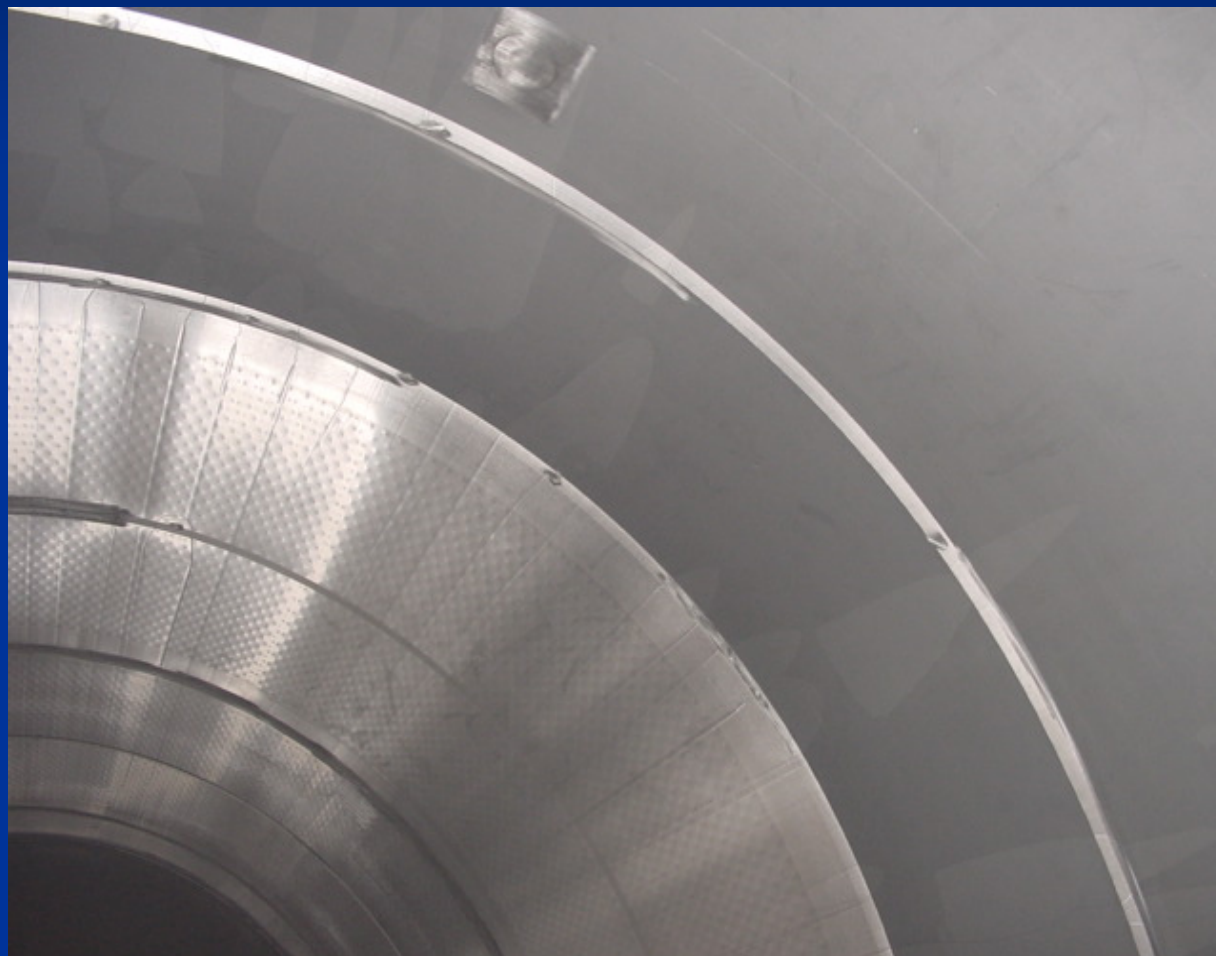
Fermentation Vessel CIP (Acid Only)

- The test was performed in the following manner:
- Acid Wash: 3% nitric/phosphoric blend & 32 oz. detergent additive – 20 minutes
- Rinse Cycle
- PAA Sanitation

FV Before CIP



FV After CIP



Acid First

REMOVING BEERSTONE

A LOOK AT ALTERNATIVE CLEANING METHODS
By Dana Johnson, Birko Corporation R&D

A big problem that can be encountered in breweries is removing the scale that forms in aging tanks, serving tanks and kegs. This particular type of scale is known in the industry as beerstone. Beerstone can be incredibly difficult to remove, especially after the buildup becomes visible to the naked eye. Why is beerstone different than other types of inorganic scale? Why is beerstone so difficult to remove? This article will detail the chemical composition of beerstone and give some alternative cleaning methods to remove this tenacious scale. Once free of beerstone, metal surfaces then typically require less aggressive chemicals to keep the problem from reoccurring.

Beerstone is a type of scale of known as calcium oxalate (CaC₂O₄). In the brewing industry, calcium oxalate is a precipitate. This precipitate is largely due to a reaction between alkaline cleaners (caustic), hard water minerals (calcium and magnesium) and protein (amino acids). (1,2) To be sure, there are other factors involved as well, but for the purpose of this article, I will focus on traditional cleaning methods which assist in creating a beerstone problem. If left unchecked, beerstone can have disastrous consequences for the beer.

If not completely removed in the cleaning process, beerstone leaves an unsanitary surface that can harbor microorganisms. (2) An unsanitary surface in the aging, serving tank or keg will infect the beer. Minimally, beerstone can cause "off flavors" or shorten the shelf life of beer. In the worst case scenario, undesirable organisms can ruin an entire batch of beer, costing time and money to replace. This situation is best to be avoided, so let's take a look at so-called "normal" cleaning methods used in the brewery that may assist in creating a beerstone buildup.

TRADITIONAL CLEANING METHODS

Caustic based products have traditionally been the standard in most breweries to remove soil. Generally speaking, in CIP (clean in place) applications, the caustic based product is used at a concentration of 2-4% with hot water. The solution is then rinsed and followed with a phosphoric based acid to neutralize the caustic to remove any beerstone or hard water scale left behind by the caustic. In cleaning primary fermentors and uni tanks this approach usually works just fine.



Dana Johnson is the manager of CONFACT IT Systems for the Birko Corporation of Denver, Colorado.

The caustic is subsequently rinsed out and followed with a phosphoric acid rinse. Some brewers also consider the phosphoric acid step as the sanitizing step, as most organisms cannot withstand the extreme temperature and pH swings involved in the cleaning process. Most brewers, however, use a sanitizing compound (such as Iodophor) to ensure that any surviving bacteria, yeast or mold do not create a problem later. Even if a sanitizer is used, however, the surface will still harbor organisms if a beerstone problem exists. The organisms simply "hide" in the cracks and crevices of the beerstone. When conditions later improve, the organisms then proliferate.

THE PROBLEM WITH BEERSTONE

Beerstone is not a straight inorganic scale like a hard water scale (which tends to be calcium and/or magnesium based). Beerstone also contains carbon in the form of protein. Protein acts as the "bindor", making the scale tenacious. To remove protein soil, sodium hydroxide (caustic) is typically the chemical of choice. (2) Using a form of hydrolysis known as saponification, the protein soil is hydrolyzed by the caustic to form soap. Once this reaction has taken place, the soil can then be termed, "saponified". In hard water, the calcium and magnesium can attach to these soaps. If the result-

A New Approach

- We have discovered a new way to keep brewery equipment clean using the following procedure:
 - Rinse out beer and yeast with ambient to warm (not hot) temperature water.
 - Use a 1-2 ounce per gallon phosphoric/nitric or nitric/phosphoric acid mixture (140 degree F. maximum temperature) for 15-30 minutes.
 - **No rinse!**
 - Use a noncaustic alkaline cleaner at 1-2 ounces per gallon of warm (120-140 degree F.) to start. CIP for 15-30 minutes depending on conditions.
 - Rinse with ambient temperature water until the pH of the rinse water is neutral (same pH as the tap water coming in).

Brewkettle CIP

- The test was performed in the following manner:
- Acid wash: 3% v/v nitric/phosphoric blend– 1200 s
- Acid rinse cycle
- **NO NEUTRAL WATER RINSE!!!**
- Caustic wash – 3% w/v pre-blended mixture of 25% w/w caustic and caustic additive – 2400 s
- Caustic rinse cycle

Kettle-Before CIP



Kettle-After CIP (Acid First)

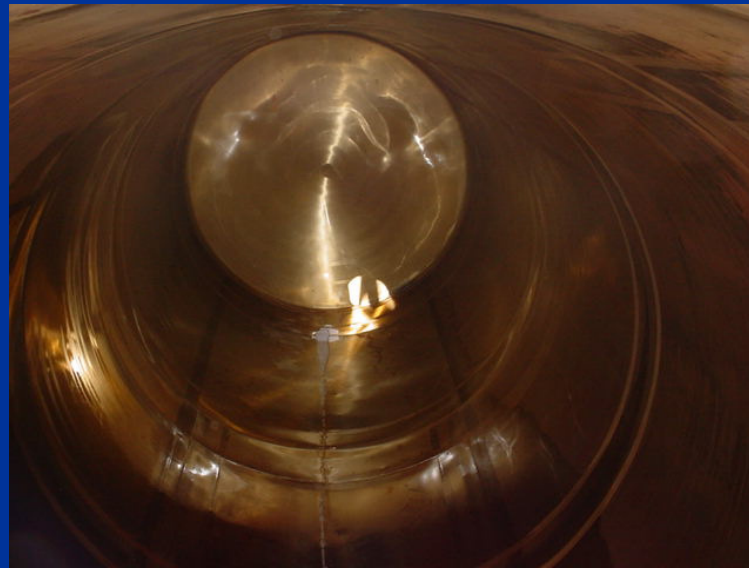


Brewkettle After CIP (Acid First)

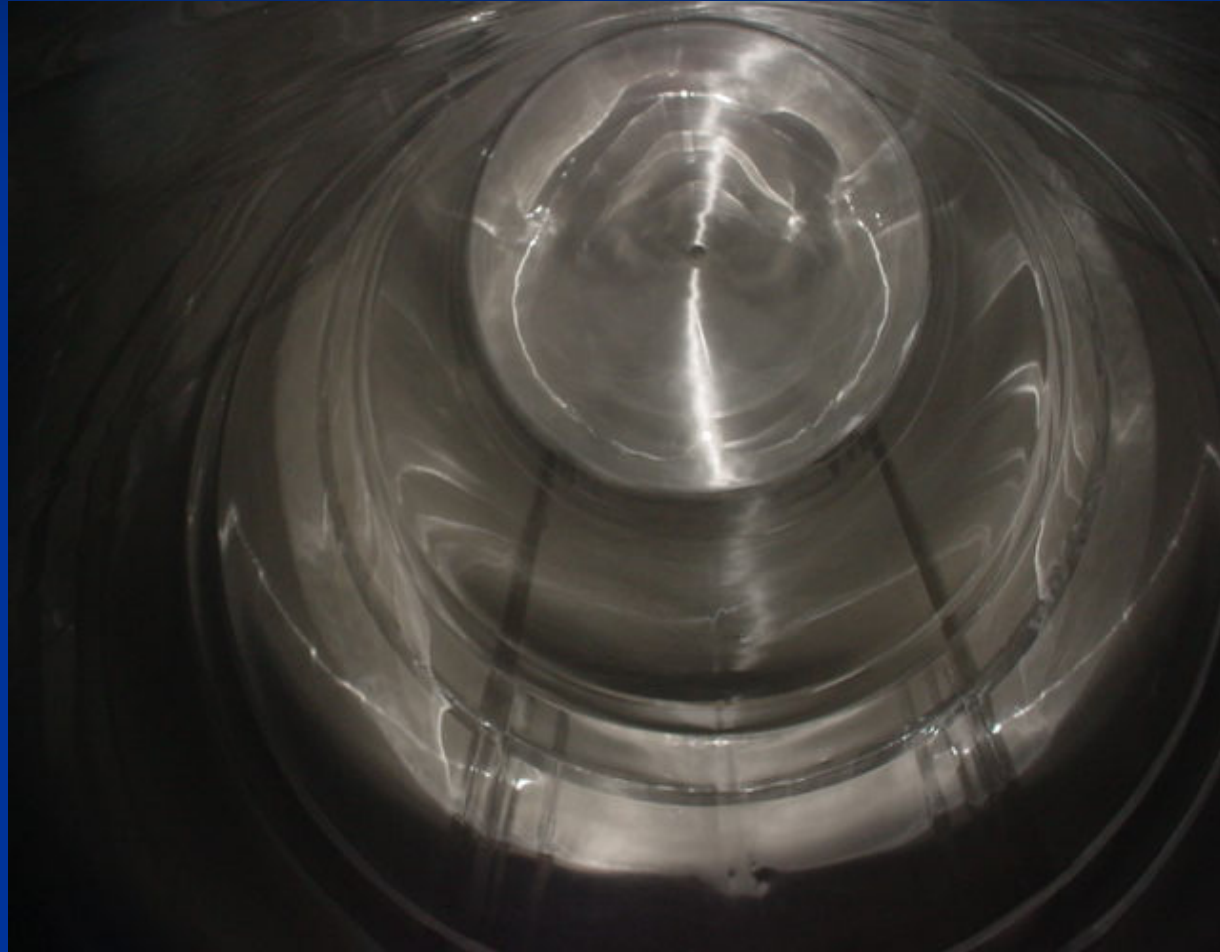


Acid First Works! Need More Proof?

- Wine Trailer Before Acid First/No Rinse/Noncaustic Treatment



Wine Trailer After Treatment



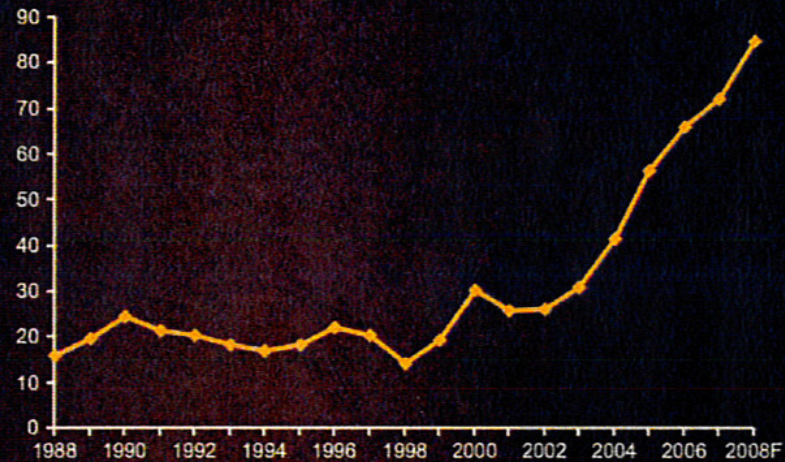
Chemical Prices

- More bad news. The rising cost of energy coupled with the fuel ethanol industry taking a lot of the commodity chemicals is driving up chemical prices.
- Look for higher prices on phosphoric acid, caustic (both sodium and potassium hydroxide). Nitric has not gone up as much yet.
- The fuel ethanol industry is using a lot of fertilizer to grow corn, which is causing phosphoric and potassium prices to rise as well.

Oil Prices 1988 - Present

Oil Prices are High

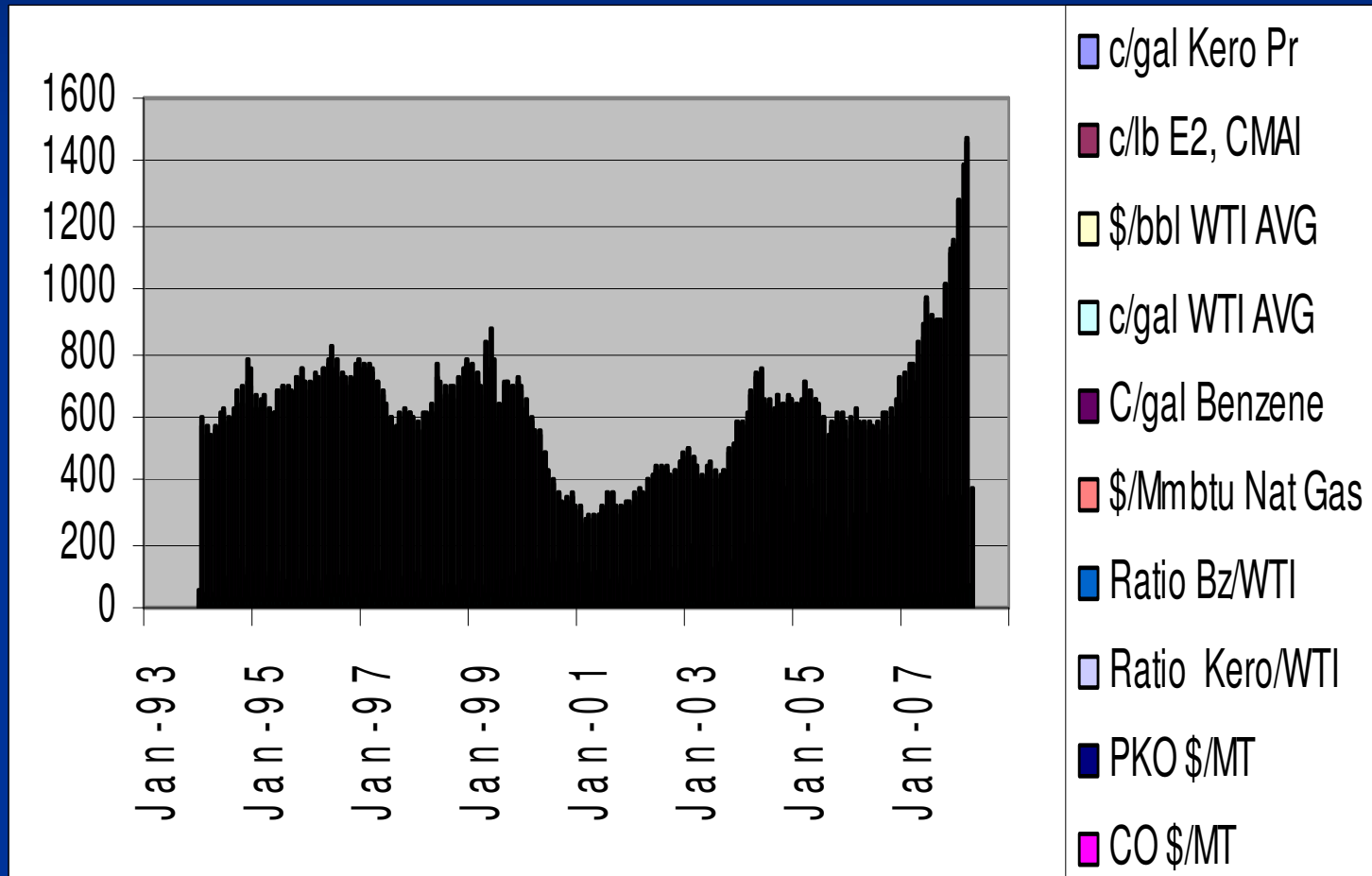
WTI Annual Average Spot Oil Price – \$US/Barrel



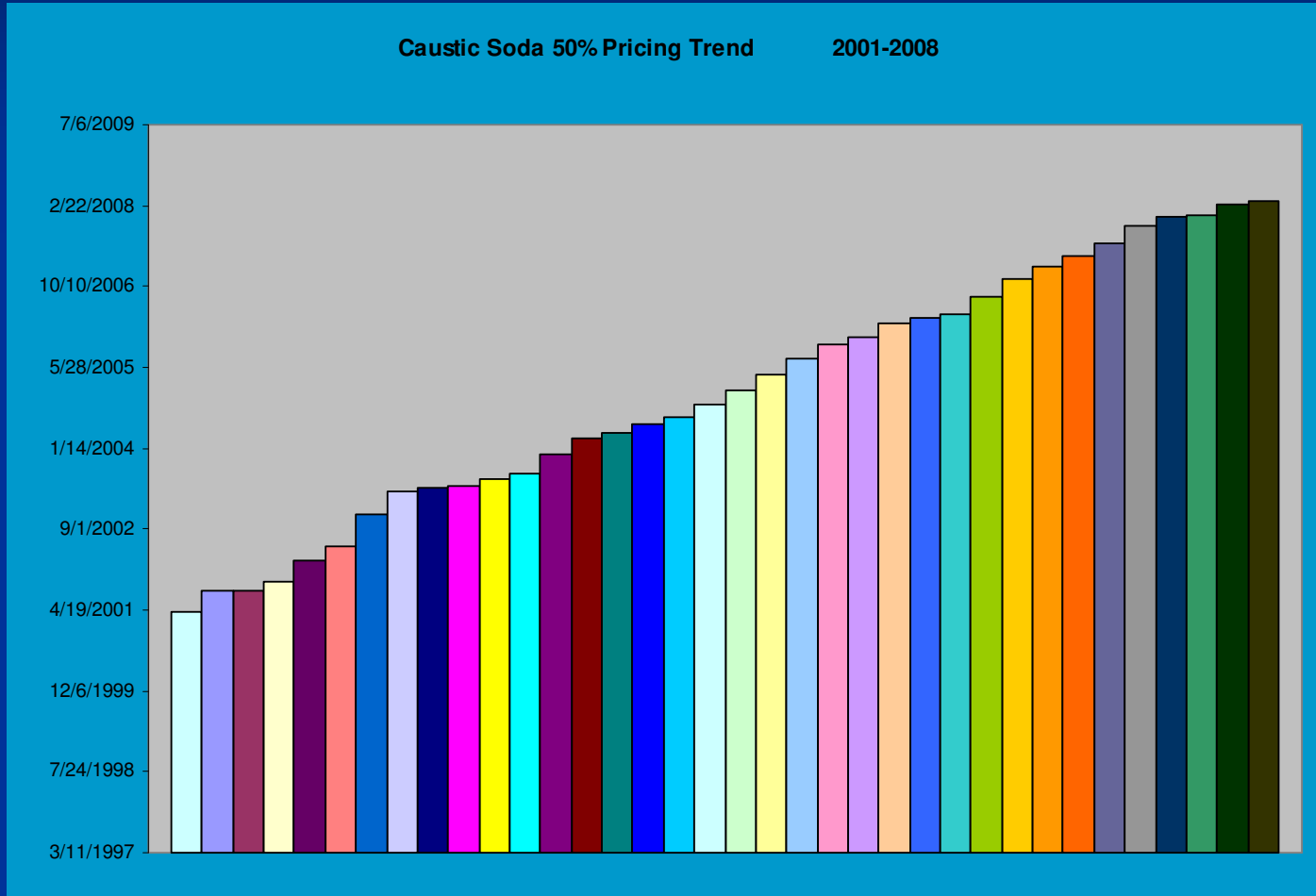
Source: Energy Information Administration

 **PotashCorp**
Helping Nature Provide

Commodity Raw Material Prices 1993-Present

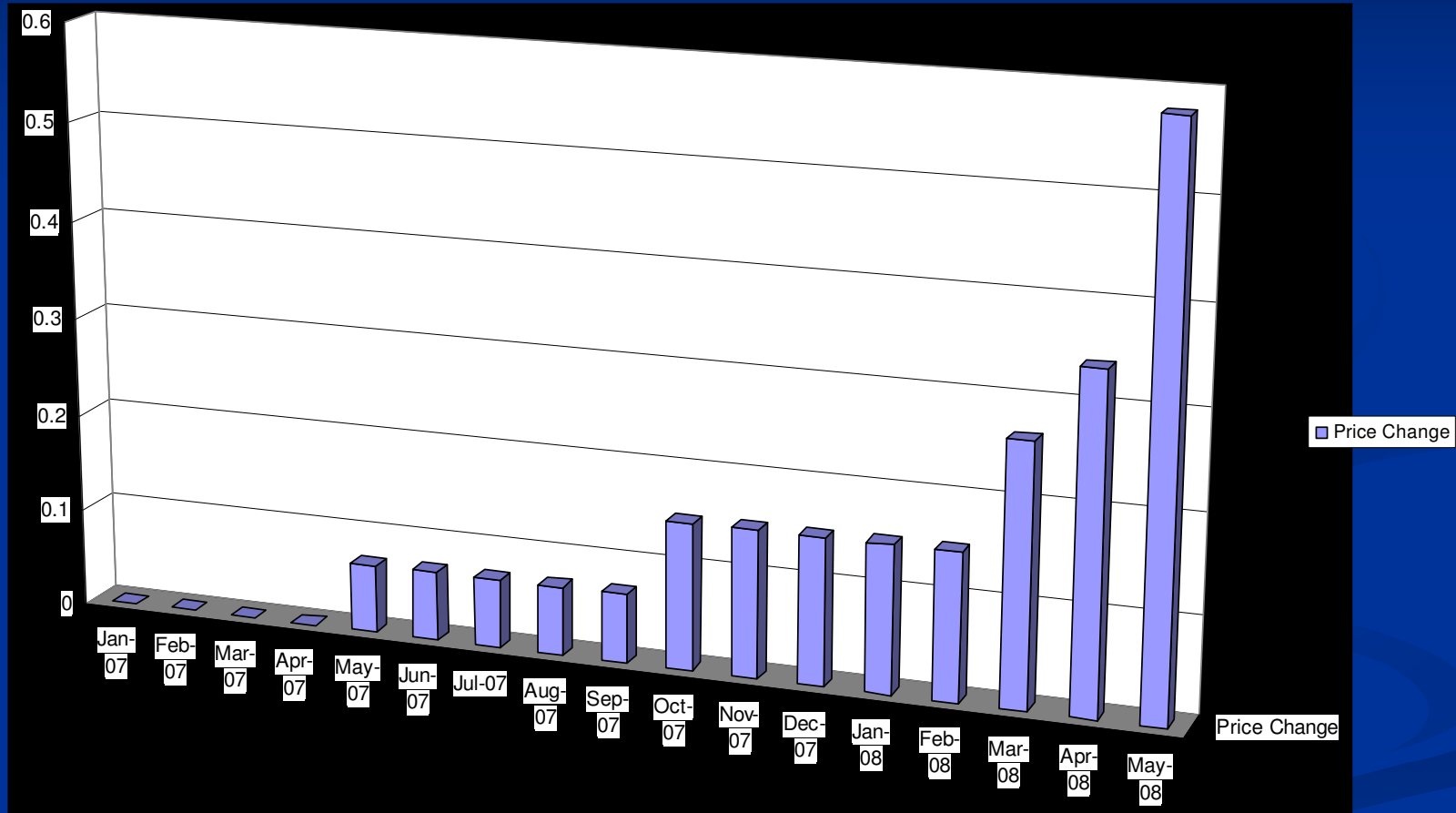


Sodium Hydroxide (50% NaOH) Price Trend: 2001-2008

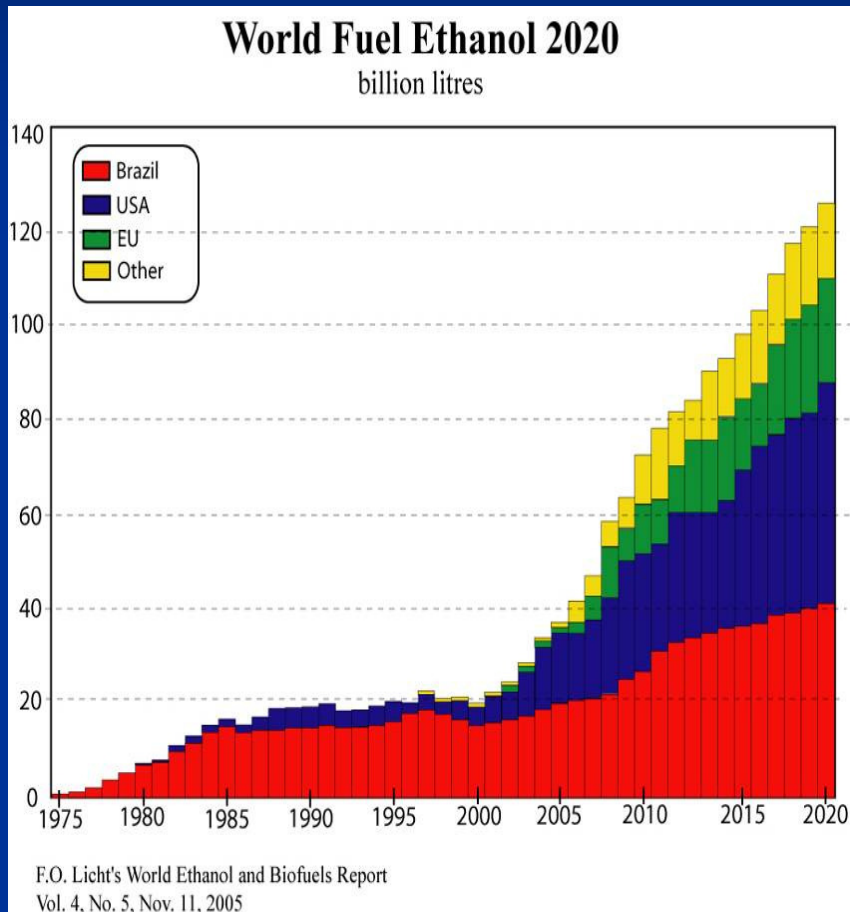


Phosphoric Acid 75%

Price Trend Jan. 2007-May 2008



Why is phosphoric acid getting so expensive?



Purified Phosphoric Acid (PWA)

→ The starting point for Purified Phosphoric Acid is Merchant Grade Phosphoric Acid (MGA), a fertilizer raw material which is then purified to food and technical grade specifications.

Market Conditions:

- Phosphoric acid cost drivers have increased at unprecedented rates (main cost drivers: phosphate rock + sulfuric acid). Price of sulfur is expected to at least triple in by Q2 2008. OCP, the largest exporter of phosphate ore, is raising prices to unprecedented levels. Buyers expect that Q1 prices for high grade phosphate rock will rise to between \$175 and \$195/tonne FOB North Africa., more than 3 times the 2007 prices.
- Global demand for fertilizers has increased dramatically:
 - Rising global population, higher incomes and increased protein consumption continues to propel strong demand for agriculture commodities, pushing prices for key crops to record levels.
 - The stocks-to-use ratio of wheat and coarse grains has fallen to the lowest level ever recorded by the USDA. Favorable weather and good growing conditions have allowed for record plantings. Dealer inventories of all 3 nutrients (NPK) have been depleted.
 - These conditions provide farmers in all regions with the foundation for vastly improved profitability. They are motivated to increase plantings and invest in fertilizer to maximize yields because grain prices are at record levels.
 - Also, increased production of ethanol and biofuels from corn and other biomass has added to the demand for fertilizers to improve crop yields. (Biofuel is expected to consume an additional 1 billion bushels of corn in 2008.)

Conclusion

- Cleaning is the least glamorous part of daily brewing/packaging routine but likely the most important for overall product quality.
- Don't work harder-Work Smarter!
- Use the proper type and amount of chemicals- don't scrimp, but overuse, either.
- Don't look for chemical prices to come down anytime soon.