Practical Water and Beer Testing For Brewers…

And Why It May Be Easier Than You Think

Eric Lehmann | Mike Feldman

April 21 | 1:15 – 2:15 PM

Attend Our VIP Event Tonight

See a full brewery in action using
Hach's suite of instrumentation

Yards Brewing Company

500 Spring Garden St.
Philadelphia, PA 19123

5:30 PM

Session Objective

By the end of this session, brewery professionals will gain an understanding of key analytical instrumentation used throughout the brewing process to support consistent, high-quality beer in every batch.

This session will highlight how these tools can be simple to use, emphasize practical testing procedures, and build confidence that accurate results can be achieved without requiring advanced chemistry training.

Focus: Common Analytical Tools

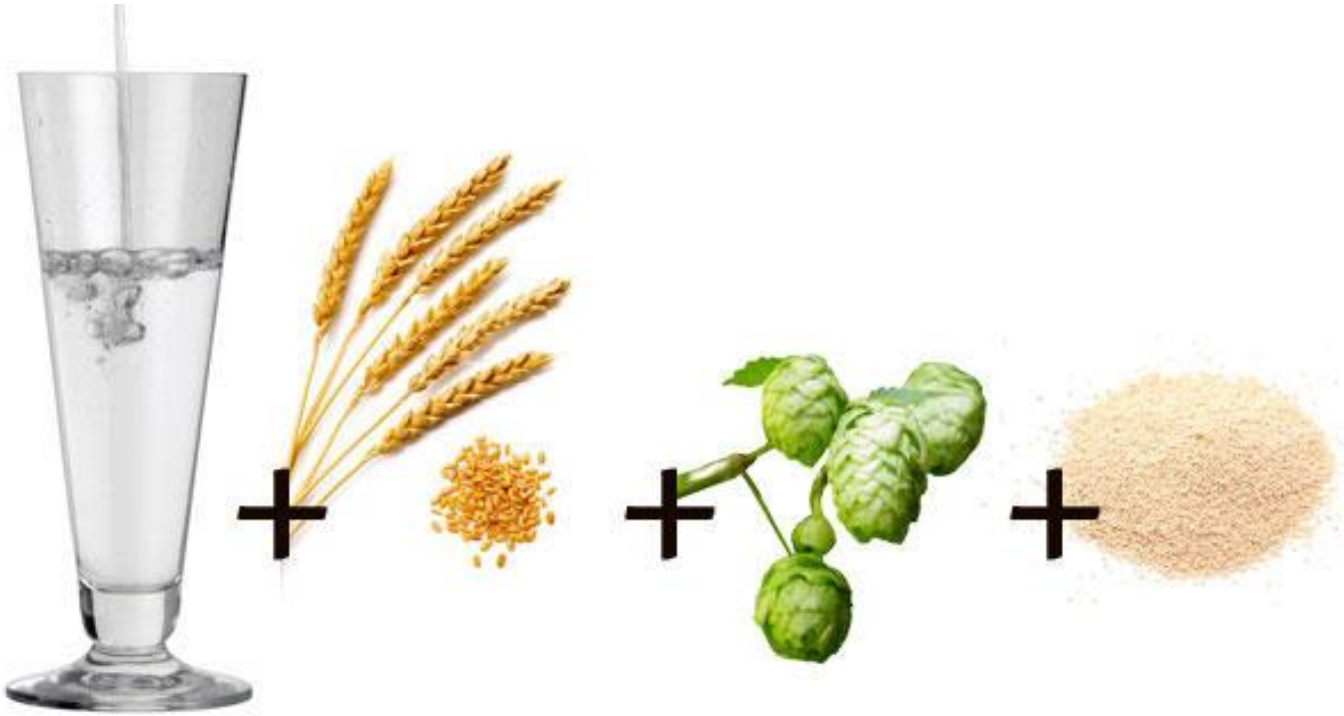
Where to use, how to choose and how to use

1. PH
   - Process
   - How to get the most out of your probe
2. Titrations
   - Alkalinity
   - Hardness
   - Total acidity
   - Chlorides
   - PAA/H2O2
   - Auto titrators
3. Turbidity
   - Chill haze
   - Filtration / cold crash
   - Packaging for hazy/ whites

4. Colorimetry
   - Chlorine/chloramines
   - IBU and alpha/beta acids
   - Color
   - VDK
   - Polyphenols
   - Sulfates
   - FAN
   - Low Range Hardness
   - Iron

Waste Water (colorimetry continued)
   - Nitrogen
   - Phosphorous
   - COD
   - pH

What Makes Beer ?



= BEER.

What was missing from the last slides and many discussions?

Raw water is it where it all begins, Is it always consistent?

a) Where does it come from
   i. Municipal
      - Disinfection process
      - pH
      - Well or surface
      - Where are you in their network?
   ii. Well
b) Is it always the same?
   i. Seasonal
   ii. Draught
   iii. Does it come from multiple sources
      - Multiple wells
      - Surface water
      - Blending

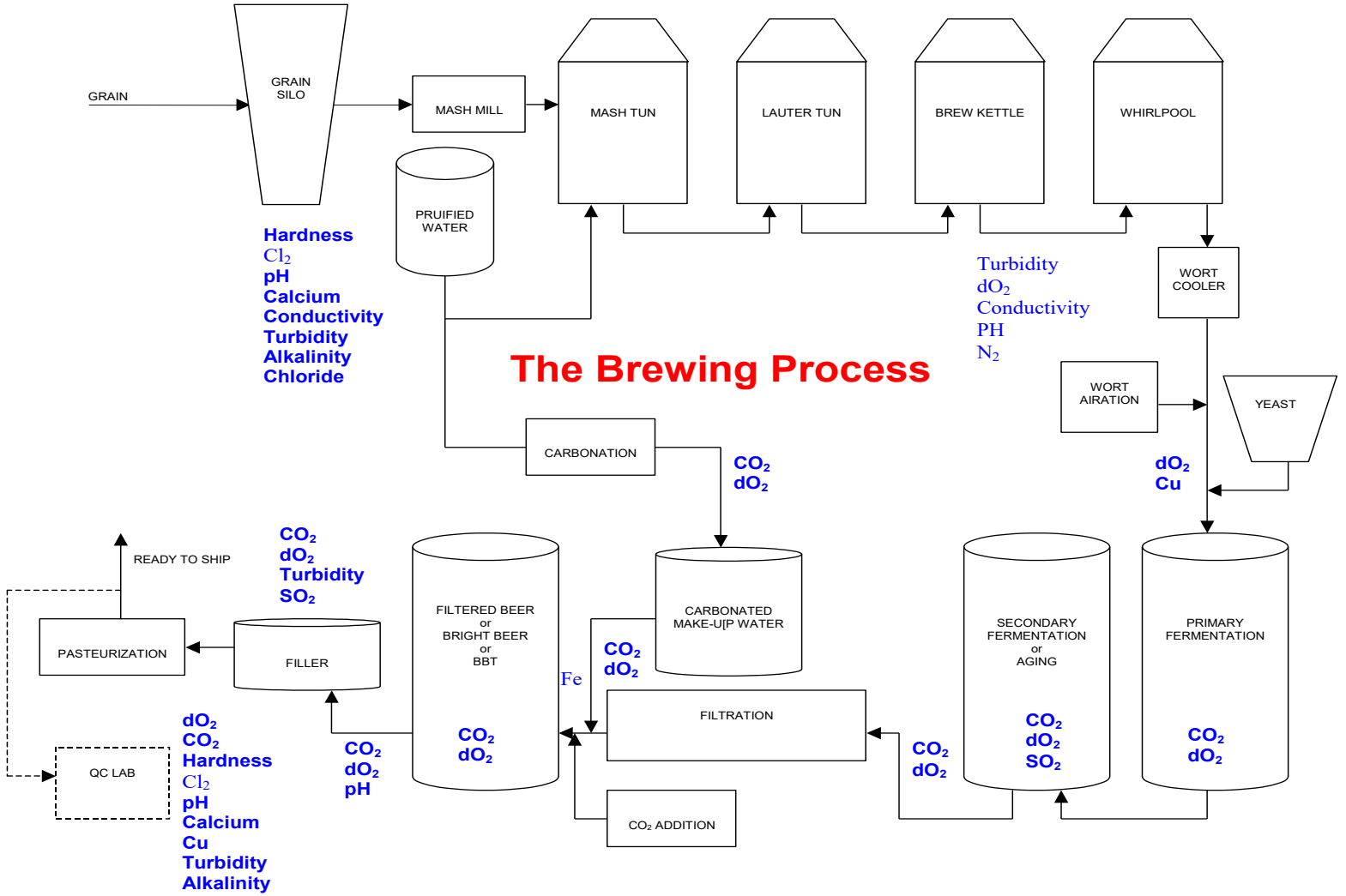
IF we understand the water chemistry, we can change it.---Water quality reports
Filtration, softening mineral addition, acid to reduce alkalinity etc.

Incoming Water: Why do we care?

Suitability of water for brewing

- Microbiologically Pure
- Clear and colorless (turbidity and color can be caused by suspended solids)
- Tasteless and Odorless
  - (Chlorinated water can affect beer flavor as well as dissolved metals)
- pH
- Free from heavy metal ions
- Minerals
- Boiler scale protection

Brewery Process Diagram
Measurements to help produce consistent finished beer

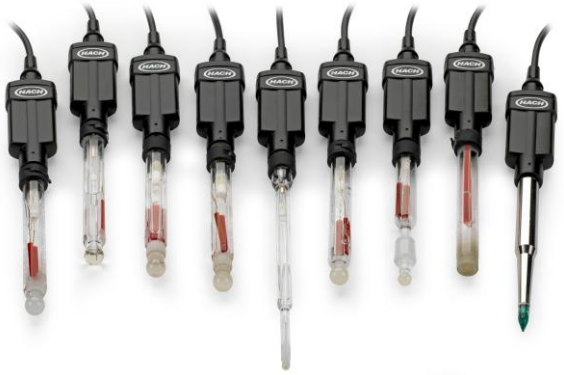


Key measuring tools

AMERICAN SOCIETY OF BREWING CHEMISTS
THE SCIENCE OF BEER & BEVERAGE

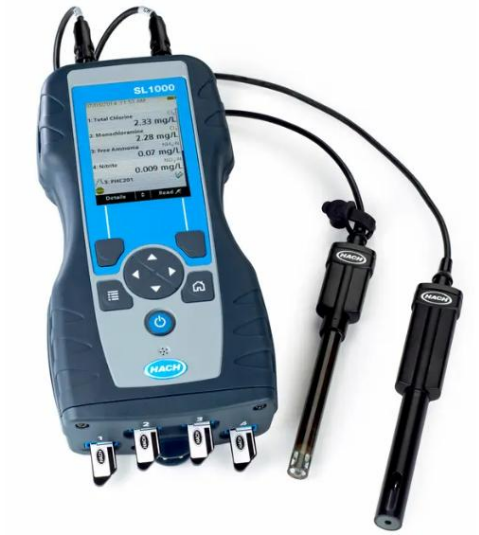
1. E-chem meter
   - pH probe
   - Other e-chem
   - Wort DO
2. Titrators
   - Drop count
   - Digital/ burette
   - Auto
3. Turbidimeters
4. Spectrophotometers
5. Accessories

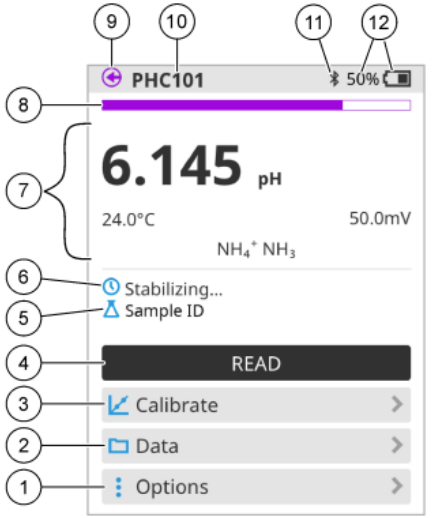
MITTELEUROPÄISCHE BRAUTECHNISCHE ANALYSENKOMMISSION
MEBAK
E.V.



What E chem meter is best for me?

1. Proper probe selections
   a) pH (focus discussion)
   b) DO
   c) Conductivity
   d) Sodium
   e) Calcium
2. Some meters can actually do colormetric tests too





1	Options menu: gives access to instructions and other menus	**7**	Measurement value section: shows the measured value, temperature and units
2	Data menu: gives access to view and manage data	**8**	Measurement stability status indicator: shows the status of the measurement
3	Calibrate button: starts a calibration	**9**	Intellical probe port: shows the port location of the connected probe
4	Read button: reads the sample or standard solution value	**10**	Intellical probe name: shows the model name of the connected probe
5	Sample ID: shows the name of the sample that is measured	**11**	Bluetooth® icon (if Hach Communication Dongle is installed): shows when a bluetooth connection is active
6	Message area: shows the measurement status, sample ID, errors and warnings	**12**	Battery charge indicator: shows the percent of the battery charge

pH: Why is it important and how accurate do I need to be?

pH is critical in many parts of your process, and can vary in your source water from source to source, or even where in network you pull from and accuracy can matter

Mashing to wort (who hits their number without adjustment after the boil?)

Optimal pH mash pH protein rest 5 to 5.2

conversion 5.2 to 5.6

kettle pH 5 to 5.5

beer 4.2 to 4.6 (sours can be lower but pH does not tell you how sour!

Aromatics! Form of the hops oil can affect its pungency by 90% and pH goes down so does the aromatic form change of .5 can change 5%

Beer haze is greatest slightly above pH of 4 and drops on both sides

- **Mash pH = enzyme performance**
  The ideal mash pH is about **5.2–5.6**
- Too high poor starch conversion, dull flavors
- Too low overly sharp/acidic beer

What probe should I use?

PHC725 High purity probe

- **Larger junction provides faster response in samples with low ionic strength i.e RO Permeate**

Temperature Range	–10 - 100 °C (14 - 212 °F)

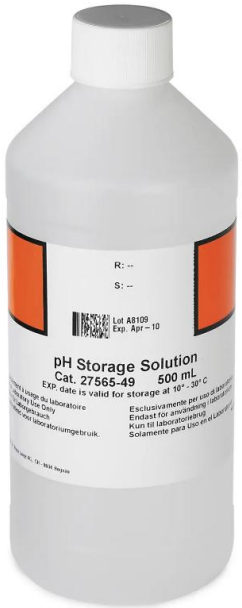
PHC101 General purpose probe

- **Designed for general purpose applications i.e. source water, wastewater**

Temperature Range	0 - 50 °C (32 - 122 °F)

pH measurement best practices

1. Use the correct probe for the application
2. Store properly after use
   a) Store in storage solution
   b) Do not store in tap or DI water *or* buffer solution
3. Calibrate daily
   a) Minimum 2-point calibration (4, **7**, 10 buffers)
   b) Use fresh buffers that are not expired
      i. pH 10 reacts with air(CO2) after opening
4. Measure sample on stir plate (no vortex)
5. Ensure electrolyte solution is visible in probe
   a) Replenish electrolyte in refillable probes
      i. Open plug when in use
   b) Replace gel filled probes with no electrolyte



Cleaning and maintenance of pH probes

Handling, storage and maintenance have a significant influence on the accuracy and life span of a pH probe. Even small things like air bubbles, crystallisation, low electrolyte filling, KCl leakage or contamination can have a negative effect. Avoid problems by doing the following:

1. Commissioning new electrodes

pH probes are supplied with a storage cap filled with internal electrolyte which is used inside the probe. This maintains the hydration of the glass bulb and the equilibrium inside and outside of the probe. The refill opening of refillable electrodes is also sealed with sticky tape to prevent liquid electrolytes from leaking during transport.

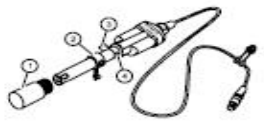
Tip: Condition a new electrode before it is used for the first time.

For refillable liquid electrolyte electrodes, first:

- Remove sticky tape (protective film) and/or cap over filling hole
- Fill with specified liquid electrolyte as required (up to approximately 3 mm below the refill opening)

Then, for electrodes using gel or liquid electrolyte:

- Check if the glass bulb contains any air bubbles. Remove any that are present by following the instructions in section 5.
- Condition according to manufacturer's instructions. This generally involves keeping the electrode in a sample or buffer solution for a few minutes. The response time of a new, conditioned electrode in pH buffers is usually less than 30 seconds at 25 °C.



1 Storage container
2 Cover
3 Sticky tape
4 (Refill) opening

2. Liquid electrolyte electrodes

Refilling electrolyte

Refillable pH probes have an opening though which electrolyte can be poured. The fill level is dependent on the function. If there is sufficient electrolyte in the electrode (up to approximately 3 mm below the fill opening), hydrostatic pressure ensures there is a sufficient electrolyte flow through the diaphragm.

This also prevents the sample solution from penetrating the electrode. Leave some space below the refill opening so that KCl does not leak or crystallise. Open the refill opening before each measurement and close it if the electrode is no longer in use and is being stored.

Cover for the refill opening

Refillable pH probe with cover

Removing electrolyte

If the internal electrolyte solution is contaminated, remove all of the liquid using a syringe with a cannula. Remove the liquid slowly and carefully to prevent damaging anything inside the electrode.

The correct refill solution is described in the electrode manual. The most used electrolyte solution is 3 M KCl; a variant is 3 M KCl saturated with AgCl.

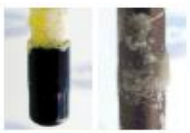
Removing internal liquid

Refilling KCl

Crystallisation

As a rule, crystallisation is neither damaging to the electrode nor affects its performance. External salt crystals can be removed by rinsing with water. Any salt crystals inside the electrode can be dissolved by immersing the electrode in warm (45 °C) water. Electrodes using saturated KCl should have visible crystals.

Formation of salt crystals on the diaphragm can be prevented by proper storage in a storage solution.



Innocuous crystallisation on storage cap, electrode shaft or refill opening

Rinsing the electrode

3. Regular maintenance

There are indications that the electrode requires cleaning:

- Long stabilisation times
- False or erroneous measurement values
- Loss of slope/sensitivity during calibration, less than 95%

Careful maintenance ensures quick measurements, increases accuracy and extends the life span of an electrode. Regular maintenance of the electrode includes storing it in the recommended storage solution between measurements, as well as checking and replenishing the electrolyte filling. Optimal results will be achieved with the electrode if the diaphragm does not dry out.

An electrode must be regularly cleaned depending on the samples as bacteria, organic compounds and proteins will adhere to the probe surface over time. A good cleaning solution works selectively on the relevant contamination. This means greases, lubricants and oils are removed by non-ionic cleaning products or ethanol; proteins, such as those in food, are purged by an acidic pepsin solution and mineral deposits are dissolved by an acidic solution. Table 9 will help you to select the correct cleaning product.

Then rinse the electrode thoroughly with distilled water and store in the prescribed storage solution.

Rinsing the electrode

Electrode cleaning solution

4. Regular cleaning of the pH glass bulb and diaphragm

For an optimum response time, it is necessary to remove impurities and deposits from the pH glass bulb and diaphragm. To clean the glass bulb, follow the instructions in the electrode manual. It is usually advisable to place the electrode in warm water or a special solution (see table 9) for a few minutes to keep the diaphragm permeable.

Contaminated reference junction

Correctly functioning ceramic diaphragm, effluence of electrolyte and liquid

Rinsing the electrode

Electrode cleaning solution

5. Air bubbles in glass bulb

The electrolyte in the electrode may move during transport or if it is stored horizontally. This may create air bubbles in the glass bulb that distort measurements or calibrations. Before every measurement, it is advisable to check that the glass bulb is sufficiently filled with electrolyte and no visible air bubbles are present.

If air bubbles are visible in the glass bulb, swing the probe in a circular motion several times till air bubble has been removed. Perform with no obstacles in vicinity. Please note: Gel filled electrodes may need to be replaced if a hole/air bubble is formed near to or around the diaphragm.

Air in the glass bulb

Mixing the electrode

6. Contamination inside the electrode

Some samples may penetrate the electrode via an open diaphragm and cause biological growth.

This contamination affects the performance of the electrode. Place the electrode in a thiourea solution for a few hours, then rinse thoroughly with distilled water.

Contaminated cloth and clean cloth / gel electrolyte

KS410 thiourea solution

7. Contamination of the outer electrode

Contaminated samples or sample residue on the glass bulb may lead to erroneous results. Table 9 will help you to select the correct cleaning product. A contaminated glass bulb is usually cleaned in the following manner: Place the electrode in an electrode detergent solution for up to sixteen hours (overnight). Then rinse thoroughly with distilled water and place the electrode in a pH 4.0 buffer solution for a further twenty minutes.

Externally contaminated glass bulb

Rinsing the electrode

Electrode cleaning solution

8. Sulphide deposit

Sulphides and silver ions can form a dark deposit in refillable electrodes. This deposit may impair the operation of the diaphragm. Place the electrode in a thiourea solution for a few minutes to dissolve the deposit.

Ceramic diaphragm blocked by a sulphide deposit

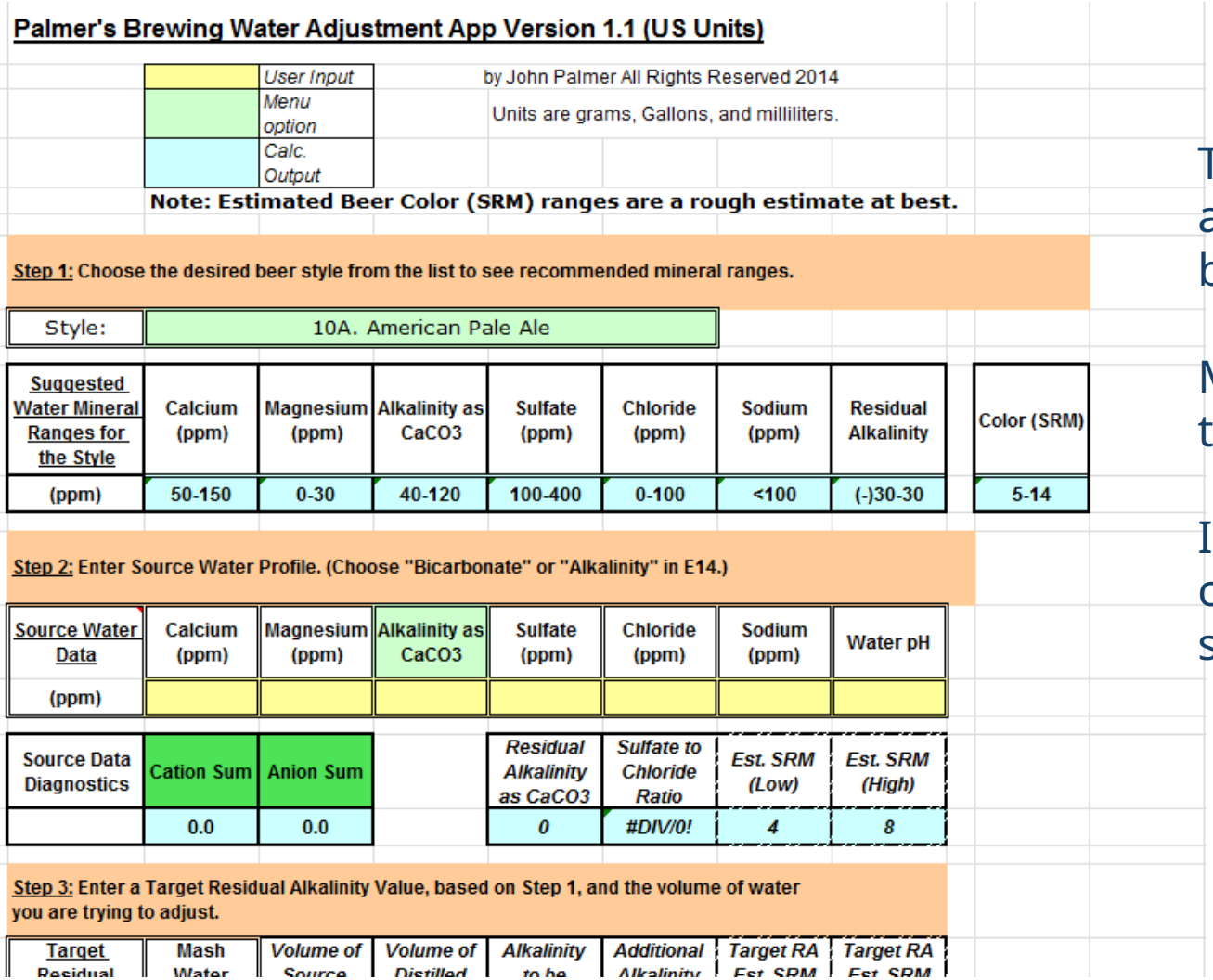
Ceramic diaphragm after treatment with KS410 solution

KS410 thiourea solution

9. Selecting the correct cleaning product

Type of contamination	Contamination by sample	Cleaning solutions for pH probes	Ethanol, acetone	Neutrolyte N (alkaline solution of surfactants and polyphosphates)	Neutrolyte X (sodium hypochlorite solution)	Electrode cleaning solution with phosphoric acid (10%)	KS400 pepsin in HCl	KS410 thiourea solution	Buffer solution pH 1.68 (KCl) 4o °C
				250 mL	250 mL	500 mL	250 mL	250 mL	500 mL
		Part number		51BM001	51BM002	2975149	C20C370	C20C360	511M000
		Surface wear		5 - 20 min					
		Seawater			5 - 10 min				
		Wastewater			5 - 10 min		5 - 30 min	5 - 30 min	
		Activated sludge			5 - 10 min	5 - 30 min	5 - 30 min	5 - 30 min	
		Soil, sludge, clay				5 - 30 min			5 - 20 min
		Food and beverages			5 - 10 min		5 - 30 min	5 - 30 min	5 - 20 min
		Medical samples	5 - 10 min		5 - 10 min		5 - 30 min	5 - 30 min	
		Electroplating		5 - 20 min	5 - 10 min				5 - 20 min
		Paint, varnish, cosmetics	5 - 10 min	5 - 20 min					
		Cosmetics, soap	5 - 10 min	5 - 20 min					
		Petroleum products	5 - 10 min	5 - 20 min					
		Paper, cardboard		5 - 20 min	5 - 10 min				5 - 20 min
		General, light contamination		5 - 20 min	5 - 10 min				
		Inorganic, alkaline		5 - 20 min	5 - 10 min	5 - 30 min			5 - 20 min
		Organic	5 - 10 min		5 - 10 min				
		Proteins	5 - 10 min				5 - 30 min		
		Greases, oils	5 - 10 min	5 - 20 min					
		Sulphides		5 - 20 min				5 - 30 min	5 - 20 min
		KCl salt crystallisation		5 - 20 min					

John Palmer Calculator



Palmer's Brewing Water Adjustment App Version 1.1 (US Units)

	User Input
	Menu option
	Calc. Output

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Units are grams, Gallons, and milliliters.

Note: Estimated Beer Color (SRM) ranges are a rough estimate at best.

Step 1: Choose the desired beer style from the list to see recommended mineral ranges.

Style:	10A. American Pale Ale

Suggested Water Mineral Ranges for the Style	Calcium (ppm)	Magnesium (ppm)	Alkalinity as CaCO3	Sulfate (ppm)	Chloride (ppm)	Sodium (ppm)	Residual Alkalinity	Color (SRM)
(ppm)	50-150	0-30	40-120	100-400	0-100	<100	(-)30-30	5-14

Step 2: Enter Source Water Profile. (Choose "Bicarbonate" or "Alkalinity" in E14.)

Source Water Data	Calcium (ppm)	Magnesium (ppm)	Alkalinity as CaCO3	Sulfate (ppm)	Chloride (ppm)	Sodium (ppm)	Water pH
(ppm)							

Source Data Diagnostics	Cation Sum	Anion Sum	*Residual Alkalinity as CaCO3*	*Sulfate to Chloride Ratio*	*Est. SRM (Low)*	*Est. SRM (High)*
	0.0	0.0	*0*	*#DIV/0!*	*4*	*8*

Step 3: Enter a Target Residual Alkalinity Value, based on Step 1, and the volume of water you are trying to adjust.

Target Residual	Mash Water	*Volume of Source*	*Volume of Distilled*	*Alkalinity to be*	*Additional Alkalinity*	*Target RA Est. SRM*	*Target RA Est. SRM*

This application helps brewers calculate salt and acid additions to create water profiles suited to specific beer styles.

Mineral salts act as the beer's seasoning and influence the pH of the mash, wort, and final product.

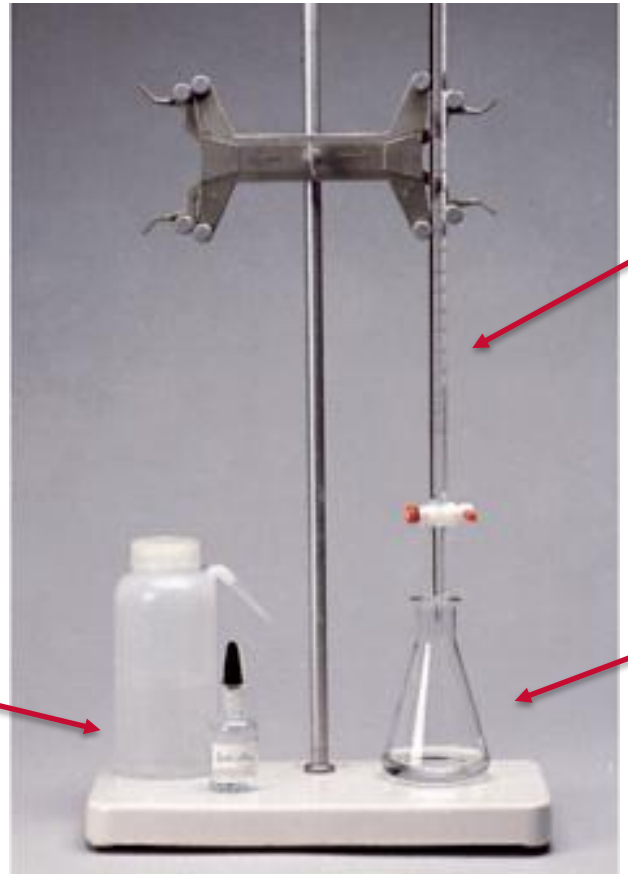
It also provides recommended ranges for key components such as calcium, magnesium, alkalinity, sodium, chloride, sulfate, and residual alkalinity

"How to Brew"
- John Palmer

Titration Parameters

- **Titrations:**
  - Alkalinity
    - Resists pH change neutralizes malt acids
    - Dark beers are higher generally due to acidic malt
    - Affects haze, bitterness and shelf stability
  - Hardness
    - Scale formation on boilers/ heat exchanger
    - Brewery parameter (yeast and flavor)
  - Acidity
    - (pH is not an indication of sourness!)
  - Peracetic Acid (PAA)
    - Disinfection and rinse
  - Chlorides
    - Body, softness, and malt emphasis
    - Sulfate chloride ratio (beer balance full vs dry)
  - Possible but not used often
    - Iron, dissolved O2, pH

Burette Titrations (Good)



Glass burette with clamp and stand

Erleynmeyer Flask

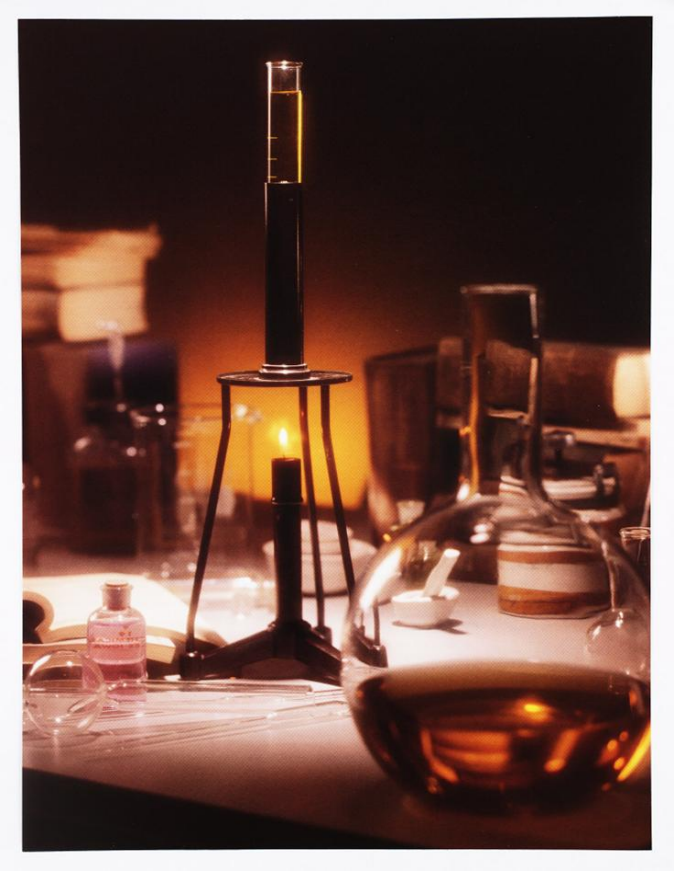
Color Indicator

Digital Titrator (Better)

Automatic Titrator (Best)

Where and Why We Measure Turbidity

1) Where: After the boil, during or after whirlpool separation
- **Why test here:**
- Measures how well **trub (proteins, hops, solids)** is settling
- High turbidity = poor separation → can affect flavor stability and fermentation

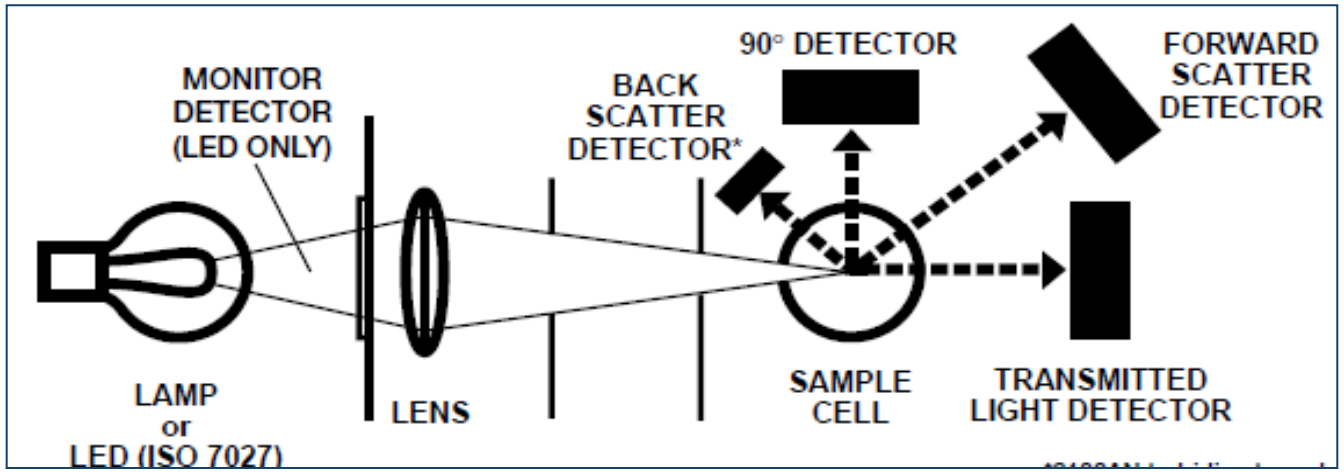


2) Where: After filtration Cold crashing or centrifuging, before packaging
- **Why test here:**
  - **Critical control point** for product clarity
  - Verifies filter performance

3) Where: During packaging transfer from brite
- **Why test here:**
  - **Critical control point** for final hazy product clarity and settling potential

Trusted Technology - Explained

1. Measurement with ‘ratio on’ means that the instruments utilizes data from all the detectors by using a mathematical calculation to ratio signals from each detector
2. ISO vs EPA (IR vs White Light)
3. Better resolution and accuracy than inline turbidimeters
4. Air purge(reduce condensation feature)

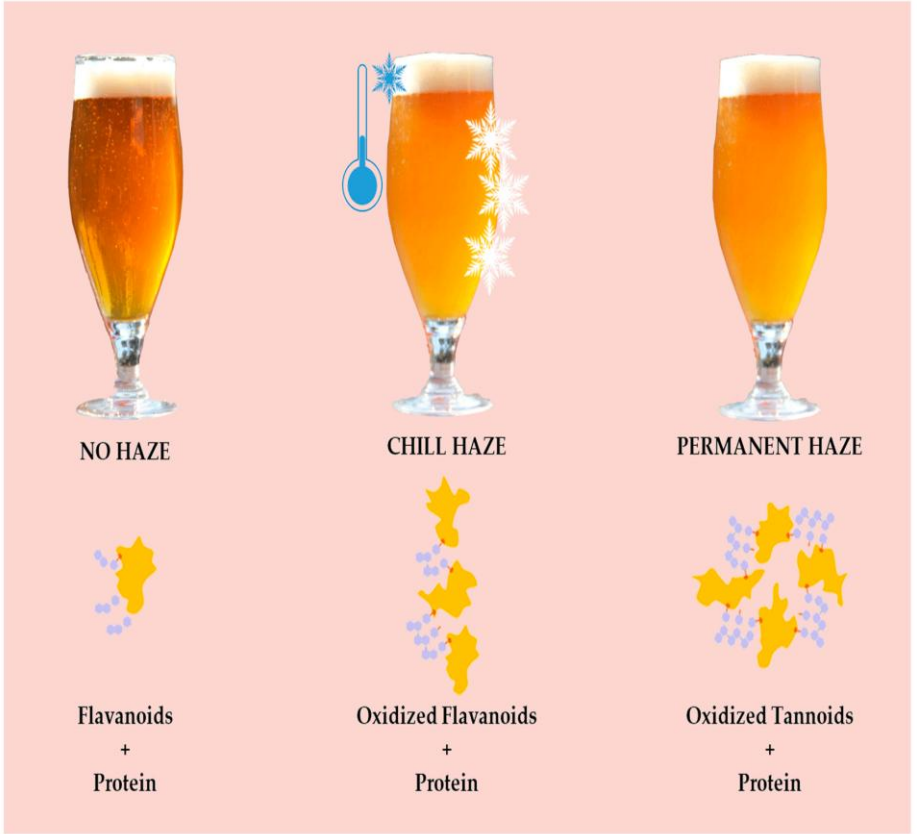


Haze

1. **What is Haze?** – Is the broad term used for turbidity in beer – however the term generally covers all form of instability in beer in which insoluble matter appears.
2. Haze can be caused by the suspension of **grain solids** – transferred over from the mash to finished beer, yeast not dropped out of suspension, or the interaction of proteins and **polyphenols forming particles** that can scatter light
3. **Proteins, carbohydrates, polyphenols, fatty acids, nucleic acids amino acids,** etc. present in the beer whilst at room temperature may be clear, when chilled reacts and clump into larger particles known as **haze**. These particles are large enough to reflect light and the turbidity can be measured.

Turbidity Chill Haze

1. **Chill haze** is what happens when colloidal particles appear in beer as it is cooled, usually to about 0°C. These particles make the beer look cloudy or hazy, and they disappear once it is warmed to 20°C or higher. However, with time, chill haze can develop into permanent **haze**, and it is irreversible
2. Haze can be caused by the suspension of **grain solids** – transferred over from the mash to finished beer, yeast not dropped out of suspension, or the interaction of proteins and **polyphenols forming particles** that can scatter light
3. **Proteins, carbohydrates, polyphenols, fatty acids, nucleic acids amino acids,** etc. present in the beer whilst at room temperature may be clear, when chilled reacts and clump into larger particles known as **haze**.



Chill Haze = Total Haze – Permanent Haze

How to Ensure Good Turbidity Measurement

1. Benchtop air purge (condensation game)
2. Calibrate the turbidimeter at least every 3 months (Hach Service available for all your maintenance needs)
3. Use non scratched clean cells or oil regularly
4. Avoid air bubbles (degas)
5. Wiping with Kimwipes not towels
6. Use IR filter for colored samples

Spectrophotometers and Colorimeters

DR3900

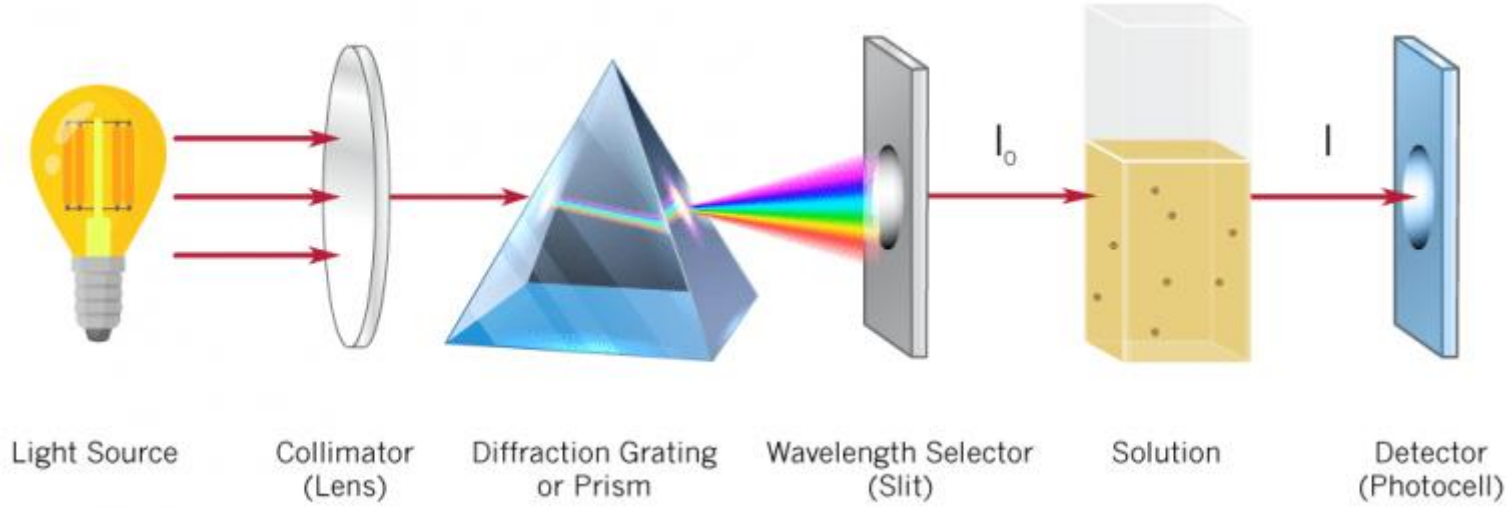
DR6000

DR900

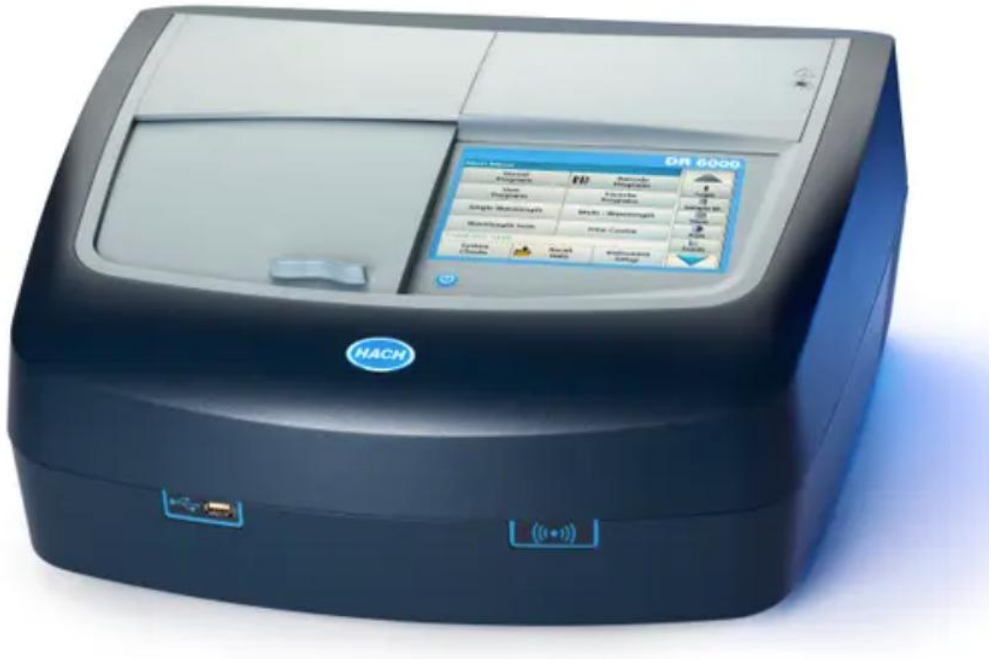
DR300

DR1900

Principle of Colorimetry



UV/VIS Spectrophotometer



UV -Vis Spectrpohotometers easy way of measuring without a trained chemist/ technician for beer, source and waste parameters

User made programs ability for new tests vs built in programs and procedures for beer, source and waste water

Assays are based on published and observed brewing methods according to MEBAK and ASBC including procedures and calculations for many including:

Anthocyanogens
Iron
Bitter units
Thiobarbituric acid number (TAN)
Free amino nitrogen
Iso alpha acid
Total Polyphenols
Vicinal diketones(VDK)

Available Tests

The following table lists available tests and overall ranges for the Hach DR 3900 Benchtop Spectrophotometer. The ranges may represent more than one available test for the instrument. Consult your Hach representative, Customer Service, the Hach Master Catalog, or the Hach web site at www.hach.com for complete details of all available tests for this instrument.

Parameter	Range	TNTplus Test
Alachlor	0.1 to 0.5 ppb, threshold	
Alkalinity, Total	25 to 400 mg/L	•
Aluminum	0.002 to 0.800 mg/L	•
Ammonia, Nitrogen	0.015 to 50.0 mg/L	•
Arsenic	0.020 to 0.200 mg/L	
Atrazine	0.5 to 3.0 ppb, threshold	
Barium	2 to 100 mg/L	
Benzotriazole	1.0 to 16.0 mg/L	
Boron	0.2 to 14.0 mg/L	
Bromine	0.05 to 4.50 mg/L	
Cadmium	.7 µg/L to 0.30 mg/L	•
Carbohydrazide	5 to 600 µg/L	
Chloramine, Mono	0.04 to 10.0 mg/L	
Chloride	0.1 to 25.0 mg/L	
Chlorine Dioxide	0.01 to 1000 mg/L	
Chlorine, Free	0.02 to 10.0 mg/L	•
Chlorine, Total	2 µg/L to 10.0 mg/L	•
Chromium, Hexavalent	0.010 to 1.00 mg/L	•
Chromium, Total	0.01 to 0.70 mg/L	•
Cobalt	0.01 to 2.00 mg/L	
Color	3 to 500 units	
COD (Chemical Oxygen Demand)	0.7 to 15,000 mg/L	•
Copper	1 µg/L to 8.0 mg/L	•
Cyanide	0.002 to 0.240 mg/L	
Cyanuric Acd	5 to 50 mg/L	
DEHA (Diethylhydroxylamine)	3 to 450 µg/L	
Dissolved Oxygen	6 µg/L to 40 mg/L	
Erythorbic Acid (Isoascorbic acid)	13 to 1500 µg/L	
Fluoride	0.02 to 2.00 mg/L	
Formaldehyde	3 to 500 µg/L	
Hardness, Total (Calcium and Magnesium as $CaCO_3$)	4 µg/L to 4.00 mg/L	
Hydrazine	4 to 600 µg/L	
Hydroquinone	9 to 1000 µg/L	
Iodine	0.07 to 7.00 mg/L	
Iron, Ferrous	0.02 to 3.00 mg/L	
Iron, Total	0.009 to 6.0 mg/L	•

Parameter	Range	TNTplus Test
Lead	3 µg/L to 2.0 mg/L	•
Manganese	0.006 to 20.0 mg/L	
Mercury	0.1 to 2.5 µg/L	
Methylethylketoxime (MEKO)	15 to 1000 µg/L	
Molybdenum, Molybdate	0.02 to 40.0 mg/L	
Nickel	0.006 to 6.0 mg/L	•
Nitrate, Nitrogen	0.01 to 35 mg/L	•
Nitrite, Nitrogen	0.002 to 250 mg/L	•
Nitrogen, Simplified Total Kjeldahl	0 to 16 mg/L	•
Nitrogen, Total	0.5 to 150 mg/L	•
Nitrogen, Total Inorganic	0.2 to 25.0 mg/L	
Nitrogen, Total Kjeldahl	1 to 150 mg/L	
Ozone	0.01 to 1.50 mg/L	
PCB (Polychlorinated Biphenyls)	1 to 50 ppm, threshold	
Phenols	0.002 to 0.200 mg/L	
Phosphonates	0.02 to 125.0 mg/L	
Phosphorus, Acid Hydrolyzable	0.06 to 100.0 mg/L	
Phosphorus, Reactive (Orthophosphate)	19 µg/L to 100.0 mg/L	•
Phosphorus, Total	0.06 to 100.0 mg/L	•
Potassium	0.1 to 7.0 mg/L	
Quaternary Ammonium Compounds	0.2 to 5.0 mg/L	
Selenium	0.01 to 1.00 mg/L	
Silica	3 µg/L to 100 mg/L	
Silver	0.005 to 0.700 mg/L	
Sulfate	2 to 900 mg/L	•
Sulfide	5 to 800 µg/L	
Surfactants, Anionic	0.002 to 0.275 mg/L	
Suspended Solids	5 to 750 mg/L	
Tannin and Lignin	0.1 to 9.0 mg/L	
TOC (Total Organic Carbon)	0.3 to 700 mg/L	
Tolyltriazole	1.0 to 20.0 mg/L	
Toxicity	0 to 100% Inhibition	
TTHM (Trihalomethanes, Total)	10 to 600 µg/L	
TPH (Total Petroleum Hydrocarbons)	2 to 200 ppm, threshold	
Volatile Acids	27 to 2800 mg/L	•
Zinc	0.01 to 3.00 mg/L	

Examples of Preprogrammed calibration curves for basic water testing parameters!!

How do I know my meter is working right?

Primary Standard

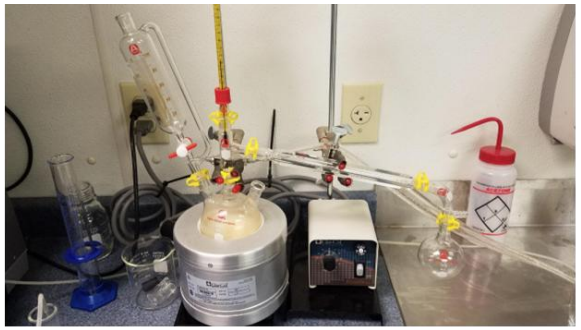
Secondary Standard

Spec Check - Gel Standards

Sample Preparation Steps

1.6.2 Degassing methods and alternatives

Method	Procedure	Time	Residual CO_2	Pros and Cons
Beer-1 A	Add the sample to a 500-mL Erlenmeyer flask. Shake by hand until there is no more gas in the sample.	5 to 20 minutes	Moderate to low (0.2 to 0.06)	The quantity of residual CO_2 depends on time and vigor of shaking.
Beer-1 D (Rotary shaker)	Add the sample to a 500-mL wide-mouth baffled Erlenmeyer flask. Put the sample in a rotary shaker for 12 minutes.	12 minutes	Low	Very specific in procedure with uniform results.
Pouring[1]	Pour the sample back and forth between two 500-mL beakers until there is no more gas in the sample.	5 to 20 minutes	Moderate to low (0.2 to 0.01)	The quantity of residual CO_2 depends on time and amount of pouring.
Ultrasonic bath[1]	Put the sample in the ultrasonic bath until there is no more gas in the sample.	15 minutes	Higher (0.56 vol)	The least effective of all methods, but the easiest to process a large number of samples.
Filtration	Filter the sample with fluted filter paper.	10 to 15 minutes	Higher (0.529 vol)	—
Ultrasonic bath and filtration[1]	Put the sample in the ultrasonic bath, then filter the sample with fluted filter paper.	10 minutes ultrasonic bath 10 to 15 minutes filtration	Moderate (0.41)	More effective than ultrasonic bath or filtration alone, still higher.
Gas purging	The sample has other inert gas bubbled through it to remove CO_2.	25 minutes	None	Not automated and is time consuming.
Membrane degassing[1]	The sample goes through an instrument that contains a semi-permeable membrane with negative pressure on one side to remove CO_2.	30 to 40 mL/min (5 to 10 minutes for a complete sample)	None	Not automated.
Water vacuum pump[1]	Put the sample under a water vacuum pump to remove CO_2 from negative pressure.	5 to 10 minutes	None	Not automated, removes other volatiles.
Microwave	Put the sample in a microwave to remove CO_2.	15 to 20 seconds	Low	Faster and more effective than filtration and ultrasonic bath.



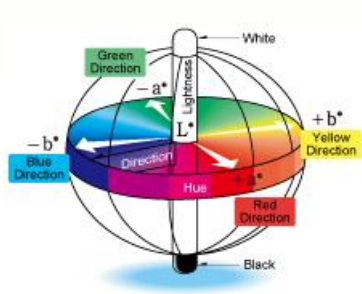
Color

1. Why are color measurements made?
   a) Color measurements are made to ensure the beer meets the requirements for a particular style

   Example: American Wheat 3-6 SRM
   American IPA 6-14 SRM
   American Porter 17-30 SRM
   American Stout 30-40 SRM

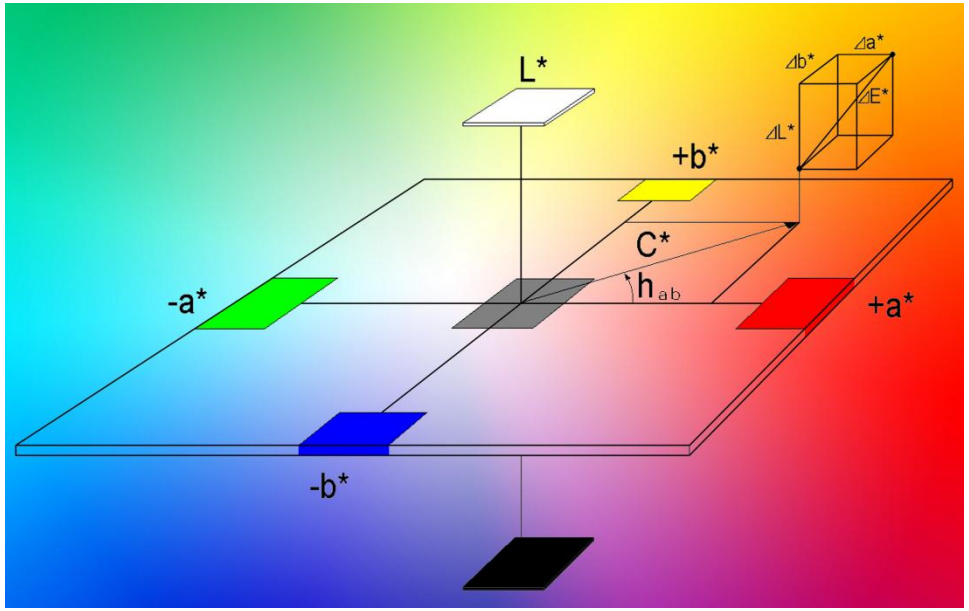
   a) To monitor batch to batch consistency

2. Where are color measurements made?
   a) Samples can be taken in the final product (BBT or Package)
3. DR6000 method
   a) ASBC Methods Beer-10A and Beer-10C
      i. 2020 (1-40 SRM @ 430nm)
      ii. 2301 Tri-Stimulus CIE L*A*B (380nm to 780nm)
   b) MEBAK
      i. 2006 (1-60 EBC units @ 430nm)



DR 6000 and Color Measurement

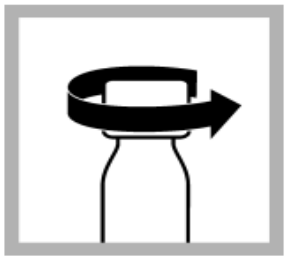
1. L*a*b
2. Hazen
3. Gardner
4. EBC



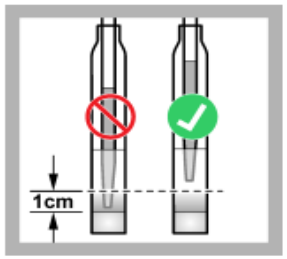
Real color measurements

IBU Test Procedure

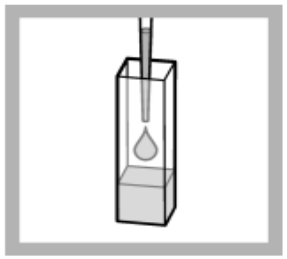
Procedure



1. Remove the cap from the TNTplus® vial.

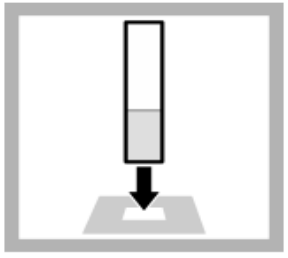


2. Prepare the blank: Remove most of the iso-octane phase (top layer) from the vial with a pasteur pipet. Keep a minimum of 1 cm of the iso-octane phase in the vial.

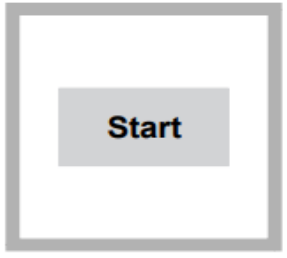


3. Put the iso-octane phase in a clean 1-cm quartz sample cell.

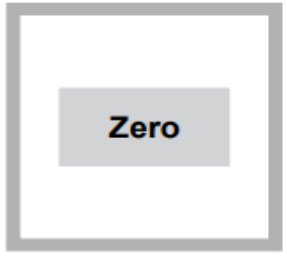
4. Clean the sample cell.



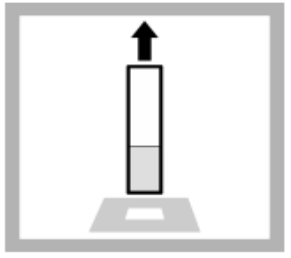
5. Insert the sample cell into the cell holder.



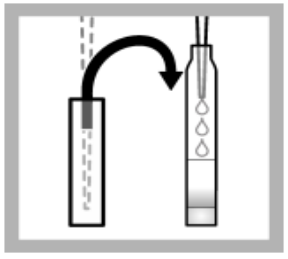
6. DR 5000/DR 6000: Go to Stored programs. Select program **817**.



7. Push **ZERO**.

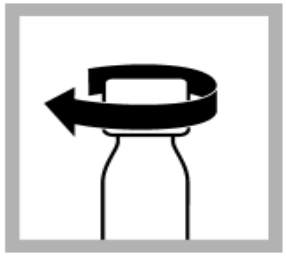


8. Remove the sample cell from the cell holder.

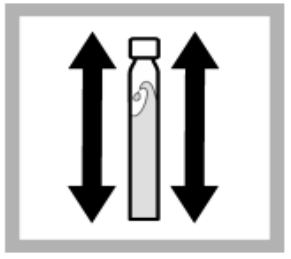


9. Remove all of the iso-octane phase from the sample cell with a pasteur pipet. Put the iso-octane phase in the TNTplus® vial.

10. Prepare the sample: Add 1 mL of sample slowly along the length of the vial inner wall with a pipet.



11. Put the cap on the vial.

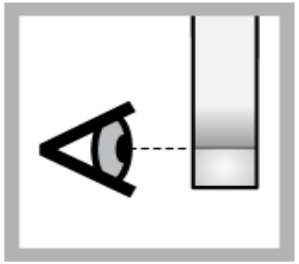


12. Shake the vial vigorously for 10 seconds.

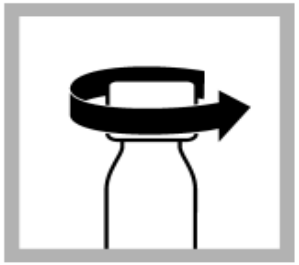
13. Do not move the vial for 20 seconds.

14. Do steps 12 and 13 two more times.

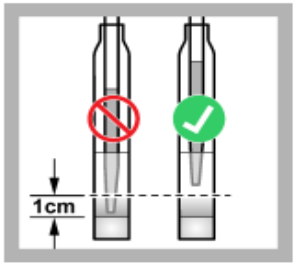
15. Do not move the vial for 1 minute.



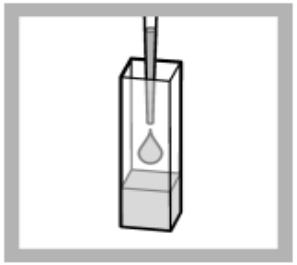
16. Make sure that the two phases (layers) are divided.



17. Remove the cap from the TNTplus® vial.

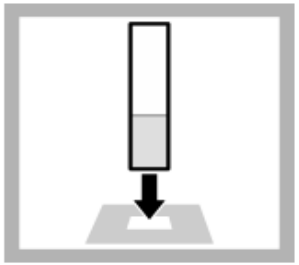


18. Remove most of the iso-octane phase (top layer) from the vial with a pasteur pipet. Keep a minimum of **1 cm** of the iso-octane phase in the vial.

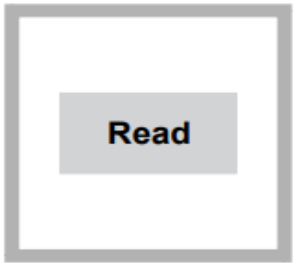


19. Put the iso-octane phase in the 1-cm quartz sample cell.

20. Clean the sample cell.



21. Insert the sample cell into the cell holder.



22. Push **READ**.

23. Do steps 10–22 with a new TNTplus® vial to measure the next sample.

For samples with largely different bitter units, clean the quartz sample cell between samples with iso-octane.

What and How Can We Measure to Help Our Processes?

1. Test strips
    a) Chlorides
    b) Chlorine
    c) Iron
    d) Copper
    e) Alkalinity
    f) Hardness
    g) pH

Stop By The Hach Booth

Get in-booth exclusive promotions, swag, product demoes, special funding opportunities, and more.

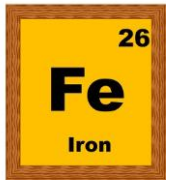
Let's continue the conversation! We're happy to answer all your pointed questions (may require diligent taste testing of your product by us).

Booth #1942

Cheers!

Extra Slides

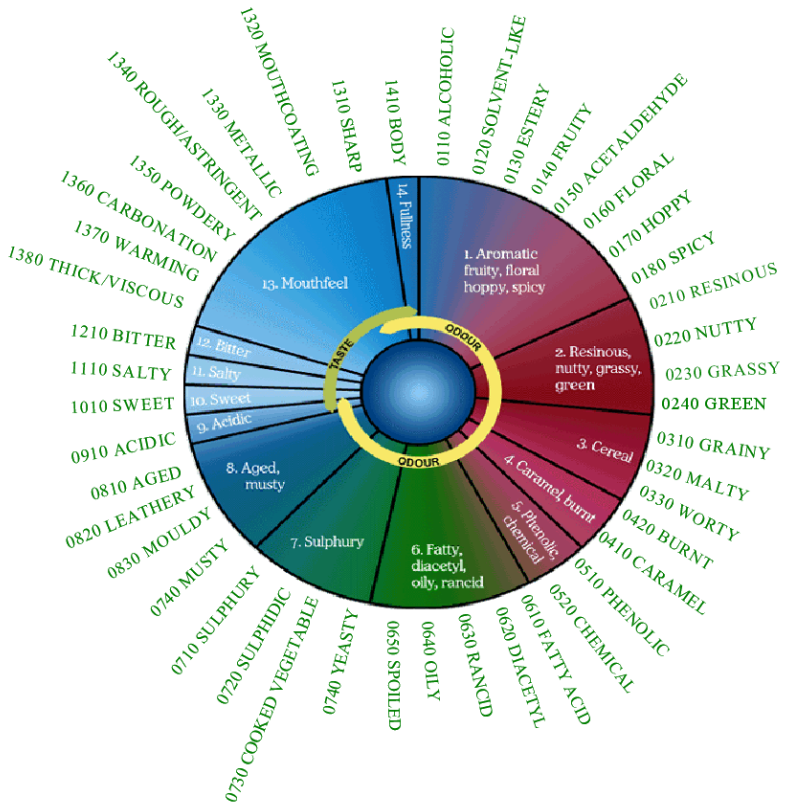
The FUNCTION OF DIFFERENT MINERAL IONS IN BEER



Iron should be absent from brewing water (<0.5ppm) since this has a negative effect on start of brewing process

In packaged beer this acts as a catalyst in the anti oxidation of polyphenols resulting in production of irreversible hazes in beer

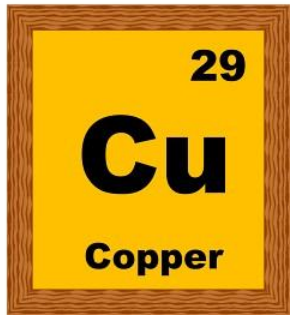
Also imparts metallic taste



- Na (+)

At low concentrations Na gives a sweet flavor to beer but at higher values (150ppm) provides a salty flavour beer - it is often added to beer to give a salty taste. At low levels 75-150ppm adds palate fulness

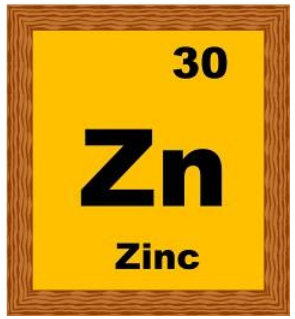
The FUNCTION OF DIFFERENT MINERAL IONS IN BEER



- **Cu (2+)**

At high levels (>10ppm) copper is toxic to yeast

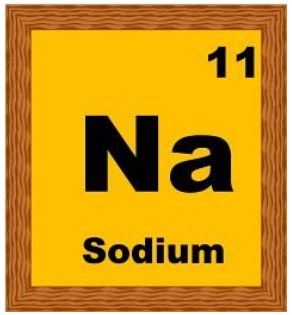
At lower concentrations it also acts as a catalyst in the anti oxidation of polyphenols accelerating the production of irreversible hazes in beer

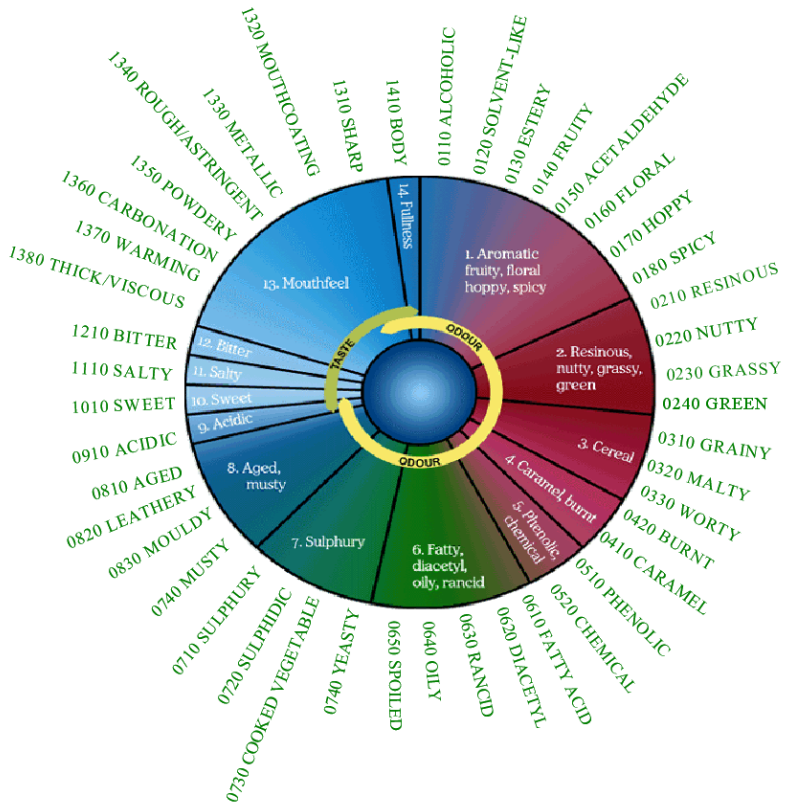


- **Zn (2+)**

At high levels Zn also has a toxic effect on yeast however in trace amounts (0.15 to 0.20 ppm) can act as a yeast nutrient (strain dependent)

The FUNCTION OF DIFFEREnT MINERAL IONS IN BEER



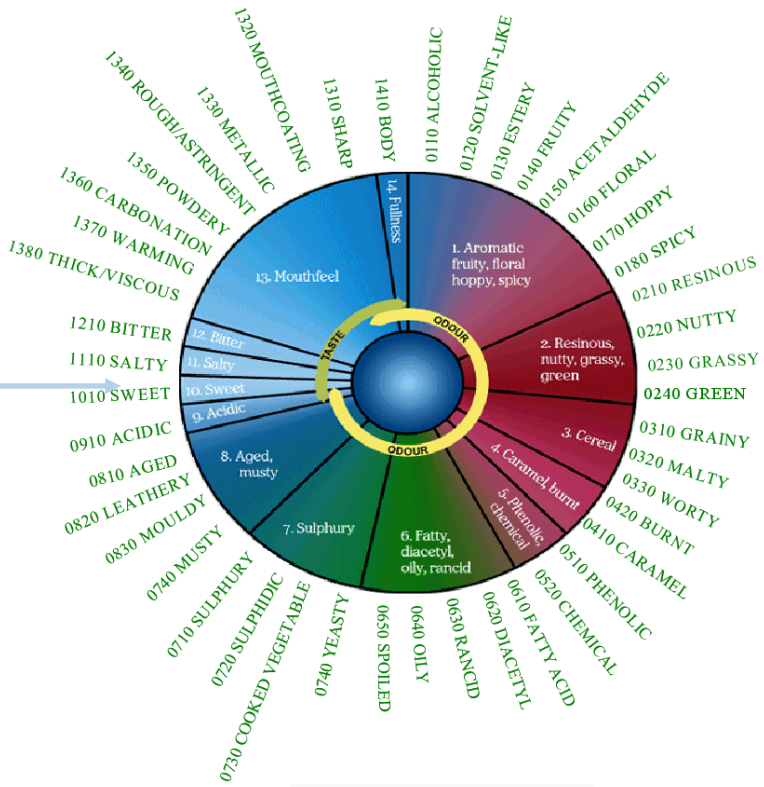


- **Na (+)**

At low concentrations Na gives a sweet flavor to beer but at higher values (150ppm) provides a salty flavour beer - it is often added to beer to give a salty taste. At low levels 75-150ppm adds palate fulness

vicinal diketones

1. Diacetyl - main flavor component
   a) Butter / microwave popcorn aroma
2. Sources
   a) Fermentation – **low VDK** indicates when fermentation is complete
   b) Spoilage – Diacetyl is formed by some wild yeast contaminates
   c) Aging – flavour can reappear during aging
3. Sensory Threshold
   a) Taste threshold is 10 to 30 ppm
   b) Brewers objective is < 30 ppm
4. Why Measure?
   a) Indicates the true end of fermentation
      i. May be able to **"turn the tank"** sooner
   b) Perceived as negative flavor attribute - less is typically desired

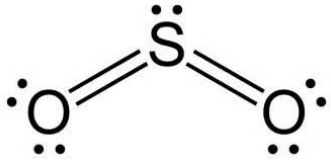


Total polyphenol

1. What is Total Polyphenols?
   a) Polyphenols are components that come from the hop and malts that can contribute to beer haze and staling
2. Why are Total Polyphenols measured?
   a) Measuring total polyphenols will give the brewer an idea on how well the filter is preforming
   b) Total polyphenols is a good indication of product stability and can effect things like haze and flavor
3. Where are measurements of total polyphenol made
   a) Samples can be taken in the bright beer tank (BBT)
4. DR6000 method
   a) ASBC Beer-35
      i. 2035 (0 to 800 mg/L @ 600nm)
   b) MEBAK
      i. 2002 (0 to 800 mg/L @ 600nm)

SO2

1. SO2 can be derived from yeast metabolism or found as a component of finings or priming's
2. Is also added with sulfiting agents which helps inhibit beer oxidation during storage



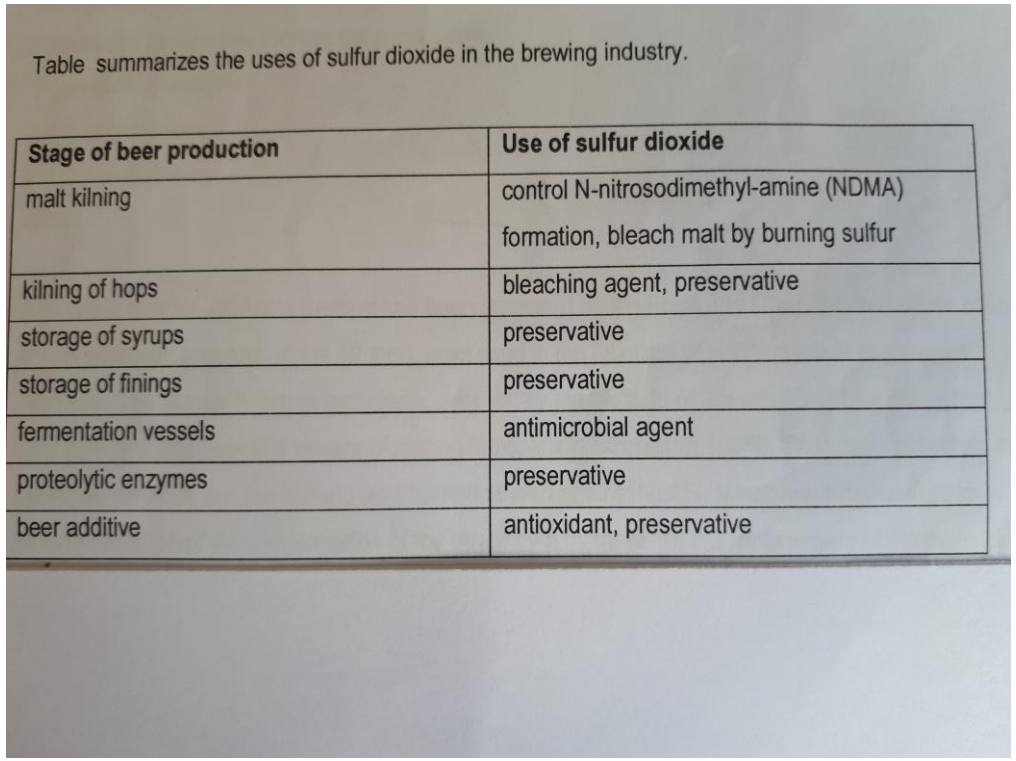


Table summarizes the uses of sulfur dioxide in the brewing industry.

Stage of beer production	Use of sulfur dioxide
malt kilning	control N-nitrosodimethyl-amine (NDMA) formation, bleach malt by burning sulfur
kilning of hops	bleaching agent, preservative
storage of syrups	preservative
storage of finings	preservative
fermentation vessels	antimicrobial agent
proteolytic enzymes	preservative
beer additive	antioxidant, preservative

Isinglass is a substance obtained from the dried swim bladders of fish.