

The background of the entire page is a light gray gradient. Scattered across this background are numerous water droplets of various sizes and shapes. Some are large and prominent, while others are small and subtle. The droplets have a realistic appearance with highlights and shadows, suggesting they are on a smooth surface.

A DISCUSSION OF THE ROLE OF WATER IN BREWING

BY: MICHAEL BADE



WHEN I TOOK THE BJCP EXAM I MADE THESE OBSERVATIONS:

- THE STYLE GUIDELINES WERE GOING TO BE THE BULK OF THE POINTS
- I MAY OR MAY NOT GET A QUESTION ON BREWING WATER
- IF I DID GET A QUESTION ON BREWING WATER, I DIDN'T WANT TO GET A ZERO

SO I CAME UP WITH “TEN THINGS”

- TEN THINGS I COULD WRITE DOWN ABOUT IONS IN WATER TO HOPEFULLY COVER THE BULK OF ANY WATER QUESTION AND GET ME MAX POINTS, BUT IN AN EASILY MEMORIZABLE FORMAT SO I COULD SPEND MOST OF MY STUDY TIME ON THE STYLE GUIDELINES.
- IN ADDITION TO THE TEN THINGS I ADDED FOUR MACRO QUALITIES OF WATER, SO ITS ACTUALLY FOURTEEN THINGS, BUT EVERYONE I SHARED IT WITH REMEMBERS IT AS “THE TEN THINGS”.
- BUT FOURTEEN THINGS IS A LOT TO REMEMBER ALL BY THEMSELVES, SO I BROKE IT DOWN INTO FOUR THINGS AND FOUR THINGS AND THREE THINGS AND THREE THINGS.



THE FIRST FOUR THINGS: MACRO (BULK) QUALITIES OF WATER

1. pH
 2. ALKALINITY
 3. HARDNESS
 4. CHLORINE /CHLORAMINE DISINFECTION
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pH

- pH 7 IS NEUTRAL, RANGE IS 0-14, 0-7 IS ACIDIC, 7-14 IS BASIC.
- IT'S A MEASURE OF HOW MANY H⁺ IONS ARE IN THE WATER, MORE H⁺, MORE ACIDIC.
- EXPONENTIAL SCALE, SO A pH OF 7 MEANS 1×10^{-7} H⁺ IONS.
- UNITS ARE SU (STANDARD UNITS)

ALKALINITY

- CAUSED BY BICARBONATE DISSOLVED IN THE WATER.
- NOT THE OPPOSITE OF ACIDITY – RATHER THE ABILITY TO NEUTRALIZE ACIDITY.
- HIGH ALKALINITY MAY MAKE IT DIFFICULT TO ACHIEVE PROPER MASH PH (5.2-5.7).
- EXPRESSED AS CaCO_3 EQUIVALENTS.

CHLORINE/CHLORAMINE DISINFECTANTS

- VERY UNDESIRABLE IN BEER – LEAD TO CHLOROPHENOL “BAND AID” FLAVORS.
- REMOVE BY ACTIVATED CARBON FILTER – BEST,
- CAMPDEN TABS GOOD ALSO, BUT INCREASES SODIUM SALINITY.
- BOILING WORKS ON CHLORINE, BUT CHLORAMINE? NOT SO MUCH

HARDNESS


- A MEASURE OF THE AMOUNT OF Ca^{+2} AND Mg^{+2} IN WATER
- CALLED HARDNESS BECAUSE THE HARDER WATER IS, THE HARDER IT IS TO GET SOAP TO LATHER
- FORMULA FOR HARDNESS IS $\text{Ca}^{+2} \times 2.5 + \text{Mg}^{+2} \times 4.1 = \text{HARDNESS}$
- EXPRESSED AS CaCO_3 EQUIVALENTS.

THE SECOND FOUR THINGS; MINOR IONS IN WATER

- IRON, MANGANESE, ZINC AND, COPPER
- MICRONUTRIENTS NEEDED BY YEAST AT TRACE LEVELS, BUT AT LEVELS APPROACHING 1 PPM THEY CAN BECOME POISONOUS TO YEAST AND MAY ADD NASTY METALLIC FLAVORS TO BEER
- USUALLY AREN'T ENCOUNTERED IN MUNICIPAL WATER SYSTEMS. (MAYBE Cu)



THE FIRST THREE THINGS: POSITIVE IONS, “CATIONS”

- CALCIUM AND MAGNESIUM
 - BOTH ARE YEAST NUTRIENTS, BOTH CONTRIBUTE TO ALKALINITY
 - IMPROVE BREAK AND CLARITY, AID ENZYME ACTIVITY
 - HIGH LEVELS CAN LEAD TO ASTRINGENT BITTERNESS
 - SODIUM
 - ADDS ROUNDNESS, FULLNESS OR SWEETNESS TO THE PALATE
 - TASTES SALTY AT HIGH LEVELS (>100 PPM) AND BECOMES TOXIC TO YEAST
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THE SECOND THREE THINGS: NEGATIVE IONS “ANIONS”

- BICARBONATE – THE BIG PLAYER IN BEER – RESPONSIBLE FOR ALKALINTY
 - INCREASES MASH pH, EXTRACTS TANNINS FROM THE MASH IMPEDES YEAST ACTIVITY
 - ADDING DARK MALTS OR ACID TO THE MASH HELPS COUNTERACT THESE EFFECTS
- SULFATE
 - GIVES BEER A DRIER FULLER FLAVOR – MAY BE HARSH AT HIGH LEVELS
 - INCREASES PERCEPTION OF HOP BITTERNESS
 - AT HIGH LEVELS MAY HAVE A LAXATIVE EFFECT
- CHLORIDE
 - ENHANCES PALATE FULLNESS, INCREASES STABILITY CLARITY OF BEER. MAY TASTE SALTY AT HIGH LEVELS

RESOURCES FOR DETAILED INFORMATION ON BREWING WATER CHEMISTRY

- HOW TO BREW, JOHN J. PALMER, CHAPTER 15
- NEW BREWING LAGER BEER, GREGORY J. NOONAN, SECTION 1, CHAPTER 3
- BREW CHEM 101, LEE W. JOHNSON
- ZYMURGY
 - JULY/AUG 2008 ON RESIDUAL ALKALINITY
 - MAY/JUNE 2012 NEW RULES OF BREWING WATER
 - NOV/DEC 2015 WATER CHEMISTRY
 - NUMEROUS ISSUES PROFILE THE WATER OF MAJOR WORLD BEER STYLES

RESOURCES FOR DETAILED INFORMATION ON BREWING WATER CHEMISTRY

- [HTTP://BEERSMITH.COM/](http://beersmith.com/)
- [HTTP://BREWERY.ORG/LIBRARY/WCHMPRIMER.HTML](http://brewery.org/library/wchmprimer.html)
- [HTTPS://BYO.COM/BOCK/ITEM/1569-WATER-CHEMISTRY-TIPS-FROM-THE-PROS](https://byo.com/bock/item/1569-water-chemistry-tips-from-the-pros)
- [HTTPS://WWW.MOREBEER.COM/ARTICLES/TREATING_HOMEBREW_WATER](https://www.morebeer.com/articles/treating_homebrew_water)
- [HTTP://WWW.LOVE2BREW.COM/ARTICLES.ASP?ID=326](http://www.love2brew.com/articles.asp?id=326)
- [HTTP://WWW.HOMEBREW-TALK.COM/SHOWTHREAD.PHP?T=198460](http://www.homebrewtalk.com/showthread.php?t=198460)

WATER PROFILES OF SOME CITIES FROM BEERSMITH

Name	Calcium	Magnesium	Sodium	Sulfate	Chloride	Bicarbonate
Antwerp, Belgium	90.0 ppm	11.0 ppm	37.0 ppm	84.0 ppm	57.0 ppm	76.0 ppm
Atlanta, GA	6.0 ppm	1.0 ppm	3.0 ppm	7.0 ppm	0.0 ppm	19.0 ppm
Boston, MA	4.0 ppm	1.0 ppm	10.0 ppm	8.0 ppm	14.0 ppm	10.0 ppm
Burton On Trent, UK	295.0 ppm	45.0 ppm	55.0 ppm	725.0 ppm	25.0 ppm	300.0 ppm
Chicago, IL	34.0 ppm	11.0 ppm	6.0 ppm	25.0 ppm	11.0 ppm	106.0 ppm
Dallas, TX	24.0 ppm	3.0 ppm	17.0 ppm	44.0 ppm	34.0 ppm	45.0 ppm
Deer Park (R), Bottled Water	3.8 ppm	1.2 ppm	2.8 ppm	6.0 ppm	0.5 ppm	32.9 ppm
Denver, Colorado	31.5 ppm	8.5 ppm	21.4 ppm	50.8 ppm	23.5 ppm	104.0 ppm
Distilled Water	0.0 ppm	0.0 ppm	0.0 ppm	0.0 ppm	0.0 ppm	0.0 ppm
Dortmund, Germany	250.0 ppm	25.0 ppm	70.0 ppm	280.0 ppm	100.0 ppm	550.0 ppm
Dublin, Ireland	115.0 ppm	4.0 ppm	12.0 ppm	55.0 ppm	19.0 ppm	200.0 ppm
Edinburg, Scotland	120.0 ppm	25.0 ppm	55.0 ppm	140.0 ppm	20.0 ppm	225.0 ppm
London, England	52.0 ppm	16.0 ppm	99.0 ppm	77.0 ppm	60.0 ppm	156.0 ppm
Los Angeles, CA (East)	63.0 ppm	22.0 ppm	84.0 ppm	151.0 ppm	99.0 ppm	0.0 ppm
Los Angeles, CA (West)	32.0 ppm	14.0 ppm	68.0 ppm	75.0 ppm	85.0 ppm	105.0 ppm
Milwaukee, WI	96.0 ppm	47.0 ppm	7.0 ppm	26.0 ppm	16.0 ppm	107.0 ppm
Munich, Germany	75.0 ppm	20.0 ppm	10.0 ppm	10.0 ppm	2.0 ppm	200.0 ppm
New York, NY	13.0 ppm	4.0 ppm	11.0 ppm	12.0 ppm	21.0 ppm	29.0 ppm
Pilsen, Czech	7.0 ppm	2.0 ppm	2.0 ppm	5.0 ppm	5.0 ppm	15.0 ppm
Portland OR	2.0 ppm	1.0 ppm	2.0 ppm	0.0 ppm	2.0 ppm	9.0 ppm
Salt Lake City, UT	30.0 ppm	17.0 ppm	5.0 ppm	12.0 ppm	7.0 ppm	252.0 ppm
Seattle, WA	17.0 ppm	1.0 ppm	4.0 ppm	2.0 ppm	4.0 ppm	18.0 ppm
Vienna, Austria	200.0 ppm	60.0 ppm	8.0 ppm	125.0 ppm	12.0 ppm	120.0 ppm
Washington, DC	38.0 ppm	9.4 ppm	19.4 ppm	32.7 ppm	35.6 ppm	10.0 ppm

AURORA WATER

SECONDARY CONTAMINANTS	UNITS	MCL	SMCL	AVERAGE LEVEL DETECTED	RANGE	SAMPLE DATE	TYPICAL SOURCE
Alkalinity (as CaCO ₃)	ppm	N/A	N/A	84	46-109	daily	Water Quality Parameter
Calcium	ppm	N/A	N/A	43	27-68	monthly	Erosion of natural deposits
Chloride	ppm	N/A	250	48	22-75	monthly	Erosion of natural deposits
Conductivity	µmhos/cm	N/A	N/A	461	261-624	monthly	Water Quality Parameter
Hardness (as CaCO ₃)	ppm	N/A	N/A	135	71-197	daily	Erosion of natural deposits
pH	SU	N/A	N/A	7.4	7.1-8.1	daily	Water Quality Parameter
Sodium	ppm	N/A	10,000	33	15-57	yearly	Erosion of natural deposits
Sulfate	ppm	N/A	250	61	30-90	monthly	Erosion of natural deposits

DENVER WATER

Component	Concentration (mg/L)		
	South Platte treated water	Moffat treated water	Desirable levels *
Total alkalinity (as CaCO ₃)	30-81	18-35	25-300
Sodium (Na)	15-23	4-8	10-150
Chloride (Cl)	12-33	4-7	Less than 150
Sulfate (SO ₄)	47-78	17-23	10-70
Calcium (Ca)	21-37	9-15	50-150
Magnesium (Mg)	5-10	2-3	10-30

HIGHLANDS RANCH WATER (2012)

- ALKALINITY 93
- CHLORIDE 27
- SULFATE 41
- CALCIUM 31
- MAGNESIUM 4
- SODIUM 57

The background features a light gray gradient with several realistic water droplets of various sizes scattered in the corners. The droplets have highlights and shadows, giving them a three-dimensional appearance. They are located in the top-left, top-right, and bottom-right areas of the frame.

CASTLE ROCK WATER

(UNIQUE IN THE FACT THAT IT IS ALMOST ENTIRELY GROUNDWATER)

ELDORADO SPRINGS WATER

Chemical Analysis

Eldorado Artesian Springs, Inc. is regularly inspected by the FDA, Colorado Department of Public Health and Environment (usually accompanied by the Boulder County Health Department) and the Department of the Army (for military food sales).

Keep your body hydrated and your body's natural pH levels in balance! **Eldorado water is always naturally alkaline — approximately 7.3 pH.** Mother Nature created the perfect recipe which includes naturally occurring minerals and electrolytes.

All units in milligrams per liter (mg/L) unless otherwise noted.

ND = None Detected

Constituent	Result
Sulfate	20
Bicarbonate	35.5
Calcium	11.4
Iron	ND
Magnesium	3.4
Potassium	3
Sodium	6.2

SOURCES FOR WATER ANALYSIS

- [WARD LABS, KEARNEY NEBRASKA, BREWERS TEST KIT <\\$30.00](http://www.wardlab.com/feeschedule/)

[HTTP://WWW.WARDLAB.COM/FEESCHEDULE/](http://www.wardlab.com/feeschedule/)

- KARLABS, KALAMAZOO MICHIGAN, "95 ANALYSES" \$60.00 – INCLUDES SHIPPING

[HTTP://WWW.KARLABS.COM/INDEX.HTML](http://www.karlabs.com/index.html)

COMMON SALT ADDITIONS

FROM: KEN SCHWARTZ "QUICKIE WATER CHEMISTRY PRIMER"
1 GRAM PER GALLON ADDITION WILL INCREASE BY THE FOLLOWING IN MG/L

ADDITIVE	Ca	SO ₄	Mg	Na	Cl	CO ₃	HRDNS	ALK'Y
GYP SUM	61.5	147.4	-----	-----	-----	-----	153.6	-----
CHALK	105.8	-----	-----	-----	-----	158.4	264.2	264.2
CaCl ₂	72.0	-----	-----	-----	127.4	-----	179.8	-----
SALT	-----	-----	-----	103.9	160.3	-----	-----	-----
BKNG SODA	-----	-----	-----	72.3	-----	188.7	-----	157.4
EPSOM	-----	103.0	26.1	-----	-----	-----	107.8	-----

- HARDNESS AND ALKALINITY ARE "AS CaCO₃"



SO THAT'S IT

- YOU HAVE AN IDEA WHERE YOU ARE STARTING AT
 - YOU HAVE SOME GUIDANCE ON WHERE YOU WOULD LIKE TO GO
 - YOU HAVE THE MEANS TO GET YOU THERE
- 