Hydrometer Usage and Specific Gravity Tables

Hydrometry

- Hydrometry (Hydro - water, metry/meter - measure) use the principles of buoyancy or flotation to measure liquid densities.
- The simplest device used to measure the degree of flotation is a hydrometer.
- There are many different hydrometer designs with varying ranges and calibration units, depending on what is being measured.
- Specific gravity (SG) is one of the base hydrometry units used for relative density.

  In most cases this is relative to the density of water, water therefore having a specific gravity of one (1).
- Alcohol has a lower density then water (Ethanol - p = 0.789 kg/m^3 @ 20^oC, water - p = $1.000kg/m^3$ @ 4^oC) and hence will reduce the density of water and will have a SG (specific gravity) reading below 1.
- On the other hand sugar has a higher density than water and like most dissolved solids will raise the water's density.

  In cleared juice, devoid of alcohol, the juice's specific gravity can be related to the juice's sugar content and hydrometry is often used to determine the sugar content of and hence ripeness of grapes and the potential alcohol.

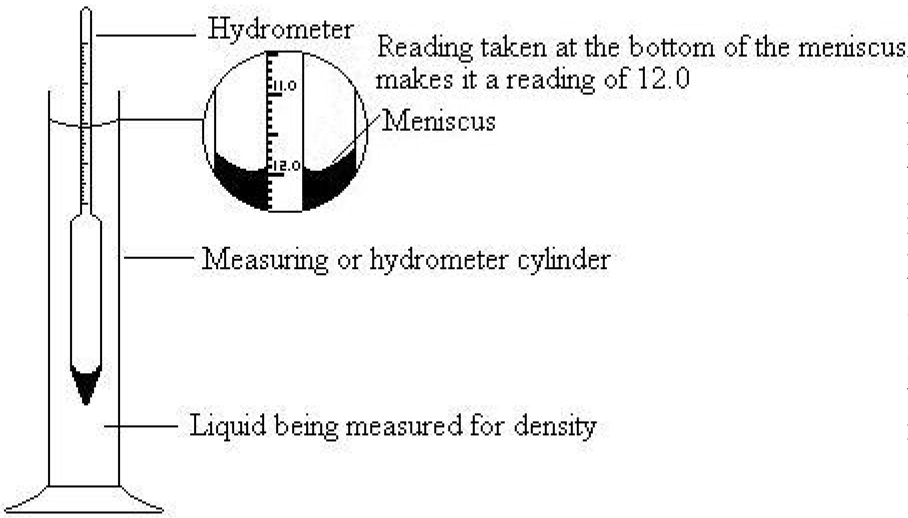
  This is because sugar accounts for most of the dissolved solids in grape juice (90%).
- The ^{o}Baume (^{o}Be$^/$) of wine can be determined by hydrometry but requires the alcohol concentration to calculate the true sugar concentration.

A hydrometer measures the density of a liquid compared to water. For our purposes, this is for finding the potential alcohol that will be obtained through fermentation, as well as the actual fermented alcohol percentage through a simple calculation. A hydrometer will not work for testing the alcohol percentage in a finished product, however. Water is more dense than alcohol, therefore a hydrometer's use is restricted to finding density when compared to water, and not alcohol. To test alcohol percentage in a finished product, you need an alcoholmeter.

While there are several scales used on hydrometers, those most commonly used in home brewing are Specific Gravity, Oeschle, and Potential Alcohol. Because the Potential Alcohol scale is included on only some hydrometers, and can be easily calculated from the Specific Gravity or Oeschle reading, we will focus on these two scales.

Before we begin may I suggest you follow the link to first make 100% sure your Hydrometer is calibrated correctly so you can make the best use of it possible. This is a valueable tool, makin gsure it is correct is vital. **See Calibrating Your Hydrometer** Hydrometer Calibration

The two scales- Specific Gravity and Oeschle- are directly related. This makes it easy to convert the reading for any reason. This can be very important if, for example, your hydrometer breaks between readings, and your replacement uses the opposing scale only. While Specific Gravity reads in decimals, Oeschle scale reads in whole numbers. As an example, a Specific Gravity reading of 1.090 is the same as an Oeschle reading of 90. SG 1.055 is Oeschle 55, and so on. You simply remove the 1 before the decimal, and multiply by 1000 to convert a Specific Gravity reading to an Oeschle reading The advantage to the Oeschle scale is that instead of reading in decimals below 1.000, it goes into the negative scale. This can simplify some calculations that you may use the numbers for. This is because in Specific Gravity, water is 1.000, whereas in Oeschle water is 0. While with experience one can become comfortable with Specific Gravity, many starting out find calculations with a finishing SG below 1.000 to become very confusing.



In order to make full use of your hydrometer the first thing that you need to know how to do is to take a reading with it. In order to take a reading, pour a sample of the liquid to be tested into your test cylinder, leaving room for the hydrometer to displace the liquid. In order to obtain the most accurate reading possible, try to ensure that the liquid is as close to 68'F (20'C) as possible, as this is the temperature that the hydrometer has been calibrated to (should your hydrometer be calibrated to a different temperature, which should be stated on the meter, ensure that your liquid is at the quoted temperature). Place your hydrometer in the liquid and spin it in order to dislodge any bubbles that may be in the liquid, which would otherwise cause you to get a false high reading. Read the number on the paper where the liquid crosses the stem of the hydrometer.

There are multiple uses for taking readings of your mash. First, you can use a reading taken prior to pitching your yeast to calculate the potential alcohol that will be achieved through the fermentation. This calculation generally assumes an ending reading of SG 1.000 (Oeschle 0):

Original Reading- SG 1.090 (Oeschle 90)

For SG reading subtract 1 and multiply by 125
1.090 - 1 = 0.090 x 125 = 11.25% potential alcohol

For Oeschle reading divide by 8
90 ÷ 8 = 11.25% potential alcohol

You can also use virtually the same calculation to find the actual fermented alcohol percentage by taking the difference between the original reading (prior to pitching yeast) and the final reading (after fermentation is complete). For example, if your original reading is SG 1.090 (Oeschle 90), and your final reading is SG 0.990 (Oeschle -10):

SG 1.090 - 0.990 = 0.1 x 125 = 12.5% alcohol

Oeschle 90 - (-10) = 100 ÷ 8 = 12.5% alcohol
remember basic math- when subtracting a negative number, you add the two numbers together

A hydrometer can also be used to check that fermentation has completed. To do this, you will take a reading two days apart and compare the results. If there is any change in the results, then your fermentation was still active during this period. If the reading remains stagnant, then fermentation is completed and you may move to the next stage of the process.

Hydrometer Tables and Charts

Specific Gravity S.G.	Brix	Potential Alcohol By Volume (%)	Pounds and Ounces of Sugar in One U.S. Gallon of Water lbs. ozs.
1.000	0.00	0	0 – 0
1.005	1.28	0.5	0 – 2
1.010	2.56	0.9	0 – 4
1.015	3.82	1.6	0 – 6
1.020	5.08	2.3	0 – 8
1.025	6.32	3.0	0 – 9
1.030	7.55	3.7	0 – 11
1.035	8.77	4.4	0 – 13
1.040	9.98	5.1	0 – 15
1.045	11.18	5.8	1 – 0
1.050	12.37	6.5	1 – 2
1.055	13.55	7.2	1 – 4
1.060	14.72	7.8	1 – 6
1.065	15.88	8.6	1 – 7
1.070	17.03	9.2	1 – 9
1.075	18.18	9.9	1 – 10
1.080	19.31	10.6	1 – 12
1.085	20.43	11.3	1 – 14
1.090	21.54	12.0	2 – 0
1.095	22.65	12.7	2 – 2
1.100	23.75	13.4	2 – 4
1.105	24.83	14.1	2 – 5
1.110	25.91	14.9	2 – 7
1.115	26.98	15.6	2 – 9
1.150	28.05	16.3	2 – 11

Hydrometer Temperature Corrections

The data below was obtained using the "Handbook of Chemistry and Physics (CRC)", and is valid for a temperature range between 0 and 212F.

Temp (C)	Temp (F)	Density	Correction relative to 59F
0	32	0.99987	-0.74
3.98	39.16	1.00000	-0.87
5	41	0.99999	-0.86
10	50	0.99973	-0.6
15	59	0.99913	0
18	64.4	0.99862	0.51
20	68	0.99823	0.9
25	77	0.99707	2.06
30	86	0.99567	3.46
35	95	0.99406	5.07
38	100.4	0.99299	6.14
40	104	0.99224	6.89
45	113	0.99025	8.88
50	122	0.98807	11.06
55	131	0.98573	13.4
60	140	0.98324	15.89
65	149	0.98059	18.54
70	158	0.97781	21.32
75	167	0.97489	24.24
80	176	0.97183	27.3
85	185	0.96865	30.48
90	194	0.96534	33.79
95	203	0.96192	37.21
100	212	0.95838	40.75

The correction term was computed relative to 15C (59F). It may be easily calculated relative to any temperature. A third order polynomial fit to this data was also very good (R**2 = 0.999969):

```
Correction(@59F) =
   1.313454 - 0.132674*T + 2.057793e-3*T**2 - 2.627634e-6*T**3

          where T is in degrees F.
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This equation should be good for the entire temperature range of interest.

Temperature Corrections Note For Hydometers Calibrated At 68 Deg F: What ever units your hydrometer is calibrated in, the solution to be measured for its density needs to be at the temperature the hydrometer was calibrated or standardized at, adjustments or corrections for different solution temperatures will need to be made.

If hydrometers are calibrated or standardized @ 68^{o}F

^{o}Baumé

1 ^{o}C > (greater than) 20^{o}C add 0.03^{o}Be

1 ^{o}C < (less than) 20^{o}C subtract 0.03^{o}Be

^{o}Brix

1 ^{o}C > 20^{o}C add 0.05^{o}Brix

1 ^{o}C < 20^{o}C subtract 0.05^{o}Brix

^{o}SG

1 ^{o}C > 20^{o}C add 0.0002 units

1 ^{o}C < 20^{o}C subtract 0.0002 units

^{o}Oeschlé

1 ^{o}C > 20^{o}C add 0.2^{o}Oe

1 ^{o}C < 20^{o}C subtract 0.2^{o}Oe