# An Evaluation of the suitability of colorpHast strips for pH measurements in home brewing

EMD's colorpHast strips for the pH range 4.0 to 7.0 are very popular among home brewers. Their more narrow range and improved readability are an improvement over economy pH strips. While they don't provide the precision of a pH meter they don't require the maintenance necessary for the latter and are therefore a very attractive means of testing pH in home brewing.

But earlier studies done by myself have shown that these strips seem to have a systematic error of -0.3 pH. I.e. the strips tend to report a pH reading that is about 0.3 pH less than what is determined with a calibrated pH meter:

- colorpHastStrips vs. a pH meter
- micro mashing experiments

Since this error could be the result of lot specific variations I needed a larger sample. To get this larger sample I solicited the help from fellow brewers on the Northern Brewer and HomeBrewTalk.com forms. They sent me a few of their colorpHast strips and I made test mashes and tested these mashes and a sample of beer with these test strips and a pH meter.

In the end it was confirmed that the colorpHast strips have a -0.3 systematic error when they are used for testing the mash pH. No significant error was found for testing beer pH but the range of confidence with which the strip's color could be interpreted was larger than for the mash pH experiments.

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## Methods and Materials

The test mashes were prepared by mixing 60 C (140F) water with a pulverized grist at a mash thickness of 4 l/kg:

- mash A: 50% Weyermann Munich II, 50% Weyermann Pilsner, water residual alkalinity = 35 ppm $CaCO_3$
- mash B: 100% Weyermann Pilsner, water residual alkalinity = 115 ppm $CaCO_3$

The mash temperature was held stable at 60C (140F) for 10 min in a water bath and then the mashes were cooled to 25C (77F) within 5 min in an ice bath. Because of additional delays the samples stood at room temperature for about 20 min before they were tested.

Testing was done with a calibrated pH meter (Milwaukee SM101)and with the colorpHast strips. Once the colorpHast strips were submerged in the samples they were blotted with a paper towel and placed on a piece of white paper along with the color chart that was supplied with my colorpHast strips. A picture was taken with a digital camera in RAW format. The lighting was a tungsten light source. This format only captures the output of the CCD sensor and leaves additional processing to post processing software.

The beer sample was warmed to 25C and because its pH was 4.0 which was too close to the range of the strips its pH was adjusted to 4.4 with a sodium bicarbonate solution. The strips were submerged for about a minute and a picture was taken on white paper in tungsten light.

The images of the strips and the color scale were then color corrected for white balance and adjusted to the same brightness. After that the color scale and the strips were rearranged to fit into a smaller format and presented to the members at the Northern Brewer and HomeBrewTalk forums. The participating users were asked to match the color of each strip to the color scale and read the pH and a confidence range. That data was then plotted.

2 participants made an effort to use a software based color matching technique Their data was plotted as well.

Ken Rubin's technique [Rubin]:

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A simple program averages each of the rgb color components within a selected box.
The average rgb values are then used to determine the "distance" to black by using
the formula Sqrt(r^2 + g^2 + b^2).

For the reference colors on the color scale the following distances to black were
found

4.0: 273
4.4: 259
4.7: 222
5.0: 163
5.3: 129
5.5: 124
5.8: 110
6.1: 80
6.5: 71
7.0: 65.

After that the distances to black for each of the test strips were determined

1: 146
2: 170
3: 168
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4: 148
5: 170
7: 159
8: 155
9: 168.

Using simple interpolation the following pH values were determined for the
tested strips

1: 5.15
2: 4.96
3: 4.97
4: 5.14
5: 4.96
7: 5.04
8: 5.07
9: 4.97
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A.J deLange's technique [deLange]:

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The color meter of the Mac was used to measure color in the L*, a*, b* space.
It was determined that the b channel was the most sensitive so only that was
used to compare the strips. 8 channel b readings were taken for each of the
4.7, 5.0 and 5.3 reference color fields and averaged. A 3rd order polynomial
that fits the average b-channel readings was dretermined and later used to
determine the pH reading for each of the tested strips based on their b-channel
readings. For each of the strips 6 b-channel readings were taken, converted
to pH using aforementioned polynominal. After running statistics the following
results were determined

Strip 01 4.95 ± 0.03
Strip 02 5.08 ± 0.04
Strip 03 4.96 ± 0.03
Strip 04 5.05 ± 0.04
Strip 05 4.96 ± 0.03
Strip 07 5.05 ± 0.02
Strip 08 4.89 ± 0.05
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Strip 09 4.97 ± 0.07
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# Results and Discussion

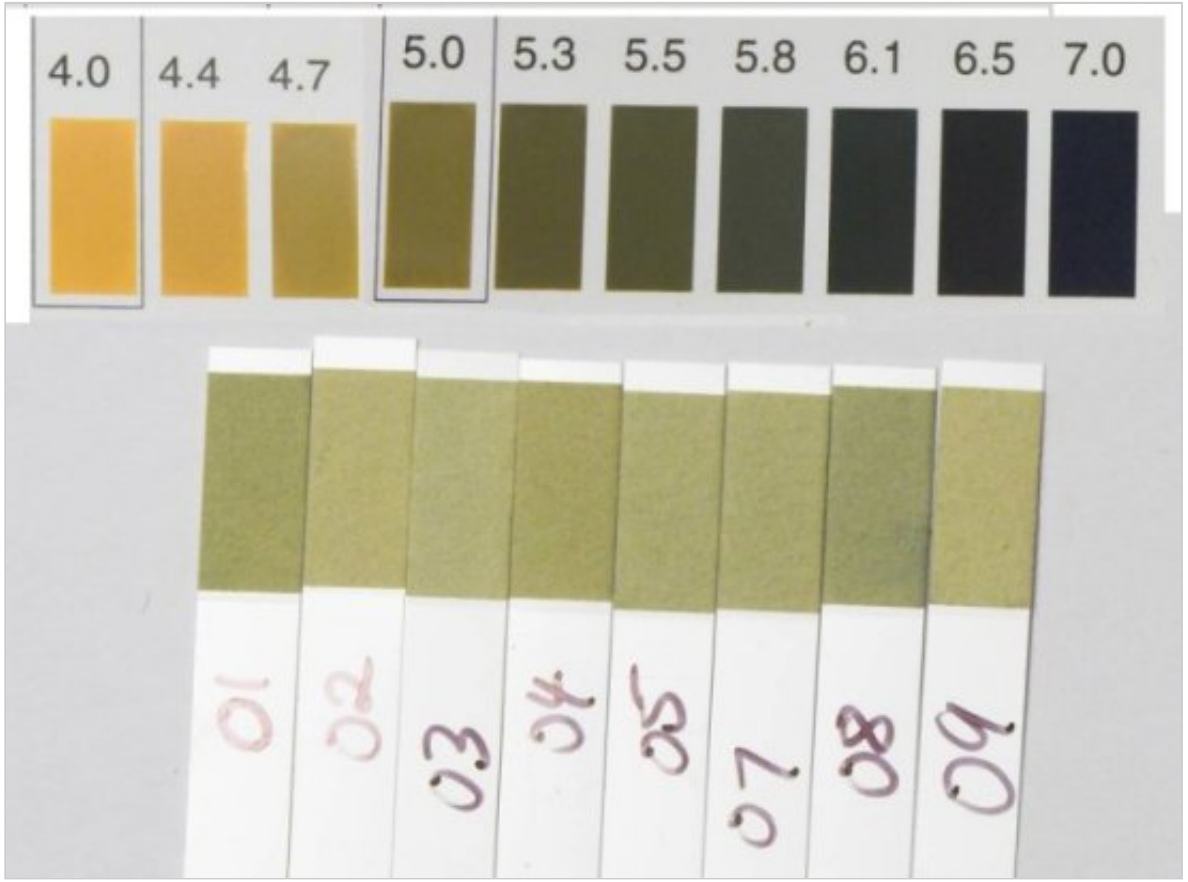


**Figure 1** - colorpHast strips before they were used

Before the colorpHast strips were used, a pictures was taken that shows that the unused strips already show different shades. This difference will also be visible later when they are used to test mash and beer samples

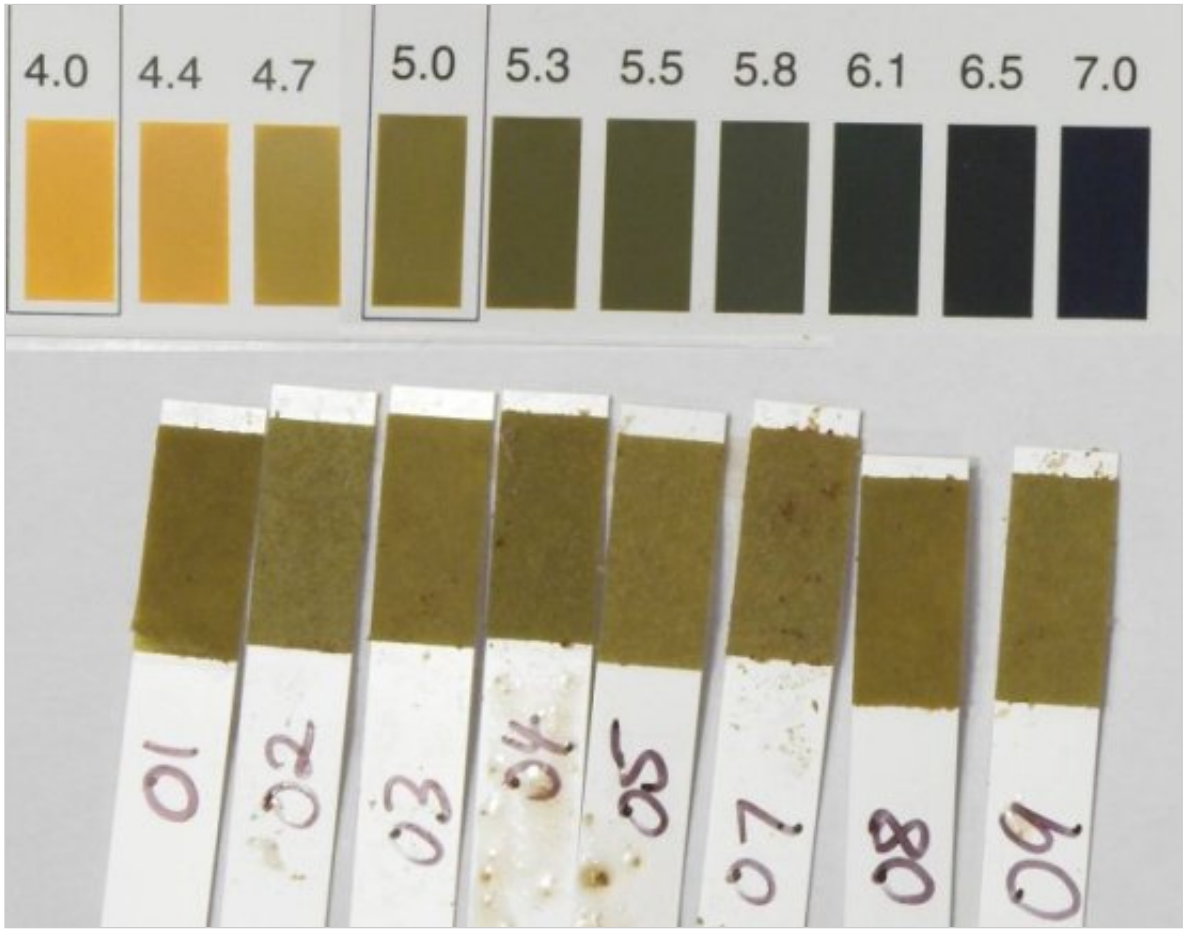


**Figure 2** - colorpHast strip after being used in a test mash with a pH of 5.35 at room temperature.

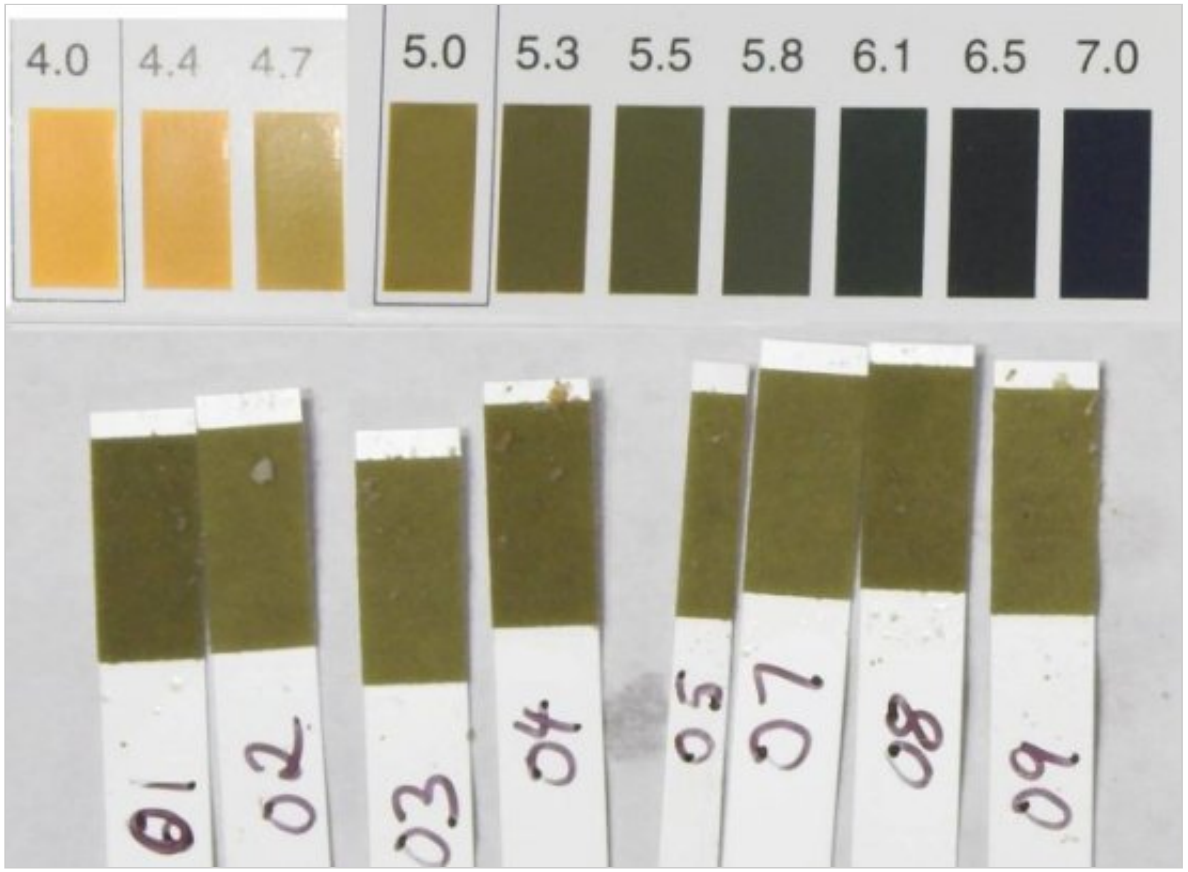


**Figure 3** - colorpHast strip after being used in a test mash with a pH of 5.66 at room temperature.


**Figure 4** - colorpHast strip after being used in a sample of beer with a pH of 4.40 at room temperature.

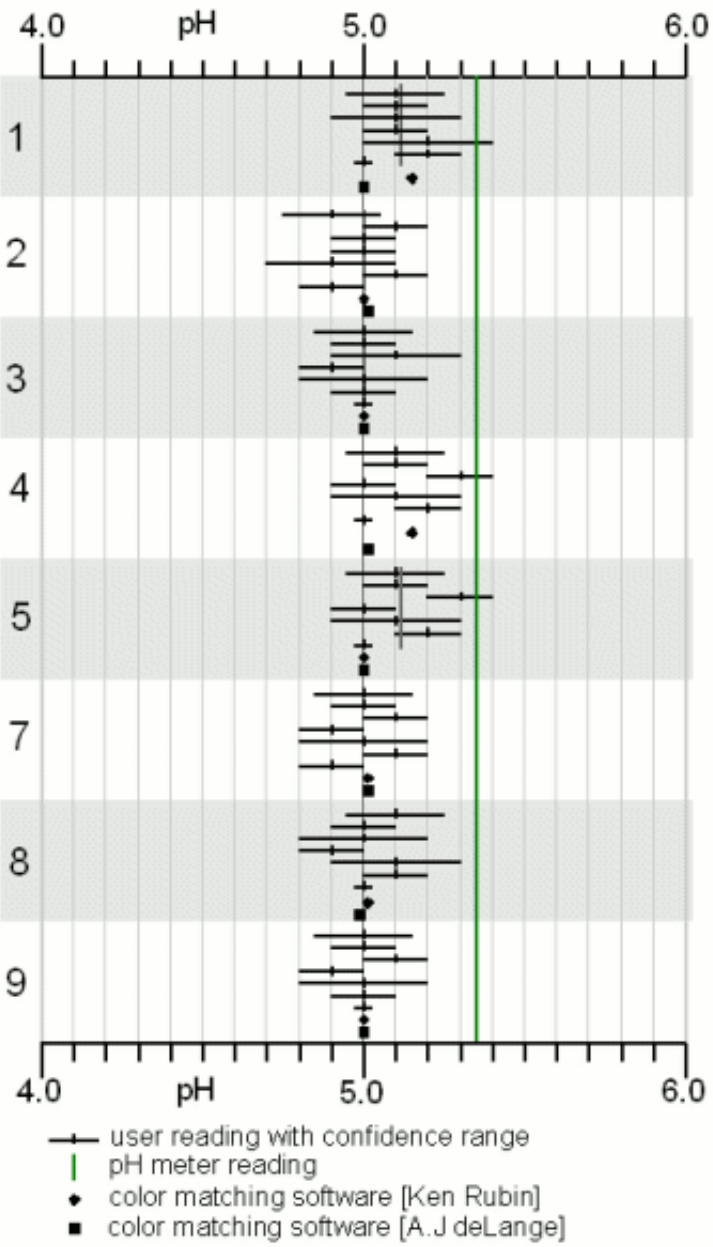


**Figure 5** - How different brewers interpreted the 8 different colorpHast strips that were used in a mash with a room temperature pH of 5.35. The horizontal lines indicate confidence ranges that were given for the readings. In addition to that it also

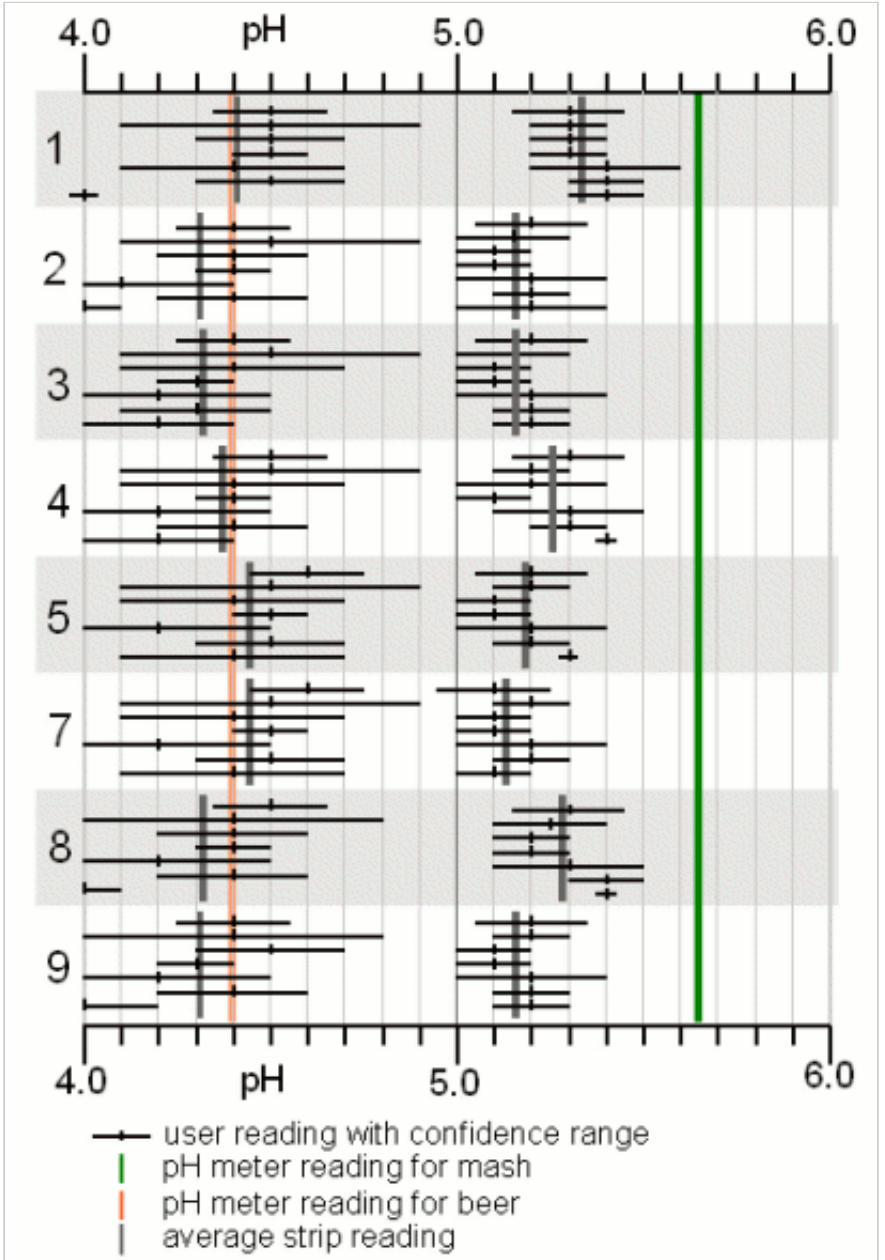


**Figure 6** - The results for the pH 5.66 mash and the pH 4.40 beer sample. The difference between the average strip reading and the actual mash pH is about 0.4 pH. For the beer sample it is about 0.0 pH

shows the results from Ken and A.J.'s approaches based on color measurements.

The results show that the colorpHast strips show a systematic error of about -0.3 to 0.4 pH. This meas that their color is matches to a pH on the supplied color scale that is on average 0.3 to 0.4 pH units lower than the actual pH of the sample. While this was true for both mash pH readings, the pH reading for the beer sample matched the actual pH fairly closely but the strips were more difficult to read which is indicated by the larger confidence ranges that were given for the pH readings.

# Conclusion

While the colorpHast strips can be read with a precision of +/- 0.2 pH units, which is sufficient for checking mash pH, they exhibit a systematic error of 0.3 - 0.4 pH which needs to be taken into account. If a proper mash pH is considered to be between 5.3 and 5.7 when measured at room temperature the pH read with the strips should be between 5.1 and 5.3 as this will place the actual pH around 5.5 which is in the middle of the acceptable range.