pH Calibration Buffers and Their Use

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Here are some guidelines how to carry out calibration and checking of pH meters in order to achieve reliable pH measurement results.

1. pH is well known to be an unstable parameter. Therefore calibration solutions cannot be stored for a long time. On the other hand, pH measurement is needed in research of many people in our group. These two factors put together mean that it would be advantageous to **prepare and monitor pH calibration solutions for common usage**, instead of everybody preparing calibration buffers separately.

2. Standard buffer solutions with pH values 4, 7 and 10 (exact values may differ depending on the used set of concentrates), possibly also others, are prepared by Ester in reasonably large batches (e.g. 1 L at a time). Exact values may occasionally differ depending on the source. Below such solutions are called "**primary buffer solutions**". They are labeled as primary solutions, together with pH value and date and are stored in the fridge of Lab 1095. Ester monitors the amounts and prepares new solutions as needed and orders the concentrates.

3. The primary buffer solutions are taken **out of the fridge only for the short time** that is needed to take some amount of solution and then are put back to fridge.[1,2] Primary buffer solution is never poured back to the primary solution bottle.

4. Ester prepares primary solutions always the same way and since they are kept in cold and dark, it is expected that their pH values are well reproducible and their lifetime is as long as possible. So, **you are encouraged to use these solutions** for calibrating pH meters for your different applications.

5. It is OK to take several hundred ml of a primary solution into another bottle and bring to a different lab (in order not to walk all the time to 1095) for use there, but please notify Ester, if you take a large amount or if less than 1/3 remains in the primary solution bottle.[3]

6. Most pH meters are calibrated with two solutions. These should be chosen according to the specific application. If acidic pH is measured (common typical with most LC mobile phases) then the best combination is pH 4 and pH 7, but depending on application, other combinations may be justified. Glass electrode for pH measurement has very good linearity in the mid-pH range, so, when calibrating with 4 and 7, you can also measure pH somewhat below 4 and somewhat above 7.[4] Calibrating with 4 and 10 gives the widest range, but solution with pH 10 needs care because of its sensitivity to CO_2.[1]

7. It is difficult to predict **how long** the primary standards will be usable, even if kept in the fridge. In order to check the stability of the primary solutions it is a good idea to keep an older primary solution still for some time in the fridge after preparing a new one and compare the values (see the next item).

[1] It is well known that keeping pH buffers in cold and dark is the best way of prolonging their lifetime. In the case of buffers with pH over 7 also protecting solution from air CO_2 is needed. This is particularly relevant for the pH 10 buffer solution, which has to be stored in a bottle that can be air-tightly closed.

[2] It is very important, however, that the solution is warmed up to the room temperature before using it.

[3] The smaller the amount that you take for storing in your room the shorter is the lifetime of the solution.

[4] Calibration with 4 and 7 should be OK for the pH range of 2.5 … 8.5.

8. It is a very good (almost mandatory) idea to **check the pH meter after calibration** by measuring the pH of some buffer solution that was not involved in making the calibration. It is recommended that the check is carried out in two ways:

    a. With a most recent primary solution with a different pH. For example, if calibrated with pH 4 and pH 10, then pH 7 would be a suitable standard solution for checking. This check will show **if the particular calibration on the particular day is OK**.

    b. With a primary solution from a previous (older) batch[5] (see item 7), which can also be with the same pH as used for calibration. This will give information on **temporal stability of the primary solutions** and will work as an additional check for the particular calibration.

9. It is strongly recommended to **enter the calibration data in the online spreadsheet:** https://docs.google.com/spreadsheets/d/1xe6z2csOveiFlnr_eSmVUyfYe6CZsrsAdCDqdsLJjyQ/edit#gid=0

    You can add to the spreadsheet comments on storage conditions of the used solutions etc. Collecting the **data on agreement between the nominal and found values of the older solutions** will make it possible to predict how long the primary solutions can be stored. This way we will in time develop quite good knowledge of the lifetimes of the primary pH buffer solutions.

[5] Use older primary solutions only for checking. For calibration always use the most recent buffer solutions.