Palintest pool & spa

# Pool Chemistry Guide

# Contents

## Introduction

The Palintest pool chemistry guide is your essential guide for understanding the fundamentals of pool water chemistry. It will go over all the necessary parameters that you may wish to test for, the frequency of testing, and the multiple testing methods available to you.

The information in this guide collates industry best practice but we always recommend you seek advice on the local regulations from your local advisory board.

For a more extensive and detailed guide take a look at the Engineers' Edition; Pool Chemistry Guide. For more information, or to contact our team please visit www.palintest.com

## Why do we test the water?

Every user of the pool has a right to feel safe and comfortable whilst swimming. This doesn't just mean the physical safety and comfort, but the water should also be tested to make sure it is suitable for people to swim in. There are four main reasons for water testing:

- Bather safety and comfort
- Removal of contamination
- Care of plant and pool surrounds
- Control of chemicals used

Failure to test the water correctly can easily lead to bather illness, irritation or problems with the pool, so a regular testing procedure should be drawn up and followed.

## Parameter Testing

Many parameters are tested in a swimming pool to ensure the pool runs at its optimal level and is safe for bathers.

## Disinfectant

Normally chlorine or bromine is used to disinfect pool water and keep it free of harmful bacteria.

Whichever disinfectant you are using, the levels should be tested regularly as outlined in the normal operating procedure (NOP). National legislation will determine frequency of testing required. Remember the more testing you carry out, the safer and better run the pool is.

All advice given in this booklet is generalised information, and you should always check your local legislation and guidelines.

## Chlorine – Free and Total

Chlorine is the most commonly used disinfectant, and it is important to monitor both the free and total chlorine levels. When chlorine reacts with nitrogen containing molecules in the water, they form combined chlorines. Although combined chlorines still have disinfection properties, they are not as efficient as free chlorine.

In the UK, if chlorine is being used in a well-designed pool you should be looking for a free chlorine residual of 1.0 mg/L, or down to 0.5 mg/L if a UV or ozone system is being used. However, the actual free chlorine level you are looking for should be stated in your NOP and can vary from pool to pool. The combined chlorine (a measure of unwelcome disinfection by-products) should be as low as possible and certainly less than half the free and never more than 1 mg/L.

## Bromine

As a general rule, bromine is used to treat hot tubs and spas and chlorine is used for the treatment of pools, although there is much cross-over. Bromine is more active at higher pH levels and more stable and effective at higher temperatures than chlorine. For those with sensitive skin, bromine can be preferable as it does not cause as much skin and eye irritation as chlorine.

Recommended bromine levels in the UK for pools and spas are 4–6 mg/L with shock dose of 10 mg/L, although this can vary if additional chemicals such as sodium hypochlorite are also added to the water.

## PHMB

PHMB is an alternative disinfectant to chlorine or bromine and is used in conjunction with a hydrogen peroxide disinfectant regime.

The recommended levels for PHMB are 20–40 mg/L, however, this will vary with exact pool temperatures and location.

## Hydrogen Peroxide

Hydrogen peroxide cannot be used as the only disinfectant in pools because it breaks down too quickly. It can enhance the disinfectant power of other oxidisers such as chlorine, UV or ozone treatments.

The recommended levels will vary according to the size of your pool and the local authority, but typically a level of 30–100 mg/L is required in a peroxide treated pool.

## Ozone

Ozone can purify water 3000 times faster than chlorine. It is also very effective at killing *Cryptosporidium* and *Giardia* which are unaffected by chlorine disinfection.

Ozone use does not affect the pH level of the pool. It does have a large initial cost, but when using ozone, the free chlorine levels can be much lower (0.5 mg/L for a pool, and 2–3 mg/L in spas and hydrotherapy pools).

## pH

The pH is a measure of how acidic or alkaline the water is, and can affect how other pool chemicals work, as well as bather comfort and lifetime of pool fittings. Ideally you are looking for a pH of 7.2–7.4 as this allows effective disinfection but is also comfortable for the bather. An overall range of 7.0–7.6 is acceptable in most pools. pH should **always** be measured at the same time as the disinfectant.

## Total Alkalinity

Alkalinity protects the water from dramatic changes in pH when the pool is in use.

Total alkalinity should be measured at least once a week and the levels should be in the range 80–200 mg/L $CaCO_3$. Levels below 80 mg/L could make the pH unstable whereas above 200 mg/L the pH could become difficult to change.

## Cyanuric Acid

Cyanuric acid is commonly referred to as a chlorine stabilizer and is often used in outdoor pools. Without cyanuric acid present, chlorine is more quickly degraded by UV light.

Levels should be below 200 mg/L, with many authorities suggesting levels between 25 and 50 mg/L are ideal.

## Calcium Hardness

If calcium levels in the water are low, pool surrounds or grout can be eroded by the water. Likewise, if there is too much calcium, deposits will start dropping (as in a kettle) and can leave 'hard water' marks. Calcium hardness should be measured once a week, and a level between 80–200 mg/L maintained.

## Phosphate

Phosphate is naturally present in water and promotes the growth of algae. Control of phosphates is especially important for outdoor pools and spas. The level of total phosphates in the pool water should be 0.01 mg/L or below.

## Dissolved solids

Mains water is likely to have several hundred mg/L total dissolved solids (TDS). Pool chemicals and pollution will increase this - so high TDS is a warning that the pool water quality is decreasing. It should not be allowed to rise more than 1,000 mg/L above that of the mains water - up to a maximum of 3,000 mg/L. Measure it weekly with an electronic meter: if it's too high, dilute.

## Salinity

Salt (sodium chloride) can be used in swimming pools as a form of disinfection. This is called salt water chlorination. Electrolysis is used to produce hypochlorous acid (HClO) and sodium hypochlorite (NaClO) which are the usual sanitizing agents commonly used in a swimming pool.

The salt water pH should remain between 7.2 and 7.6, for the chlorine to be at its most effective. For outdoor pools, additional stabilizer (cyanuric acid) will be required to help prevent the UV rays from the sun breaking down the free chlorine in the pool too rapidly.

The salt level required to maintain a safe, chlorinated pool is between 2500 and 3500 ppm. Much less that is found in seawater, and less than the level the human tongue can taste.

## Turbidity

The turbidity of the water is a measure of how cloudy the water is. This has recently become more frequently tested in pools.

Traditionally it has been that if you can see the bottom of the pool at the deep end then the clarity is sufficient. However, recent recommendations state that pool water should be measured, and the level of turbidity should be 0.5 NTU (Nephelometric Turbidity Units) or less. This level is below that which the human eye can see, and so a meter specifically designed for turbidity measurement should be used to test the water weekly.

Checking the turbidity also can indicate other problems such as:

- Poor water chemistry
- Deteriorating filter quality
- Inadequate backwashing routine
- Incorrect flow rate or pipe sizing

## Water balance

Water balance describes how likely the water is to scale or corrode its surroundings and is important when considering the lifetime of your fixtures and fittings. If the water will dissolve minerals around it, then it is described as corrosive. If the water will tend to deposit minerals it is considered scaling.

The Palintest Water Balance Index is calculated using the result from the Calcium Hardness test, the Total Alkalinity test, and the pH test. The calcium and alkalinity test results are converted to Factor values which can be used to calculate the Palintest Water Balance Index.

Calcium Hardness Factor

+ Total Alkalinity Factor

+ Actual pH

= Palintest Water Balance Index

Alternatives to the Palintest Water Balance Index are the Langelier Saturation Index, and the Ryznar Stability Index. Both of these require measurement of the temperature and total dissolved solids of the water sample as well as those parameters needed for the Palintest method. For more

information on these other methods, please contact Palintest.

*Table 1: Factor values that can be used to calculate the Palintest Water Balance Index.*

| Calcium Hardness or Alkalinity as mg/L $CaCO_3$ | Factor |
|---|---|
| 20 | 1.00 |
| 30 | 1.20 |
| 40 | 1.30 |
| 50 | 1.40 |
| 66 | 1.50 |
| 80 | 1.60 |
| 90 | 1.65 |
| 100 | 1.70 |
| 125 | 1.80 |
| 150 | 1.90 |
| 200 | 2.00 |
| 250 | 2.10 |
| 300 | 2.20 |
| 350 | 2.25 |
| 400 | 2.30 |
| 500 | 2.40 |
| 550 | 2.45 |
| 600 | 2.50 |
| 700 | 2.55 |
| 800 | 2.60 |

*Table 2: Recommendations for water balance correction based on the Palintest Water Balance Index value.*

| Palintest Water Balance Index | Water Balance Condition | Recommendation |
|---|---|---|
| Below 9.6 | Highly Corrosive | • Increase pH to 7.5–7.8<br>• Increase calcium hardness to at least 50 mg/L<br>• Increase total alkalinity to 100 mg/L or higher as necessary<br>• Retest water balance |
| 9.6–10.5 | Corrosive | |
| 10.6–10.9 | Acceptable Balance | • Retest water regularly |
| 11.0–11.2 | Ideal Balance | • No action required |
| 11.3–11.6 | Acceptable Balance | • Retest water regularly |
| 11.7–12.6 | Scale Forming | • Decrease pH to 7.2–7.5<br>• Decrease total alkalinity to 150 mg/L or lower as necessary<br>• Retest water balance |
| Above 12.6 | Highly Scale Forming | |

## Microbiological testing

Microbiological testing is checking there are no dangerous pathogens which can cause bathers serious illness present in the water.

Regularly you need to take a water sample for three tests of microbiological water quality - colony counts, coliforms and *E. coli.* (also test this if the pool has been shut down). Your local authority may request this is done by an accredited laboratory, or alternatively you can carry out an on-site test using Colitag™ or Nutridisks.

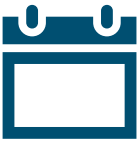
These are the results you need to be reassured everything is safe for bathing.

| | |
|---|---|
| Colony Count | Not more than 10 CFU per 100mL |
| Total Coliforms | Absent in 100 mL |
| *E. coli.* | Absent in 100 mL |
| Ps. Aeruginosa | Absent in 100 mL |

## How often should I be testing?

This will be stipulated by your local authority, and will depend on the amount the pool is used, but as a general rule;

### Daily



- Disinfectant Residual (Chlorine, Bromine, Ozone etc.)
- pH

### Weekly

- Alkalinity
- Calcium Hardness
- Cyanuric Acid
- Water Balance
- Total Dissolved Solids

### Monthly

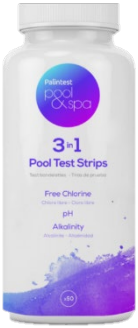
- Total Dissolved Solids
- Sulfate
- Turbidity
- Microbiological

## Test Method Selection

When testing parameters in pools there are a number of options in terms of the test method. The type most suitable to you will depend on costs and pool usage.

## Test Strips

Test strips are the simplest and most economical form of testing and although common in the domestic pool market, should be viewed as producing results that are indicative only.




## Colorimetric Methods

Colorimetric techniques involve the addition of reagents to water samples, producing a colour change which is proportional to the concentration of the parameter under test.

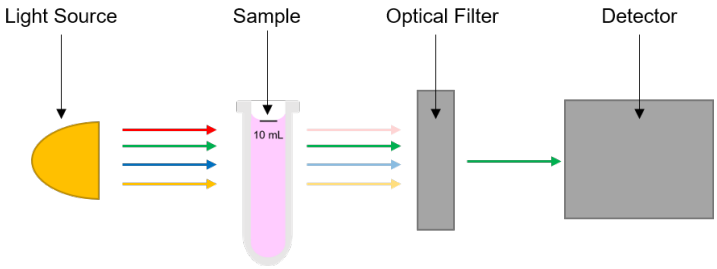
## Comparator Visual Systems

Comparator discs and block systems are utilised throughout the industry and are manufactured against verified colour standards, therefore are suitable for reporting purposes. They are a step up from test strips in terms of accuracy, whilst still being relatively low cost and easy to use.  However, these systems can have wide incremental result steps, involve a degree of interpretation and are prone to variations in colour perception by the human eye.

## Photometers

The use of photometers removes the human element from the result reading process by digitally analysing test colours, referring to calibration data stored within the instrument. Although more costly than visual techniques, photometric instruments are more accurate and reliable. In addition, test results can be stored by instruments, then downloaded to computer-based databases via cable or Bluetooth. This is particularly useful for auditing purposes.

A photometer works by measuring the amount of light that passes through the sample and optical filter and hits the detector. The darker the sample colour, the less light will pass through it.



## Electrochemical Methods

Electrochemical techniques, such as meters for measuring pH, TDS, and conductivity, are employed within the pool market but to a much lesser extent than colorimetric techniques.  TDS and conductivity can only be measured electrochemically and not using colorimetry.

Well maintained electrochemical meters are highly accurate and not influenced by many of the interfering factors seen with colorimetric measurement of some parameters.

## Turbidity

Only instrument-based techniques are suitable due to the recommended levels of turbidity being below the capability of the human eye. Specialist turbidity meters can quickly provide assurance that the pool turbidity is below 0.5 NTU.

## Choosing a Sample

When testing the key parameters of a pool and spa, getting the sample is key.

Many modern pools have multiple outlets and inlets across the pool, and so samples should be taken at various parts of the pool at a depth of 100–300 mm.

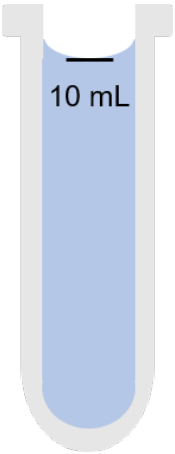
These locations should become the routine sampling points, and together will give an overall view of the pool water quality.

## Best Practice for Water Testing

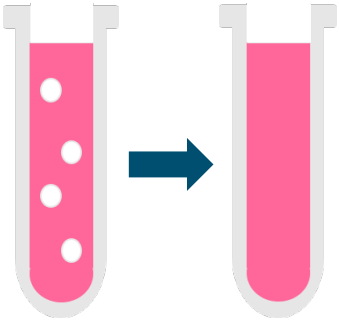
1. Testing equipment should be kept clean, with no water marks, fingerprints, scratches or stains and preferably, rinsed with distilled water where applicable. Note that plasticware can deteriorate over relatively short periods of time and should be replaced regularly
2. Test methods must be followed carefully as per instructions.
3. Reagent tablets must be fully dissolved before you try to read the result.
4. Ensure that test reagents are within the best before date.
5. Do not mix and match reagents and test kits from different manufacturers
6. If deposits or bubbles form, leave for a few minutes to clear unless the test is time specific. Bubbles can usually be cleared using a crushing rod or by tapping the side of the test tube gently.
7. For results that are above the range of the test, use the dilution method and test again.
8. Analytical instruments should be serviced annually.

## Hints and Tips to Testing with Photometers

1. To prolong the lifetime of your instrument and get the best performance, you should have full calibration checks each year. Check standards can help you quickly see if your instrument is within specification.
2. Always follow the test procedure carefully, making sure you add the reagents in the right order and stick to the recommended standing times and temperature conditions.
3. Test tubes must be kept in a clean condition. Always wash and dry them thoroughly after use. Dirty tubes may be soaked in a weak detergent solution but must be carefully rinsed after. Any tube that is scratched or stained must be replaced.
4. Caps and crushing rods should be cleaned immediately after use and discarded if they become stained.
5. When measuring the sample volume required, make sure that the lowest point of the meniscus in exactly on the fill line (see diagram).



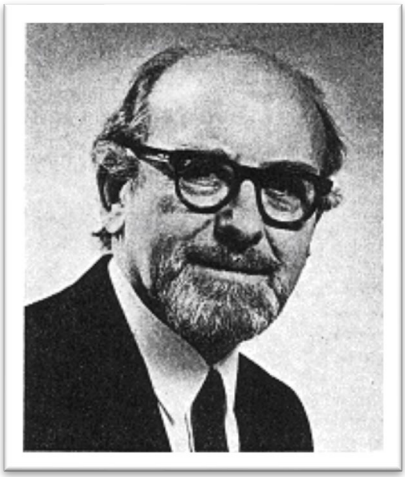
6. The blank is a test tube filled with the sample water, but no reagents. The photometer uses this as a background to compare to your test sample colour.
7. Do not touch the tablet reagents when transferring them to the test tube as it will contaminate them, and you will not get accurate results.
8. Ensure you fully crush the tablet. After the standing period, do not shake or invert the test tube. Some tests form fine particles which sink to the bottom and will not influence the test.
9. If bubbles adhere to the sides of the tube, rub them away gently using the crushing rod.
10. Always use the light cap on your photometer to get accurate results.
11. Never shake the tube to mix the contents, always stir it with a crushing rod.
12. The results for these tests are given in a number of different units, always quote the units when reporting your data, and check all data is expressed in the same units when making comparisons



## A little about Palintest

At Palintest we make water analysis technologies which help to safeguard consumers around the world each day. A critical part of the leisure industry, our technologies ensure that we can all bathe and play safely.

Our company name comes from one of the pioneers of our business, Dr Tom Palin.



Dr Palin was instrumental in the development of standard DPD methods for measuring chlorine levels in water. A key figure across the industry, Dr Palin worked at Palintest, developing chemical reagents in the form of tablets for measuring different parameters of water quality. Since then we have been continuing his legacy by making water testing simple and accessible for everyone, officially changing our name to Palintest in 1989 to honour Dr Palin's work.


www.palintest.com

**Palintest (HQ)**
Palintest House
Kingsway, Team Valley
Gateshead
Tyne & Wear NE11 0NS
UK
+44 191 491 0808
sales@palintest.com

**Palintest Australia**
1/53 Lorraine Street
Peakhurst Business Centre
Peakhurst
NSW 2210
Australia
+61 1300 13 15 16
palintest@palintest.com.au

**Palintest China**
Room 1711
Fanli Mansion
22 Chaowai Street
Chaoyang District
Beijing 100020, PRC
+86 10 6588 6200
china@palintest.com

**Palintest USA**
400 Corporate Circle
Suite J
Golden
CO 80401
USA
+1 859 341 7423
info@palintestusa.com