

# Water Treatment System and Automatic pH Control

*Operating specifications for swimming pools clad in natural calcareous stone*

## 1. Travertine and water: a natural alliance

Travertine is born in water. It forms through the stratification of calcareous deposits in springs particularly rich in this mineral. Water is therefore not an alien element to travertine: it is its natural habitat, the environment in which it originated and in which it has often lived for millennia.

History confirms this alliance. The ancient Roman baths were largely built in travertine. Bernini's Barcaccia, the Fountain of the Four Rivers, the Trevi Fountain: all works that contain water, that rise out of water, that are bathed by water. The thermal baths of Saturnia and Rapolano, still in use today, tell us that this stone has lived alongside water for timescales that exceed any human measure.

When a client asks whether travertine — or marble, or any other calcareous stone — is a suitable material for their own swimming pool, the answer is unreservedly yes. The technical precautions required are few, and form part of the normal good design and management of any natural stone pool.

### The fundamental principle

Travertine, like most marbles and calcareous stones, has one single aggressive agent: acid. Not the chemical treatment products, not chlorine, not algicides — all of which, when correctly dosed, are perfectly compatible with the stone. The only real threat is acidity of the water, whether chronic (slow pH drift) or acute (shock acid treatment). The whole of this document is built around the prevention, control and neutralisation of this single variable.

## 2. The dynamics of pH in a swimming pool

Understanding how the pH naturally behaves in a swimming pool is the prerequisite for understanding why the automatic control system described in this document exists. The narrative that follows mirrors exactly the dynamic observed in the field.

### 2.1 The pH tends to rise

In a swimming pool exposed to the sun and used by bathers, the pH of the water does not remain stable. It tends to increase due to two factors:

- **Sun action:** solar radiation degrades free chlorine in the water, altering the acid-base balance of the system.
- **Organic residues:** sweat, sunscreens, leaves, dust, particles introduced by bathers. All this material is oxidised by chlorine, and the process releases basic by-products that raise the pH.

This is a physiological drift, inevitable in any outdoor pool. Without continuous corrective action, the pH can easily exceed 8 within a few days.

## 2.2 When the pH is too high, the chemistry stops working

Chlorine and algicides are effective only within a narrow pH window (ideally 7.2–7.6). Above this threshold their disinfecting action collapses rapidly: at pH 8.0 free chlorine loses about 70% of its efficacy compared to pH 7.2. The water, now too alkaline, begins to deteriorate. The chemicals present can no longer contain the proliferation of algae and bacteria, and within a short time the water turns green.

## 2.3 The typical reaction: shock treatment

Faced with deteriorated water, the standard practice is the so-called shock treatment: a massive, concentrated injection of acid to rapidly bring the pH back to operational values, accompanied by superchlorination. The effect, on the surface, is exactly what was wanted: the pH drops, chlorine becomes effective again, the water clears within a few hours.

### And this is where the stone is damaged

From the standpoint of the stone cladding, a shock treatment is the single most destructive event that can occur in a pool. A massive dose of acid injected into a relatively small volume of water generates, at least transiently, locally highly acidic zones — with pH below 5 — that directly attack the calcium carbonate of the stone. It is therefore not the routine water of the pool that wears down travertine: it is the reactive, concentrated, periodic corrections that one is forced into when pH management has not been continuous.

## 2.4 The double threat: chronic acid drift

There is also a second risk scenario, opposite and less frequent but equally damaging: a pH that drifts chronically below 7.0 because of badly calibrated dosing or because of particularly soft mains water. This is not a shock event but a slow, continuous erosion that dulls the stone surface month after month, often without the owner noticing — until the damage becomes macroscopic.

The conclusion is univocal: the stone cladding is protected by keeping the pH stable continuously, within a narrow window, twenty-four hours a day. It is not protected by correcting after the fact.

### 3. System architecture

The system consists of six integrated subsystems. The hydraulic sequence is the one typical of forced-circulation pools, but with a level of automation and safety specifically calibrated to protect the stone cladding.

#### 3.1 Main hydraulic circuit

- **Skimmers and bottom drains:** collect surface water (floating debris) and deep water (sediments). Layout designed to avoid dead zones.
- **Recirculation pump:** variable speed (inverter), sized to ensure full pool volume turnover every 4–6 hours.
- **Basket pre-filter:** captures coarse debris before it reaches the pump.
- **Main filter:** preferably activated recycled glass filter media (15-micron fineness) or DE filter. Both are more efficient than silica sand and reduce chemical consumption.
- **Return inlets:** orientable, arranged to generate uniform rotational flow that avoids thermal and chemical stratification.

#### 3.2 Continuous measurement system

The heart of the automatic control. An analysis cell installed on a bypass of the return circuit (never on the delivery circuit, to avoid false readings from freshly dosed chemistry) houses three permanent probes:

- **pH probe:** combined glass electrode, precision  $\pm 0.01$  units, with automatic temperature compensation.
- **ORP (redox) probe:** measures the oxidation-reduction potential in mV, a real-time indirect indicator of disinfection efficacy.
- **Temperature probe:** PT100, required for compensation of the other readings and for heating control.

The probes send data to a programmable control unit with a sampling frequency of at least one reading every 30 seconds.

#### 3.3 Dosing system

Two peristaltic or membrane pumps, controlled by the unit, draw the corrective product from the relevant tanks and inject it into the delivery circuit, downstream of the filter:

- **pH-minus pump:** doses the acidic corrective. Sodium bisulphate is preferred over diluted hydrochloric acid because it is less aggressive in local diffusion and has lower point impact on the stone.
- **Disinfectant pump:** doses sodium hypochlorite, or — the recommended solution — is replaced by a salt electrolyser (see section 5).

The tanks are fitted with level sensors and empty-tank alarms to prevent dry-running of the pumps.

### 3.4 Electronic control unit

Microprocessor unit with display, Wi-Fi or GSM connectivity and remote application. Essential functions:

- Simultaneous reading of pH, ORP and temperature.
- Continuous comparison with programmed setpoints.
- Proportional activation of the dosing pumps (PID algorithm, not simple on/off).
- Historical data-logging of values for at least 12 months.
- Sending of notifications to the operator in case of anomaly.
- Automatic blocking of dosing in case of no flow or faulty probe.

## 4. Automatic pH control operation

### 4.1 Principle: continuous micro-dosing instead of shocks

The operating philosophy of the system is to replace reactive management (periodic shocks) with preventive management (continuous small corrections). The control unit, reading the pH every 30 seconds, intervenes as soon as it detects any minimal deviation from the setpoint. The resulting dose is always proportionate and instantly diluted in the circulating volume of the pool, never generating the point-source acid concentrations typical of manual treatments.

From this principle derive the two benefits that justify the entire investment: the stone never suffers localised acid attack, and the water maintains stable quality without requiring shock corrections.

### 4.2 PID control logic

The regulation algorithm is closed-loop PID (Proportional-Integral-Derivative). Three components act together:

- **Proportional:** doses the corrective in proportion to the magnitude of the deviation from the setpoint.
- **Integral:** compensates for slow, systematic drifts.
- **Derivative:** anticipates intervention based on the rate of change of pH.

A simple on/off algorithm (found in economy controllers) generates oscillations and overdosing, and is therefore inadvisable in pools with stone cladding.

### 4.3 Setpoints and operating parameters

The control unit must be programmed on the following reference values:

Parameter	Setpoint value
pH	7.4 (range 7.3–7.5)
pH dead band	±0.05 units
ORP	650–720 mV
Water temperature	26–28 °C (residential pools)
Total alkalinity (TA)	80–120 ppm (weekly check)
Calcium hardness	200–400 ppm (monthly check)
Langelier Saturation Index (LSI)	$-0.2 \leq \text{LSI} \leq +0.2$

**Technical note:** the setpoint at 7.4 is slightly higher than the typical value of conventional pools (7.2). This choice places the water in a zone of mild supersaturation with respect to calcium carbonate, slowing the dissolution of the stone. The modest risk of micro-precipitation is by far preferable to the risk of erosion.

#### 4.4 Safety locks and automatic shutdowns

The control unit must autonomously interrupt dosing in the presence of one or more of the following conditions:

- Flow switch on the recirculation circuit signalling no flow.
- Probe reading outside the plausibility range (pH < 6.5 or > 8.5).
- Continuous dosing time exceeding the programmed maximum (typically 15 minutes).
- Empty-tank alarm on the corrective reservoir.
- Communication error between probe and unit.

Each block triggers a notification to the operator and is recorded in the system log.

##### **Why safety locks are indispensable**

A faulty pH probe that returns a constantly elevated reading can cause the control unit to dose acid continuously. Without the locks described, the pH of the pool can crash below 6 within hours, with effects analogous to an uncontrolled shock treatment. The resulting damage to the cladding would be irreversible and not covered by warranty.

## 5. Disinfection system

The choice of disinfection system directly affects the lifespan of the cladding. PIETRE DI RAPOLANO® recommends, in order of preference:

### 5.1 Salt electrolysis (recommended solution)

A concentration of 3–5 g/l of salt (NaCl) in the water is electrolytically split by a titanium cell, generating active chlorine continuously and under control. Benefits for stone pools: constant production with low point-source impact, no chemical shocks from manual dosing, recombination of chlorine into salt after disinfection (closed cycle). Salt water also offers superior sensory comfort (less irritation to skin and eyes).

The control unit drives the cell based on the ORP value read in real time: when the potential drops below threshold, chlorine production automatically increases.

### 5.2 Complementary systems

- **UV-C lamp:** installed inline on the return circuit, eliminates residual microbial load and allows chlorine to be kept at minimum levels (0.3–0.5 ppm).
- **Ozone generator:** high-end alternative, particularly suitable for indoor or prestige pools. Requires contact chamber and degasser.

**To be strictly avoided:** slow-release trichlor or dichlor tablets placed in the skimmers. They locally generate an extremely acidic pH (3–4) which, transiting over the surface of the stone, causes concentrated and visible erosion within a few months. Also to be avoided are manual shock treatments, for the reasons set out in section 2.

## 6. Filtration and recirculation

Efficient filtration reduces chemical consumption, because cleaner water requires less disinfectant to be maintained in hygienic class. In stone-clad pools this translates into less chemical stress on the cladding and greater pH stability.

- **Filtration velocity:** reduced (25–35 m<sup>3</sup>/h·m<sup>2</sup>) to maximise retention of fine solids.
- **Filter media:** activated recycled glass, 15-micron fineness (compared with 30–40 microns of silica sand).
- **Backwashing:** automatic, programmed according to the pressure drop read by the inlet and outlet filter manometers.
- **Turnover time:** at least full pool volume every 4 hours during the season; possible winter reduction to 8 hours with covered pool.

## 7. Infinity pools: additional considerations

Infinity pools — in which water overflows one or more sides of the basin into a collection channel, creating a continuous flow along the edge — introduce a second stress factor on the stone: the hydroabrasive action of the flow. On a surface that is chemically well protected, this passage causes no significant deterioration. However, if the water is even slightly acidic, the two effects combine and

amplify each other: the flow continuously exposes new surface to chemical attack, accelerating the dissolution of the edge.

The operational conclusion is simple: in infinity pools the automatic pH control is not just recommended, it is indispensable. The setpoint tolerance band should also be reduced to  $\pm 0.03$  units, and corrective dosing should be split into several smaller injections over the course of the day.

## 8. System maintenance

### Daily frequency (automatic):

- Check parameters from display or remote app.
- Review alarm notifications.

### Weekly frequency (operator):

- Manual cross-check of pH and chlorine with a colorimetric kit (verify probe calibration).
- Check corrective reservoir levels.
- Clean skimmer baskets and pump pre-filter.
- Measure total alkalinity and calcium hardness.

### Monthly frequency (technician):

- Calibration of pH and ORP probes with buffer solutions.
- Inspection of peristaltic tubes of dosing pumps (preventive replacement every 12 months).
- Check of the electrolytic cell (descaling if needed).
- Filter backwash.

### Annual frequency (scheduled intervention):

- Replacement of pH and ORP electrodes (typical service life 12–18 months).
- Full overhaul of pumps, valves and flow switch.
- Inspection of sealants and condition of stone cladding.
- Renewal of the hydro-oleo-repellent protective treatment on the stone.

### Telemetry and traceability

All data recorded by the control unit (pH, ORP, temperature, dosing events, alarms) must be stored and exportable. This log is not just a diagnostic tool: it is the documentation that attests to the correct management of the system and, in case of dispute over cladding defects, constitutes the objective evidence of compliance with the parameters recommended by PIETRE DI RAPOLANO®.

## 9. Standards and technical references

- UNI 10637 — Requirements for swimming pool water quality (Italy).
- DIN 19643 — Treatment of water in swimming pools and bathing facilities (Germany / EU reference).
- State-Regions Agreement 16/01/2003 — Hygiene and sanitary aspects for the construction, maintenance and supervision of swimming pools for swimming use (Italy).
- Langelier Saturation Index (W.F. Langelier, 1936) — Reference model for the calcium-carbonate equilibrium.

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**PIETRE DI RAPOLANO® — Accompanying technical document**

*The specifications contained in this document constitute a technical recommendation for the correct management of swimming pools clad with natural stone materials supplied by PIETRE DI RAPOLANO®. Compliance with these specifications is a condition for the validity of the warranties on the cladding.*