TECHNICAL ENGINEERING GUIDE

Optimization of Storage Basins and Raw Water Preservation Strategies Against Water Stress in Europe

2026 REFERENCE EDITION

Thermodynamic modeling of passive evaporation, evaluation criteria for covering polymers, and deployment protocols for agro-industry and local authorities.

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1. Introduction and Hydro-Climatic Challenges

Water stress within the European Union is no longer a cyclical crisis, but a structural mutation of drought indices. Regions in Southern Europe (Andalusia, Catalonia, Sicily, Po Valley) as well as climate transition zones like Occitania or the PACA region are facing a groundwater recharge deficit coupled with a continuous increase in net global radiation.

In this context, the construction of hillside reservoirs, industrial lagoons, wastewater treatment plants (WWTP), and mega-basins responds to a logic of volume security. However, storing water on the surface without active protection exposes the resource to an invisible but massive enemy: passive evaporation induced by solar radiation and wind mass transfer.

> ***CLIMATOLOGICAL OBSERVATION***
>
> *An uncovered basin located in the Mediterranean area can lose between 1,100 mm and more than 1,500 mm of water depth per year. For a 10,000 m² reservoir, this represents a direct net loss of up to 15,000 m³ of water annually, which is a drastic reduction in storage efficiency.*

2. Physics and Thermodynamics of Evaporation

To accurately quantify the water loss of a free surface, engineering models rely on the adaptation of mass transfer and heat balance equations. Evaporation is fundamentally a liquid-vapor phase change governed by the vapor pressure deficit of the ambient air and the kinetic energy input from the wind.

The Mass Transfer Equation

The unit evaporation flux of a free water surface can be modeled in the following simplified linear form:

$$E = (a + b \times W) \times (es - ea)$$

Where:

- E is the standardized evaporation rate (mm/day).
- W is the wind speed measured at a standardized height of 2 meters (m/s).
- es is the saturation vapor pressure at the water surface temperature (kPa).
- ea is the actual vapor pressure of the ambient air (kPa).
- a and b are empirical coefficients specific to the local geometry and aerodynamic exposure of the basin.

Boundary Layer Disruption

Deploying a floating modular structure acts directly on two key variables of this equation:

1. **Interception of energy radiation:** The modules absorb and reflect the incident solar flux, preventing the water temperature from rising at the surface. Consequently, the es pressure collapses.
2. **Suppression of the wind boundary layer:** By covering the surface, the elements prevent the wind from coming into direct contact with the liquid layer, eliminating the dynamic coefficient $b \times$

W. The stagnant air trapped under the module's geometry immediately saturates with humidity, blocking any subsequent mass transfer.

3. Comparative Analysis of Materials and Geometries

The structural integrity of an industrial or agricultural basin cover depends on the physico-chemical characteristics of the polymer used. Outdoor environments impose extreme resistance to ultraviolet (UV) radiation, thermal variations, and mechanical stresses due to wind.

3.1 The Choice of Virgin High-Density Polyethylene (HDPE)

Hexprotect AQUA (AWTT) modular floating covers are manufactured exclusively from virgin High-Density Polyethylene (HDPE). Unlike recycled or low-density plastics (LDPE), virgin HDPE offers highly stable polymeric molecular bonds.

Technical Property	Hydropreserve Virgin HDPE	Standard Recycled Polymers	PVC Tarpaulins/ Geomembranes
Specific Gravity	0.95 - 0.96 g/cm³	Variable (0.91 - 0.94)	>1.20 g/cm³ (requires floats)
Anti-UV Stabilization	Carbon Black + Additives	Weak or superficial	Migrates and degrades in 3-5 years
Thermal Resistance	-40°C to +70°C	Brittle at frost < -5°C	Rapid loss of elasticity

3.2 Modular Geometry vs. Tensioned Tarpaulins

- **Dynamic level adjustment:** The modules rise and fall freely with the basin's water level variations without creating air pockets or mechanical tensions on the banks.
- **Passive aerodynamic resistance:** Water infiltrates slightly above the lower lip of the module during strong winds, naturally ballasting the structure.
- **Controlled gas permeability:** Micro-interstices allow for the gas exchanges essential to the natural chemical balance of the stored water while reducing the available evaporation surface by 96%.

4. Biological Impacts and Water Quality

The reduction in evaporation is accompanied by an equally crucial agronomic and industrial benefit: the control of algal and bacterial proliferation. By covering up to 99% of the visible surface, the modular cover blocks the penetration of photosynthetically active radiation (PAR). Deprived of light, micro-algae, and particularly cyanobacteria, can no longer synthesize their energy.

> *IMPACT ON TREATMENT COSTS*
>
> *The elimination of algae leads to a reduction of more than 75% in the consumption of chemical treatment products (chlorine, copper sulfate, algaecides) in industrial lagoons and raw water reserves.*

5. Sizing Protocol and ROI Calculation

The annual preserved volume is calculated according to the following engineering formula:

$$V\_saved = (S \times E\_ref \times \eta) / 1000$$

Where:

- V_saved is the annual volume of preserved raw water (m^3/year).
- S is the useful surface area of the basin at nominal level (m^2).
- E_ref is the regional meteorological evaporation value (mm/year).
- η is the overall efficiency coefficient of the cover (0.88 to 0.96).

If the use value of water during a crisis period is estimated at 2.50 euros/m^3, the direct financial gain on a 5,000 m^2 basin in Southern Europe (e.g., Andalusia) amounts to 13,200 euros per year, amortizing the infrastructure within 3 to 5 years.

6. Installation and Maintenance Specifications

- **Zero civil engineering:** No heavy anchoring at the bottom of the basin.
- **Continuous water installation:** The installation is carried out without draining the basin.
- **Zero maintenance:** The self-lubricating virgin HDPE does not accumulate heavy sediments.