WATER ABSORPTION CAPACITY

This is an essential parameter, not just for identifying the type of tile [product groups in standard EN 14411], but also for advancing certain fundamental characteristics:

► Greater or lesser stain resistance in unglazed tiles (UGL)
► Larger or smaller coefficient of moisture expansion based on greater or lesser porosity, related in turn to delayed crazing and the tile installation mode
► Resistance to frost/thaw cycles, this only being assured in tiles with $E \leq 0.5\%$
► Mechanical strength, this being greater in tiles with low absorption, at the same thickness
► The possibility of efflorescences appearing in UGL tiles of group III if the fixing background is not waterproofed
► The choice of tile installation technique, which will shall be thin-bed with cementitious adhesives C1 or C2 for tiles of Group I

The manufacturer usually supplies this information in the corresponding trade documentation, expressed by the letter $E$, as a percentage, based on the result of the boiling test set out in standard EN ISO 10545-3. In addition, the manufacturer shall indicate the product group on the label and CC mark.

Water absorption capacity in ISO 10545-3

Microstructure of a porous body (in a single-fired process). Magnification 1700x

Microstructure of a semi-vitrified body. Magnification 1700x

Microstructure of a body with zero or almost zero porosity. Magnification 1700x

Abundant, large pores interconnected by capillarity

Lower porosity, smaller-sized pores, and absence of capillarity

Little porosity, small-sized pores, with a larger concentration inside the tile

Physico-chemical characteristics
Water absorption capacity
Water absorption capacity identifies the nature of the ceramic body in regard to internal structure, which is directly related to mechanical strength (measured by modulus of rupture and breaking strength) and to other characteristics that affect ceramic tile durability (particularly in unglazed tiles), such as resistance to deep abrasion, stain resistance, and resistance to frost/thaw cycles, as well as to dimensional quality.

Standard ISO 10545-3 establishes the test methods for determining ceramic tile water absorption, apparent porosity, apparent relative density, and bulk density.

It envisages two methods of impregnating the open pores of test pieces with water: by boiling and under vacuum. The boiling method is used to classify the tiles in groups in standard EN 14411, and to characterise the tiles. The vacuum method is used in the laboratory to determine water absorption, apparent porosity, bulk density, and apparent relative density with greater precision.

► **Boiling method**: This allows impregnation of the open pores that can be easily filled. It is only used to characterise and classify the ceramic tiles.

► **Vacuum method**: It allows almost all open pores to be filled. It serves to determine apparent porosity, apparent relative density, and water absorption.

<table>
<thead>
<tr>
<th>Water absorption</th>
<th>Boiling method</th>
<th>[ E_b = \frac{m_{2b} - m_1}{m_1} \times 100(%) ]</th>
<th>(only for classification purposes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum method</td>
<td>[ E_v = \frac{m_{2v} - m_2}{m_2} \times 100(%) ]</td>
<td>(for the determination of the real water absorption capacity) (*)</td>
<td></td>
</tr>
</tbody>
</table>

(*) \( E_v \) usually gives a water absorption capacity value that is 1% higher than \( E_b \)

The foregoing formulas contain the following magnitudes, all expressed in grams (g):

- \( m_{2b} \): mass of the tile impregnated with boiling water
- \( m_1 \): mass of the dry tile
- \( m_{2v} \): mass of the tile impregnated with water after the vacuum process and weighing, also under vacuum

The vacuum process is conducted in a chamber in which the air pressure is lowered to a value of \((10 \pm 1)\) kPa and held at that value for 30 minutes.
Comments

Once the vacuum method had been introduced in the new standard ISO 10545-3, it would have been logical to convert all the water absorption capacity values to those provided by this test method, which constitutes a closer approximation to the apparent porosity of the ceramic tile and, as a result, better characterises the tile in relation to the following features:

► Anchoring capacity (mechanical adhesion) that develops in the hydration of the cement agglomerates and/or lime in all tile types
► The phenomenon of efflorescences in highly porous unglazed tiles
► The phenomenon of staining in every type of unglazed tile

The tile fixer needs to know that the water absorption capacity stated by the manufacturer according to standard EN 14411 is 1% less than the real apparent porosity of the tile. Thus, for example, a BIₐ porcelain tile with a stated value of E=0.1% really has an approximate apparent porosity of 1%.