



**WUFI®**

# **Modelling water-repellent treatment of a façade by adjusting the A-value**

**Date: September 2017**

## Requirements for a water-repellent treatment

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### German Recommendation according to WTA-Merkblatt 3-17

(“Hydrophobierende Imprägnierung von mineralischen Baustoffen”)

- Water-repellent treatments of façades reduce the capillary water absorption. After correct performance, values of  **$A < 0,1 \text{ kg/m}^2\sqrt{\text{h}}$**  should be achieved.  
→ In WUFI® this can be modeled by adjusting the liquid transport properties of a thin surface layer of the façade material, corresponding to the penetration depth of the water-repellent agent.
- A sufficient water vapour diffusion capability must be ensured in order to allow the drying out of water due to imperfections. Due to the water-repellent treatment the **diffusion resistance** of the treated layer **must not be increased by more than 50 %**.  
→  $\mu$ -value of the surface layer must be adapted separately!

### Consideration by adjusting the A-value and the $\mu$ -value:

Proceeding:

- 1) Separate a thin surface layer (0.5 – 1 cm depending on penetration depth of treatment) from the normal wall. To do this, duplicate the original layer and then adjust the two thicknesses as needed.
- 2) Edit the material properties of the new exterior layer:
  - Unlock the material.
  - Check the “Generate“ boxes at “Liquid Transport Coefficients” for suction and redistribution.
  - Adjust “Water Absorption Coefficient”.  
Be careful with the units:  $[\text{kg}/\text{m}^2\sqrt{\text{s}}]$  is the A-value in  $[\text{kg}/\text{m}^2\sqrt{\text{h}}]$  divided by 60!
  - Adjust the “Water Vapour Diffusion Resistance Factor” of the new surface layer.

# Proceeding in WUFI®

**1. Select exterior layer**

**2. Duplicate layer**

WUFI® Pro 6.1

Project Inputs Run Outputs Options Database Result Analysis ?

Project

- Case: 1 water-repellent treatment
  - Component
    - Assembly/Monitor Positions
    - Orientation
    - Surface Transfer Coeff.
    - Initial Conditions
  - Control
  - Climate

Case: water-repellent treatment

Assembly/Monitor Positions Orientation/Inclination/Height Surface Transfer Coeff. Initial Conditions

Layer Name Thicken. [m]

Solid Brick Masonry 0.4

Exterior (Left Side) 0.4 Interior (Right Side) 0.015

Material Data

Sources, Sinks

New Layer

Duplicate

Delete

Edit Assembly by:

Graph

Table

Assign from

Material Database

Example Cases

Grid

Automatic (I)

100 Fine

Copy Auto. Grid Def. for Manual Editing

Total Thickness

Thickness: 0.415 m

Total Thermal Performance

R-Value: 0.65 m²K/W

U-Value: 1.193 W/m²K

Units: SI No calculation results available.

# Proceeding in WUFI®

The screenshot displays the WUFI Pro 6.1 software interface. The main window is titled 'Case: water-repellent treatment'. The 'Assembly/Monitor Positions' tab is active, showing a table of material layers. The first layer is 'Solid Brick Masonry' with a thickness of 0.39 m. A blue circle highlights the 'Thickn. [m]' field, and a blue arrow points to it from the text '3. Reduce thickness (e.g. minus 1 cm)'. Another blue arrow points to the 'Exterior (Left Side)' column of the layer table from the text '4. Select exterior layer'. The interface also shows a grid view of the assembly, a 'Material Data' button, and a 'Total Thermal Performance' summary at the bottom.

Layer Name	Thickn. [m]	Exterior (Left Side)	Interior (Right Side)
Solid Brick Masonry	0.39	0.4	0.39

Total Thermal Performance  
Thickness: 0.805 m    R-Value: 1.22 m<sup>2</sup>K/W    U-Value: 0.711 W/m<sup>2</sup>K

The screenshot displays the WUFI Pro 6.1 software interface. The main window is titled 'Case: water-repellent treatment'. The 'Assembly/Monitor Positions' tab is active, showing a cross-section of a wall assembly. The top layer is 'Solid Brick Masonry' with a thickness of 0.01 m. The 'Thickn. [m]' field is circled in blue. A blue arrow points from the 'Material Data' button to the 'Thickn. [m]' field. Another blue arrow points from the 'Material Data' button to the 'Material Database' button in the 'Assign from' section. The 'Total Thickness' is 0.415 m, and the 'Total Thermal Performance' R-Value is 0.65 m²K/W. The 'U-Value' is 1.193 W/m²K. The status bar at the bottom indicates 'Units: SI' and 'No calculation results available.'

**5. Change thickness (e.g. 1 cm)**

**6. Double click on layer or click on “Material Data”**

## 7. Unlock material

Layer/Material Name: Solid Brick Masonry - unlocked

Bulk density [kg/m<sup>3</sup>]: 1900  
Porosity [m<sup>3</sup>/m<sup>3</sup>]: 0.24  
Spec. Heat Capacity [J/kgK]: 850  
Thermal Conductivity [W/mK]: 0.6  
Water Vapour Diffusion Resistance Factor [-]: 10

Typical Built-In Moisture [kg/m<sup>3</sup>]: 100  
Layer Thickness [m]: 0.01  
Thermal Conductivity, Design Value [W/mK]:  
Color: ██████████

Hygrothermal Functions | Material Information

Moisture Storage Function  
Liquid Transport Coefficient, Suction  
Liquid Transport Coefficient, Redistribution  
Water Vapour Diffusion Resistance Factor, moisture-dependent  
Thermal Conductivity, moisture-dependent  
Thermal Conductivity, temperature-dependent  
Enthalpy, temperature-dependent

Generate

No.	Water Cont... [kg/m <sup>3</sup> ]	DWS [m <sup>2</sup> /s]
1	0	0
2	10	1.5E-10
3	190	1.7E-6

Normalized Water Content [-]

Liquid Transport Coefficient [m<sup>2</sup>/s]

Water Content [kg/m<sup>3</sup>]

Buttons: Paste into Database, Import, Export, OK, Cancel, Help

8. Select “Liquid Transport Coefficient, Suction”

Layer/Material Name: Solid Brick Masonry - unlocked

Bulk density [kg/m³]: 1900  
Porosity [m³/m³]: 0.24  
Spec. Heat Capacity [J/kgK]: 850  
Thermal Conductivity [W/mK]: 0.6  
Water Vapour Diffusion Resistance Factor [-]: 10

Typical Built-In Moisture [kg/m³]: 100  
Layer Thickness [m]: 0.01  
Thermal Conductivity, Design Value [W/mK]:  
Color: ██████████

Hygrothermal Functions | **Material Information**

Moisture Storage Function  
**Liquid Transport Coefficient, Suction**  
Liquid Transport Coefficient, Redistribution  
Water Vapour Diffusion Resistance Factor, moistu...  
Thermal Conductivity, moisture-dependent  
Thermal Conductivity, temperature-dependent  
Enthalpy, temperature-dependent

No.	Water Cont... [kg/m³]	DWS [m²/s]
1	0	0
2	18	2.45E-9
3	190	1.27E-6

Generate

Approximation Parameters:  
Reference Water Content [kg/m³]: 18  
Free Water Saturation [kg/m³]: 190  
Water Absorption Coefficient [kg/m²√s]: 0.001667

Paste into Database | Import | Export | OK | Cancel | Help

9. Check  
“Generate”

10. Enter A-value in [kg/m²√s]  
in this case:  $0,1 \text{ kg/m}^2\sqrt{\text{h}} / 60 = 0,001667 \text{ kg/m}^2\sqrt{\text{s}}$



Layer/Material Name: Solid Brick Masonry - unlocked

Bulk density [kg/m<sup>3</sup>]: 1900  
Porosity [m<sup>3</sup>/m<sup>3</sup>]: 0.24  
Spec. Heat Capacity [J/kgK]: 850  
Thermal Conductivity [W/mK]: 0.6  
Water Vapour Diffusion Resistance Factor [-]: 10

Typical Built-In Moisture [kg/m<sup>3</sup>]: 100  
Layer Thickness [m]: 0.01  
Thermal Conductivity, Design Value [W/mK]:  
Color: [Red Box]

Hygrothermal Functions | **Material Information**

- Moisture Storage Function
- Liquid Transport Coefficient, Suction
- Liquid Transport Coefficient, Redistribution**
- Water Vapour Diffusion Resistance Factor, moisture-dependent
- Thermal Conductivity, moisture-dependent
- Thermal Conductivity, temperature-dependent
- Enthalpy, temperature-dependent

No.	Water Cont... [kg/m <sup>3</sup> ]	DWW [m <sup>2</sup> /s]
1	0	0
2	18	5.63E-13
3	190	2.93E-11

Generate

Approximation Parameters:  
Reference Water Content [kg/m<sup>3</sup>]: 18  
Free Water Saturation [kg/m<sup>3</sup>]: 190  
Water Absorption Coefficient [kg/m<sup>2</sup>·√s]: 0.001667

Normalized Water Content [-]

Liquid Transport Coefficient [m<sup>2</sup>/s]

Water Content [kg/m<sup>3</sup>]

Paste into Database | Import | Export | OK | Cancel | Help

12. Check  
“Generate”

11. Select “Liquid Transport Coefficient, Redistribution”

Layer/Material Name: Solid Brick Masonry - unlocked

Bulk density [kg/m<sup>3</sup>]: 1900  
Porosity [m<sup>3</sup>/m<sup>3</sup>]: 0.24  
Spec. Heat Capacity [J/kgK]: 850  
Thermal Conductivity [W/mK]: 0.6  
Water Vapour Diffusion Resistance Factor [-]: 15

Typical Built-In Moisture [kg/m<sup>3</sup>]: 100  
Layer Thickness [m]: 0.01  
Thermal Conductivity, Design Value [W/mK]:  
Color: [Red Box]

Hygrothermal Functions | Material Information

- Moisture Storage Function
- Liquid Transport Coefficient, Suction
- Liquid Transport Coefficient, Redistribution
- Water Vapour Diffusion Resistance Factor, moisture-dependent
- Thermal Conductivity, moisture-dependent
- Thermal Conductivity, temperature-dependent
- Enthalpy, temperature-dependent

Generate

Approximation Parameters:

Reference Water Content [kg/m<sup>3</sup>]: 18  
Free Water Saturation [kg/m<sup>3</sup>]: 190  
Water Absorption Coefficient [kg/m<sup>2</sup>√s]: 0.001667

No.	Water Cont... [kg/m <sup>3</sup> ]	DWW [m <sup>2</sup> /s]
1	0	0
2	18	5.63E-13
3	190	2.93E-11

Normalized Water Content [-]

Liquid Transport Coefficient [m<sup>2</sup>/s]

Water Content [kg/m<sup>3</sup>]

Buttons: Paste into Database, Import, Export, OK, Cancel, Help

**13. Increase “Water Vapour Diffusion Resistance Factor” by 50 % (safe side!)  
in this case: from  $\mu = 10$  to  $\mu = 15$**