In Field Determination of Installed R-Value

Bill Spohn

testo, Inc.

R-Value – U-Value

- R-Value is a measure of the resistance of building materials and structures to the flow of heat; the higher the R-value the better the substance performs as a thermal insulator.

$$R = ((\text{Delta T}) \times (\text{area}) \; X \; (\text{time}) \;) \; / \; (\text{Heat loss})$$

- Where the temperature difference is in degrees Fahrenheit, the area is in square feet, the time in hours, and the heat loss in BTUs.

Relation to U-value

- The reciprocal of R-value (1/R) is known as the U-value. The higher the U-value, the better the conduction of heat.

- In Europe it is customary to use U-values instead of R-values. There, U-values are defined as follows:

$$U = \text{Watts} \; / \; ((\text{Kelvin}) \times (\text{Sq.meters}))$$

- To convert an American R-value into a European U-value, divide 1 by the R-value, then multiply the result by 5.682.

- To convert a European U-value to an American R-value, multiply by 0.176, then divide 1 by the result.

Definitions from www.sizes.com

Enabling Technology

Testo technology provides:

- **wireless probes** for easy and synchronous measurement of the outside temperature
  - no second instrument required
  - no need to put a cable through the window

- **patented temperature probe for U-value measurements:** measures wall surface and indoor air temperature simultaneously

- **automatic calculation of U-value and direct display**

U-Value Measurements

To calculate the U-value ***three*** temperatures need to be measured:

1

⇒ **indoor air temperature (T_i)**
with the cold junction in the plug of the U-value probe.

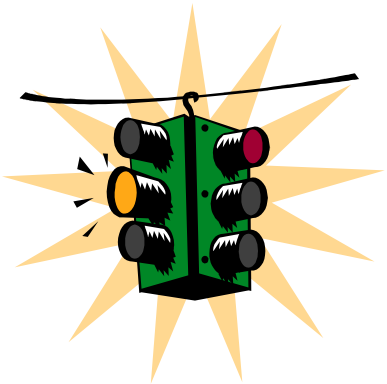
2

⇒ **wall surface temperature inside (T_w)**
with the U-value probe adhered to the wall..

3

⇒ **outside temperature (T_e)**
with the wireless probe outside.

Precautions



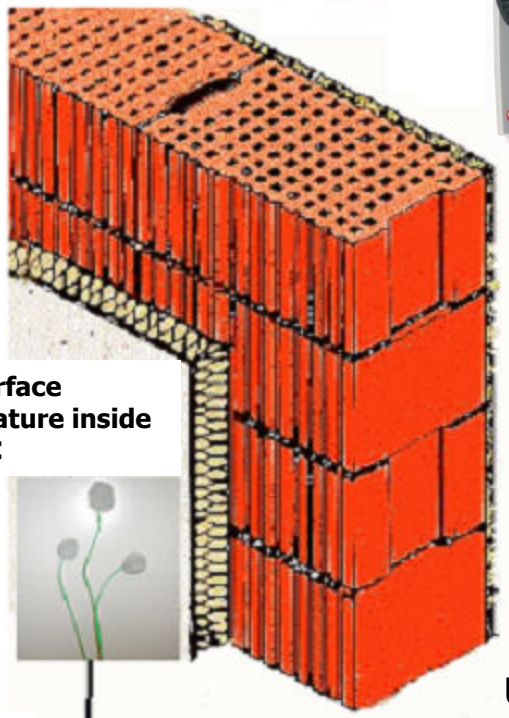
- Moderate temperature difference between inside and outside air
  - ideally >27°F (15°C)
- constant conditions (steady state) *Eg. No sun on the outside wall*.
- heat transfer coefficient correctly set in the instrument (alpha = 7.69)
- placement of measuring instrument:
  - → protected from cold or radiant heat *Eg.not on window sill or in hand*
  - → about 12“ (30cm) from the wall, at the same height as the U-value probe
- ***Do not touch wires or plug of the U-value probe during the measurement***!

Test Procedure

- Connect U-value probe to instrument. Turn on wireless probe & analyzer.
- The alpha factor for heat transmission (7.69) can be regarded as constant and is set as a default (7.69) in the instrument.
- Position the probes
  - outside temperature probe (shielded from the sun)
  - Attach the ends of the three wires of the U-value probe with sticky tack (plasticine) to the inside wall approximately 4“ (10 cm apart), in a triangular pattern
- Wait for stable values and the U-value is automatically displayed.
- Best to conduct a longterm measurement (datalog and PC post process)
  - e.g. Overnight using data storage and a measuring rate of 15 minutes

U-Value Probe Review

Outside air temperature
T_e-2°C



Wall surface temperature inside
T_w 21°C

Inside air temperature

T_i 22°C

U-Value= α x $\frac{\text{delta T1}}{\text{delta T2}}$

α = 7.69 W/m²K

delta T1= $T_i - T_w$

delta T2= $T_i - T_e$