Home energy audit assignment

HURRAY! – with some thermal transfer calculation

DUE: 16 October 2016

Instructions on Building energy Auditing will be delivered on Oct 14

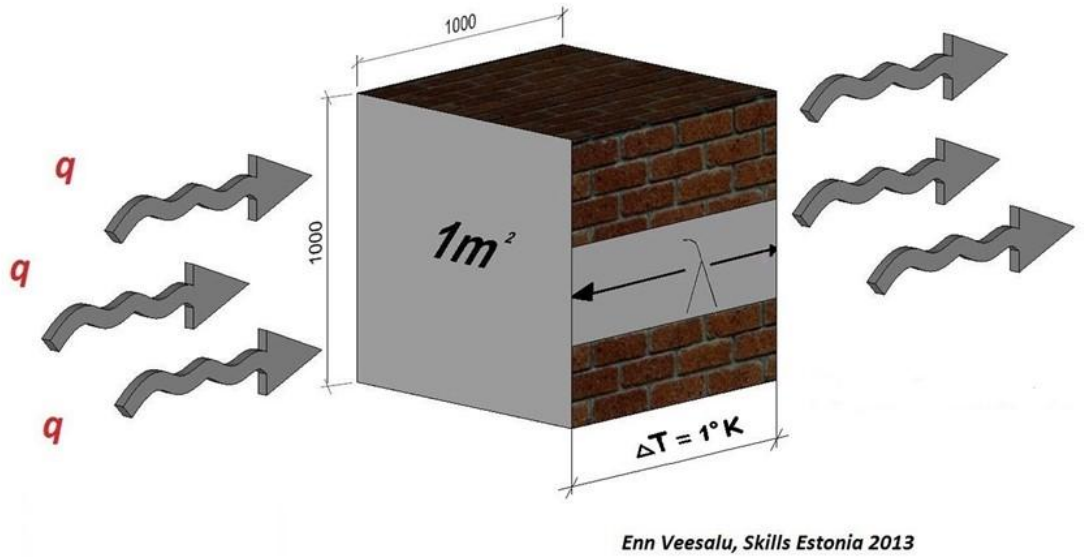
You will present your audit findings on Oct 16th

Carry out your home energy audit

- Follow the checklist (on Moodle)
  - https://www.ase.org/resources/home-energy-audit
  - Skip sections irrelevant to your households
- Use the energy audit data collection table (on Moodle)
- Calculate the U-values of your building envelope
  - Use the science part of the class (slides)
  - Use the catalog of insulation materials (on Moodle)
  - Refer to advisory handbook for insulation (if you don't know what your wall is)
- Recommend energy efficiency improvements
- Recalculate your envelope U-values after energy efficiency added
  - Aim for no less than R= 2.2 $m^2 \cdot °C/W$

Lambda (λ) Thermal Conductivity

- The value of lambda **λ (W/m. ^{o}C)** = is the insulation value of the material.
- E.g.` Thermal conductivity of polystyrene W/m^{o}C = 0.028 - 0.035
- The lower the lambda, the higher the insulation worth of the material (mind the thickness).



Lambda (Thermal Conductivity) --- Thermal conductivity (also known as Lambda) is the rate at which heat passes through a material, measured in watts per square metre of surface area for a temperature gradient of one kelvin for every metre thickness.This is expressed as W/mK. Thermal conductivity is not affected by the thickness of the product. The lower the conductivity, the more thermally efficient a material is.
Example:
PIR Board: Lambda = 0.022 W/mK
Glass Fibre Roll: Lambda = 0.044 W/mK

R-value. Thermal resistance

- Lambda values (λ), combined with information on the thickness of material, represent the thermal resistance of individual materials used in the building envelope, or their R-value.

$$R = \frac{\text{Thickness}}{\lambda}$$ measured in $m^2 \cdot °C/W$

- The higher the R-value, the better it resists the heat transfer.
- The cumulative thermal resistance of a mixed structure is comprised of individual R-values of the layers in the structure.

R-Value (Thermal Resistance) --- Thermal resistance is the ability of a material to prevent the passage of heat. It's the thickness of the material (in metres) divided by its conductivity. This is expressed as m2K/W.
If the material consists of several elements, the overall resistance is the total of the resistances of each element. The higher the R-value, the more efficient the insulation.
Example:
PIR Board: 0.022 W/mK and 100mm thick; R-value = 0.1 metres ÷ 0.022 = 4.54 m2K/W
Glass Fibre Roll: 0.044 W/mk and 100mm thick; R-value = 0.1 metres ÷ 0.044 = 2.27 m2K/W

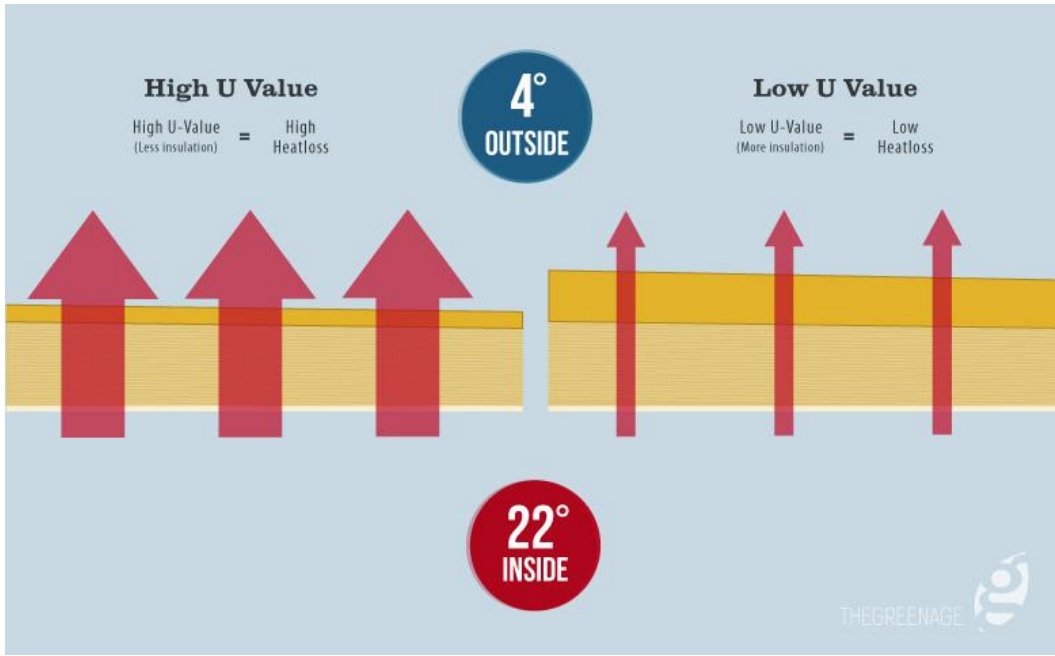
U-value

Watt /m^2 K

amount of heat loss (in Watts)

per square meter of material (e.g. roof, window, floor, wall etc)

when the temperature outside (K) is at least one degree lower



Calculating U-Values

- Start by calculating the thermal resistances of each element (R-values).
- The R-value is the thickness of the product in metres ÷ Lambda (thermal conductivity).
- Add the R-values of all materials used in the application (including any air gaps) and calculate the reciprocal. The reciprocal = 1 ÷ total of all R-values
- Example:
  PIR Board 0.022 W/mK100mm thick + Glass Fibre Roll 0.044 W/mK100mm thick
  Total combined R-value = 4.54 + 2.27 = 6.81 m2K/W
  U-value = 1 ÷ 6.81 = 0.147 W/m2K

Table of Insulation & Other Building Material Properties
http://inspectapedia.com/insulation/Insulation_Values_Table.php

Efficient window features

- Triple Glazing
- Thermal break
  - One or more
- Inert gas filling
  - Argon/
  - Krypton
- Low-E
  - Reflected undesired heat loss
- Multiple Chambers
  - Reduced heat transfer
- Tight seals
  - Compression

Glazing options	u-Value in W/m^2K
single glazing	4.6
low E single-glazing*	3.2
double-glazing	2.6
low E double-glazing*	1.9
Argon double-glazing**	1.6

Features of Selected Window Types

Types of windows	R-value
4-chamber PVC profile, double glazed 4M1-16-4M1	0.48
5-chamber PVC profile, double glazed 4M1-Ar16-4M1	0.5
4-chamber PVC profile, triple glazed 4M1-16-4M1-16-4M1	0.54
6-chamber PVC profile, triple glazed 4M1-10-4M1-10-4M1	0.56
5-chamber PVC profile, triple glazed 4M1-Ar16-И4	0.57
6-chamber PVC profile, double glazed 4M1-12-4M1-12-И4	0.61
Wooden frame	0.55
Metal-reinforced wooden frame	0.55

Types of windows	R-value
4-chamber aluminium profile, thermal bridge, double glazed 20mm thick 4M1-10-И4	0.47
5-chamber aluminium profile, thermal bridge, double glazed 20mm thick, 4M1-16-И4	0.48
6-chamber aluminium profile, thermal bridge, triple glazed 20mm thick, 4M1-10-4M1-10-И4	0.52
4-chamber aluminium profile, thermal bridge, triple glazed 20mm thick, 4M1-Ar12-4M1-Ar12-4M1	0.54
5-chamber aluminium profile, thermal bridge, triple glazed 20mm thick, 4M1-16-4M1-16-И4	0.57
6-chamber aluminium profile, thermal bridge, triple glazed 20mm thick, 4M1-Ar8-4M1-Ar8-И4	0.61

Summary of characteristics of typical insulation materials

№	Material	Density	Longevity (years)	Water permeability	Flammability	Chemical and environmental resistance	Workability	Additional materials	Cost of material*
1	Perlite board	250±10%	≥100	Absorbs	Resists up to 1300°C, Non-combustible	Resists to alkali and acids, ecologically clean	Easy to work	Glue, anchors	$150-$200 per cubic meter
2	Perlite loose-fill	80-120	≥100	Absorbs	Resists up to 1300°C	Resists to alkali and acids, ecologically clean	Easy to work	bags, wooden or metal risers	$100-$200 per metric ton
3	Mineral wool	15-200	up to 60	Absorbs	Resists up to 3000°C	Resists to alkali and acids, ecologically clean	Easy to cut and work	Glue, anchors, wind- and water protective membrane	$1-$5 per piece or $50-$100 per cubic meter
4	Extruded polystyrene (XPS)	28-45	up to 15	Absorbs	Resists up to +80 °C	Vulnerable to alkali and acids, contains gas. When burned emits harmful hydrocyanic gases.	Easy to cut and work	Glue, anchors	$50-$150 per cubic meter
5	Polyurethane foam boards	40-80	more than 50	Resists	Resists up to 250°C	Resists to alkali and acids, contains gas	Easy to cut and work	Glue, anchors	Up to $30 per standard board
6	Sprayed polyurethane foam	40-80	more than 50	Resists	Resists up to 250°C	Resists to alkali and acids, contains gas	Easy to spray, no joints	special spraying machine	1mm thickness up to $5 per square meter
7	Foam glass	120-160	≥100	Resists	Resists up to 730°C	Resists to alkali and acids	Easy to cut and work	Glue, anchors	$300-$350 per cubic meter

Note: (*) The material costs noted are from various sources and are presented for illustrative purposes only. Actual prices internationally and in the local market may vary greatly.

Insulation materials of perlyte

№	Product	Density, kg/m^3	Heat transfer coefficient, W/m°C
1.	Swelled perlite sand	50-150	0.038-0.058
2.	Foam glass grains	150-200	0.058-0.076
3.	Perlite silicate slabs and segments	200-270	0.06-0.07
4.	Flexible perlite heat insulation mat	80-120	0.04-0.045
5.	Perlite cement slabs	400-500	0.06-0.14
6.	Perlite gypsum slabs	270-330	0.165
7.	Foam glass grain slabs	225-325	0.059-0.065

Insulation materials of mineral wool/fiber

№	Product	Density, kg/m^3	Heat transfer coefficient, W/m°C
1.	Mineral wool	30-160	0.039-0.045
2.	Extra-fine basalt microfiber mats	15-30	0.036-0.037
3.	Basalt fine microfiber mats	15-40	0.037-0.044
4.	Glass wool	11	0.045
5.	Basalt microfiber heat insulation cords/harnesses	150-200	0.045-0.049

Insulation materials of foam polyurethane, foam plastic and foam polystyrol

№	Product	Density, kg/m^3	Heat transfer coefficient, W/m°C
1.	Foam plastic	10-90	0.03-0.05
2.	Extruded foam polystyrol	30-50	0.029-0.040
3.	Foam polyurethane	20-200	0.020-0.029

Thermal conductivity of other materials

Can be found at http://inspectapedia.com/insulation/Insulation_Values_Table.php