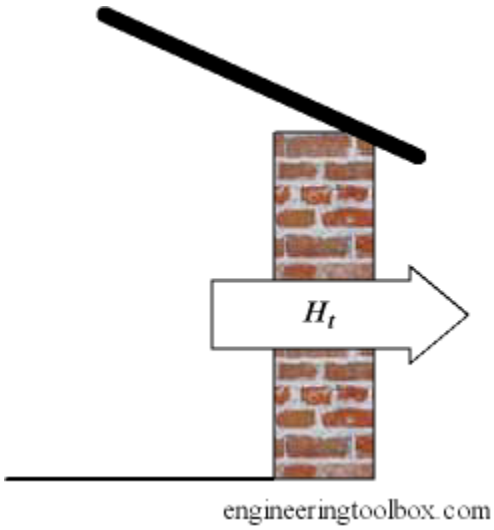
Transmission Heat Loss through Building Elements

Heat loss through common building elements due to transmission, R-values and U-values - imperial and SI units



The heat transmission through a building wall or similar construction can be expressed as:

$$H_t = U A dt \qquad (1)$$

where

H_t = *heat flow (Btu/hr, W, J/s)*

U = *overall heat transfer coefficient, "U-value" (Btu/hr ft^2 ^{o}F, W/m^{2}K)*

A = *wall area (ft^2, m^2)*

dt = *temperature difference (^{o}F, K)*

The overall heat transfer coefficient - the U-value - describes how well a building element conducts heat or the rate of transfer of heat (in watts or Btu/hr) through one unit area (m^2 or ft^2) of a structure

divided by the difference in temperature across the structure.

Online Heat Loss Calculator

1 *U-value (Btu/hr ft^2 ^{o}F, W/m^{2}K)*

1 *Wall Area (ft^2, m^2)*

40 *Temperature Difference (^{o}F, ^{o}C, K)*

calculate!

Common Heat Transfer Coefficients of some common Building Elements

Building Element		Heat-Transfer Coefficient U-value	
		(Btu/(hr ft^2 ^{o}F))	*(W/(m^{2}K))*
Doors	Single sheet - metal	1.2	6.8
	1 inch - wood	0.65	3.7
	2 inches - wood	0.45	2.6
Roofing	Corrugated metal - uninsulated	1.5	8.5
	1 inch wood - uninsulated	0.5	2.8
	2 inches wood - un-insulated	0.3	1.7
	1 inch wood - 1 inch insulation	0.2	1.1
	2 inch wood - 1 inch insulation	0.15	0.9
	2 inches - concrete slab	0.3	1.7
	2 inches - concrete slab - 1 inch insulation	0.15	0.9
Windows	Vertical single glazed window in metal frame		5.8
	Vertical single glazed window in wooden frame		4.7
	Vertical double glazed window, distance between glasses 30 - 60 mm		2.8
	Vertical triple glazed window, distance between glasses 30 - 60 mm		1.85
	Vertical sealed double glazed window, distance between glasses 20 mm		3.0
	Vertical sealed triple glazed window, distance between glasses 20 mm		1.9
	Vertical sealed double glazed window with "Low-E" coatings	0.32	1.8
	Vertical double glazed window with "Low-E" coatings and heavy gas filling	0.27	1.5
	Vertical double glazed window with 3 plastic films ("Low-E" coated) and heavy gas filling	0.06	0.35
	Horizontal single glass	1.4	7.9
Walls	6 inches (150 mm) - poured concrete 80 lb/ft^3	0.7	3.9
	10 inches (250 mm) - brick	0.36	2.0

U and R-values

U-value (or U-factor) is a measure of the rate of heat loss or gain through a construction of materials. The lower the U-factor, the greater the material's resistance to heat flow and the better is the insulating value. U-value is the inverse of R-value.

The overall U-value of a construction consisting of several layers can be expressed as

$$U = 1 / \sum R \qquad (2)$$

where

U = heat transfer coefficient (Btu/hr ft^2 ^{o}F, W/m^{2}K)

R = "R-value" - the resistance to heat flow in each layer (hr ft^2 ^{o}F/Btu, m^{2}K/W)

The R-value of the single layer can be expressed as:

$$R = 1 / C = s / k \qquad (3)$$

where

C = layer conductance (Btu/hr ft^2 ^{o}F, W/m^{2}K)

k = thermal conductivity of layer material (Btu in/hr ft^2 ^{o}F, W/mK)

s = thickness of layer (inches, m)

Note! - in addition to resistance in each construction layer - there is a resistance from the inner and outer surface to the surroundings. If you want to add the surface resistance to the *U* calculator below - use one - *1*- for thickness - l_t - and the surface resistance for the conductivity - *K*.

Online *U value* Calculator

This calculator can be used to calculate the overall U-value for a construction with four layers. Add the thickness - l_t - and the layer conductivity - *K* - for each layer. For fewer than four layers, replace the thickness of one or more layers with zero.

1. [1] *s (in, m)* [5.8] *k (Btu in/hr ft^2 ^{o}F, W/mK)*
2. [0.25] *s (in, m)* [1.7] *k (Btu in/hr ft^2 ^{o}F, W/mK)*
3. [0] *s (in, m)* [1] *k (Btu in/hr ft^2 ^{o}F, W/mK)*
4. [0] *s (in, m)* [1] *k (Btu in/hr ft^2 ^{o}F, W/mK)*

calculate!

Example - U value Concrete Wall

A concrete wall with thickness *0.25 (m)* and conductivity *1.7 (W/mK)* is used for the default values in the calculator above. The inside and outside surface resistance is estimated to *5.8 (m^2 K/W)*.

The U value can be calculated as

$$U = 1 / (1 / (5.8\ m^2K/W) + (0.25\ m) / (1.7\ W/mK))$$

$$= \underline{3.13}\ W/m^2K$$

R-values of Some Common Building Materials

Material	Resistance R-value	
	(hr ft^2 ^{o}F/Btu)	*(m^{2}K/W)*
Wood bevel siding 1/2" x 8", lapped	0.81	0.14
Wood bevel siding 3/4" x 10", lapped	1.05	0.18
Stucco (per inch)	0.20	0.035
Building paper	0.06	0.01
Plywood 1/4"	0.31	0.05

Material	Resistance R-value	
	(hr ft^2 ^{o}F/Btu)	*(m^{2}K/W)*
Plywood 3/8"	0.47	0.08
Plywood 1/2"	0.62	0.11
Hardboard 1/4"	0.18	0.03
Softboard, pine or similar 3/4"	0.94	0.17
Softboard, pine or similar 1 1/2"	1.89	0.33
Softboard, pine or similar 2 1/2"	3.12	0.55
Gypsum board 1/2"	0.45	0.08
Gypsum board 5/8"	0.56	0.1
Fiberglass 2"	7	1.2
Fiberglass 6"	19	3.3
Common brick per inch	0.20	0.04

R-values of Some Common Wall Constructions

Material	Resistance R-value	
	(hr ft^2 ^{o}F/Btu)	*(m^{2}K/W)*
2 x 4 stud wall, uninsulated	5	0.88
2 x 4 stud wall with 3 1/2" batt insulation	15	2.6
2 x 4 stud wall with 1" polystyrene rigid board, 3 1/2" insulation blanket	18	3.2
2 x 4 stud wall with 3/4" insulation board, 3 1/2" batt insulation, 5/8" polyurethane insulation	22	3.9
2 x 6 stud wall with 5 1/2" insulation blanket	23	4
2 x 6 stud wall with 3/4" insulation board, 5 1/2" batt insulation, 5/8" polyurethane insulation	28	4.9

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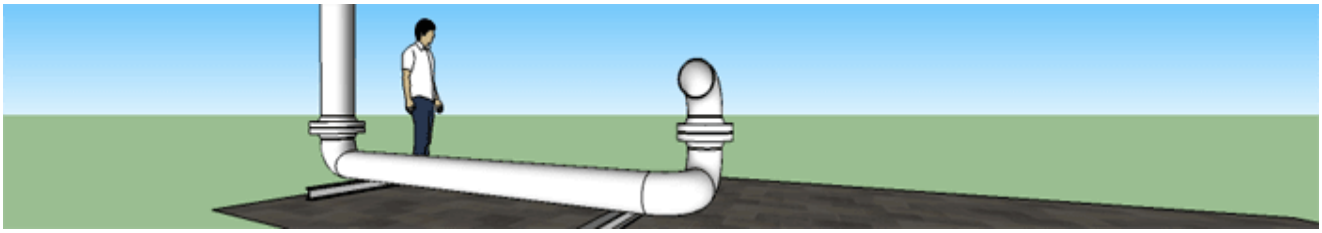

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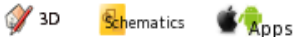

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- yards
- miles
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1.0

- m^2
- km^2
- in^2
- ft^2
- $miles^2$
- acres

Convert!

Volume

1.0

- m^3
- liters
- in^3
- ft^3
- us gal

Convert!

Weight

1.0

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- N
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- ft/min
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- mph
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1.0

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- mm H_2O
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