

$$\sin \theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \frac{\theta^7}{7!} + \dots$$

ATKINSON SCIENCE

$$e^{i\pi} = -1$$
$$\frac{u}{u_\tau} = \frac{1}{\kappa} \ln \frac{y u_\tau}{\nu}$$
$$E_b = \sigma T^4$$

USER GUIDE

CIBSE Simple Model Web Application

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Atkinson Science welcomes your comments on this User Guide. Please send an email to keith.atkinson@atkinsonscience.co.uk.

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1 Introduction

The CIBSE simple model is a steady-state heat loss model of a simple rectangular room or building. The model does not account for solar gain. Its purpose is to enable the designer to determine the size of convective and radiative heat emitters to achieve a specified operative temperature or a specified air temperature when there is a net heat loss through the building envelope. It is best suited to winter-time calculations in which there is a net heat loss from the building and the solar gain is negligible.

You can use the model by clicking on this link:

www.atkinsonscience.co.uk/WebApps/Construction/CIBSESimpleModel.aspx

If you would like to understand the science on which the model is based, there is a theory guide in PDF format that you can download by clicking on this link:

www.atkinsonscience.co.uk/PDFS/WebApps/CIBSE%20Simple%20Model%20Theory%20Guide.pdf

You can also find a description of the model in Chapter 5 of *CIBSE Guide A*, Ref. [1].

2 User interface

The user interface of the CIBSE simple model is shown in Figure 1. In the top part of the interface the user must check the external surfaces of the room or building through which heat is lost. The model assumes that there is no net heat flow through internal surfaces, so these surfaces do not have to be checked. For example, if a room has two external walls each containing one or more windows, then the user would check the boxes Wall1, Wall2, Glazing1, Glazing2. Then the user would enter the area of Wall1, excluding the glazing, and the U value of Wall1, and do the same for Wall2. Then the user would enter the total area of glazing Glazing1 in Wall1 and the U value of Glazing1, and do the same for Glazing2. If the ceiling or the floor of the room is also an external surface then the same procedure must be followed. When the Calculate button is clicked, the model will use the information to calculate the sum of the areas, $\sum A$, and the sum of $A \times U$, $\sum AU$.

The user must also enter either the operative temperature or the inside air temperature of the space. The operative temperature is a comfort temperature and represents the temperature felt by the occupants of the space. It is usual to specify this temperature rather than the inside air temperature. When heating is provided by a radiant system the comfort temperature may be perfect for the occupants even though the air around the occupants is quite cool.

The user must also enter the outside air temperature, the radiant fraction of the heating system in the space, the volume of the the space, and the ventilation in terms of the number of air changes per hour. Table 1, taken from Ref. [1], gives the radiant fraction of different types of heating system.

Table 1 Typical proportions of radiant (R) and convective heat from heating systems

Heating system	Proportion of emitted radiation	
	Convective	Radiant (R)
Forced warm air heaters	1.0	0
Natural convectors and convector radiators	0.9	0.1
Multi column radiators	0.8	0.2
Double and treble panel radiators, double column radiators	0.7	0.3
Single column radiators, floor warming systems, storage heaters	0.5	0.5
Vertical and ceiling panel heaters	0.33	0.67
High temperature radiant systems	0.1	0.9

When the user clicks the Calculate button, the user interface displays the power supplied to the heating system, the inside air temperature and the mean surface temperature (also called the mean radiant temperature).

If the user chooses to enter the inside air temperature, rather than the operative temperature, then the text box label Inside air temperature [C] will change to Operative temperature [C], and the text box will display the operative temperature.

Figure 1 User interface

CIBSE Simple Model

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Input

Surface	Area [m ²]	U value [W m ⁻² K ⁻¹]
Ceiling	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Floor	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Wall 1	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Wall 2	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Wall 3	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Wall 4	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Doors 1	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Doors 2	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Doors 3	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Doors 4	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Glazing 1	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Glazing 2	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Glazing 3	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>
Glazing 4	<input type="checkbox"/> <input style="width: 60px;" type="text"/>	<input style="width: 60px;" type="text"/>

Operative temp. [C]
 Inside air temp. [C]
 Outside air temp. [C]
 Radiant fraction []
 Volume [m³]
 Air changes per hour [h⁻¹]

Output

Heating power [W]
 Inside air temp. [C]
 Mean surface temp. [C]

3 Example

Figure 2 gives the dimensions of an office at the corner of an office block. The office is on one of the middle floors, so the ceiling, floor and two of the walls are internal structures, and information on these surfaces does not need to be entered into the model. Table 2 gives the area and U value for each of the surfaces through which heat is lost, and this information is entered into the user interface as shown in Figure 3.

Figure 2 Dimensions of the office in metres

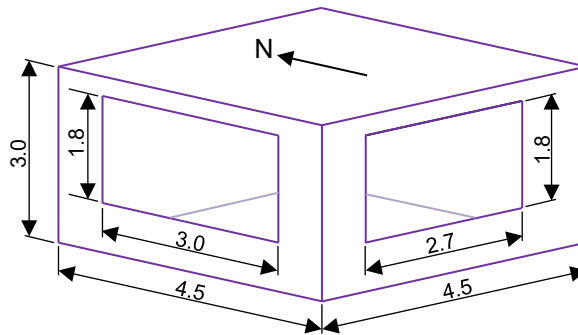


Table 2 Surface areas and U values for the office

Surface	Area A_n [m ²]	U_n value [W m ⁻² K ⁻¹]
W external wall	8.10	0.35
S external wall	8.64	0.35
W glazing	5.40	2.2
S glazing	4.86	2.2

In winter when the outside air temperature is 2°C, the office will have an operative temperature of 21°C. The office will be heated by conventional hot-water radiators, so according to Table 1 the radiant fraction will be 0.3. The volume of the office is 60.75 m³ and the office will be ventilated at a rate of 1.2 ach. This information is also entered into the user interface, as shown in Figure 3.

When the user clicks the Calculate button, the user interface displays the power supplied to the heating system, the inside air temperature and the mean surface temperature, as shown in Figure 3.

Figure 3 Completed user interface

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Input

Surface		Area [m ²]	U value [W m ⁻² K ⁻¹]
Ceiling	<input type="checkbox"/>		
Floor	<input type="checkbox"/>		
Wall 1	<input checked="" type="checkbox"/>	8.10	0.35
Wall 2	<input checked="" type="checkbox"/>	8.64	0.35
Wall 3	<input type="checkbox"/>		
Wall 4	<input type="checkbox"/>		
Doors 1	<input type="checkbox"/>		
Doors 2	<input type="checkbox"/>		
Doors 3	<input type="checkbox"/>		
Doors 4	<input type="checkbox"/>		
Glazing 1	<input checked="" type="checkbox"/>	5.40	2.2
Glazing 2	<input checked="" type="checkbox"/>	4.86	2.2
Glazing 3	<input type="checkbox"/>		
Glazing 4	<input type="checkbox"/>		

<input checked="" type="radio"/> Operative temp. [C]	21.0
<input type="radio"/> Inside air temp. [C]	
Outside air temp. [C]	2.0
Radiant fraction []	0.3
Volume [m ³]	60.75
Air changes per hour [h ⁻¹]	1.2

Calculate



Output

Heating power [W]	1009.32
Inside air temp. [C]	21.5014
Mean surface temp. [C]	20.4985

4 References

1. *CIBSE Guide A: Environmental Design*, CIBSE, 2006.