Radiator selection by considering building heat loss calculations according to ts-825 standard

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Abstract
Panel radiators are finned natural convective heat exchangers. Water flows inside chanels and outside air is heated up through finned and bare surfaces of heat exchanger. Radiator thermal performance measurements are carried out in companies labs according to EN 442-2 standard for testing radiators and convectors. Results are curve fitted according to EN 442-2 for various sizes. In order to select optimised panel radiator for domestic space heating, room heat loss should be determined accurately. Turkish standard TS-825 is given detailed definitions to determine heat loss of a building and a room. A computer model is designed according to description and data given in this standart to determine the heat loss of a single room. In heat loss considiration of the single room, each wall, ceiling etc. is investigated by also considering neigbour spaces, i.e if it is and outside or internal space, direction of the wall, location and outside conditions according to locations etc. As a part of the walls window and door heat transfers, air leaks, room air refrefshments requirements are alos considered. All this calculations are offered to user in friendly graphic user interfaces to be utilised in selection process. Program also contains curve fitted values obtained from lab measurements, so after calculating heat loss, it will suggest the best fitting Panel radiator selection available. The basic aim here is to supply a means of optimal radiator selection for a selected room in buildings. Models are intended for the users of small constructors to select appropriate radiators and approximate room heat loss with an easy to use tool.
Keywords: Building heat loss, panel radiators, radiator selection

Nomenclature

U	Overall heat transfer coefficient of wall W/m^2K
R	
R_j	Overall thermal resistance of wall m^2K/W
R_j	Internal thermal resistance of wall m^2K/W
H_j	Wall component j thermal resistance m^2K/W
h_i	Internal thermal convectivity W/m^2K
h_e	External thermal convectivity W/m^2K
k_j	Wall component j thermal conductivity W/mK
Q	Total heat transfer of the wall W
T_i	Internal temperature ℃
T_e	External temperature ℃
ΔT	Temperature difference K
T_m	Arithmetic average temperature ℃
T_{room}	Room temperature ℃
$T_{w,in}$	Water inlet temperature ℃
$T_{w,out}$	Water exit temperature ℃
η	Viscosity of air (Pa.s)
ρ	Density of air (kg/m^3)
Pr	Prandtl number
Cp	Specific heat at constant pressure (kJ/kgK)
K	k Thermal conductivity (W/mK)
Nu	Nu Nusselt Number
Re	Re Reynolds number
Ra	Ra Rayleigh number
Gr	Gr Grashoff number

1. Introduction

Panel radiators are finned natural convective heat exchangers. They are utilised to heat buildings, mostly domestic places. Relatively simple structures of this heat exchangers makes it an attractive solution for space heating process. Another important properties of these devices are the long operating life due to it'S simplicity. There are no fan to drive air through the heat exchanger, therefore possibility of device failiure is relatively low. One of the problem builders faces on selection of the required radiator in the building and sepecific rooms in the buildings is to determine the heat loss in the space and heat tranfer delivery of the radiator to compansate this heat loss. A model for heat loss based on TS825 standart and another model for heat transfer characteristics of radiatior utilising tests carried out laboratory performance tests based on TSEN442-2 standart. Model will be presented to builders to estimate room heat loss and radiator heat delivery. The details of methods carried out and formulations are presented in this paper.

2. Heat loss through walls

Heat loss through walls can be calculated by using thermal resistance and overall thermal convectivity coefficients. The thermal resistance of a wall can be calculated as

$$\frac{1}{U} = R = R_i + \sum_{j=1}^{N} R_j + R_e$$

Where:

U : Overall heat transfer coefficient of wall W/m^2K

R : Overall thermal resistance of wall $\frac{m^2K}{W}$

$R_i = \frac{1}{h_i}$ internal thermal resistance $\frac{m^2K}{W}$

$R_e = \frac{1}{h_e}$ internal thermal resistance $\frac{m^2K}{W}$

$R_j = \frac{\Delta x_j}{k_j}$ wall component j thermal resitance

h_i : Internal thermal convectivity $\frac{W}{m^2K}$

h_e : External thermal convectivity $\frac{W}{m^2K}$

k_j : wall component j thermal conductivity $\frac{W}{mK}$

Total heat transfer of the wall:

$Q = UA(T_i - T_e)$

T_i : internal temperature degree C

T_e : external temperature degree C

Building temperatures listed in standard TS825 is given in Table 1. But user of the programs are free to select any values they desired to use in the simulation program graphic user interface. Thermal resistance of air gaps are given in Table 2. Overall heat transfer coefficients for the Windows are given in Table 3. And overall heat transfer coefficient of some doors are given in Table 4.

Table 1. Building internal temperature design values

		Name of the building	
1		Residential houses	19
2		Management centers	
3		Ofices	
4		Hotel, motel and restaurants	20
5		Schools	
6		Theaters	
7		Military buildings	
8		Prisons	
9		Museums	
10		Airports	
11		Hospitals	22
12		Swimming pools	26
13		Factories	16

Table 2. Thermal resistance of air gaps

No	State	Thickness (d) mm	Thermal resistance (R) m^2K/W
1	Vertical	≤ 10	0.14
		11-20	0.16
		21-50	0.18
		51-100	0.17
		100>	0.16
2	Horizontal(heat flux in with upper direction)	≤ 10	0.14
		11-20	0.15
		20>	0.16
3	Horizontal(heat flux in lower direction)	≤ 10	0.15
		11-20	0.18
		20>	0.21

Table 3. overall heat coefficient of some windows

Overall heat transfer coefficients U for Windows W/m^2K	Single glass	Double glass		Double glass with reflective covers	
		Space between glasses (mm)		Space between glasses (mm)	
		12	16	12	16
frameless	6.7	2.9	2.7	1.6	1.3
Wooden frame (hard woods)	4.57	2.64	2.50	1.74	1.53
Composit (PVC) frame2 layers	4.73	2.79	2.79	1.89	1.68
Composit (PVC) frame3 layers	4.63	2.70	2.70	1.80	1.59
Composit (PVC) frame4 layers	4.60	2.67	2.67	1.77	1.56
Composit (PVC) frame5 layers	4.57	2.64	2.64	1.74	1.53
Composit (PVC) frame6 layers	4.54	2.61	2.61	1.71	1.50
Aliminium frame	5.62	3.68	3.68	2.79	2.58
Aliminium frame (indulated bridges)	4.73	2.79	2.79	1.89	1.68

Table 4. overall heat coefficient of some doors

		U W/m^2K
1	Simple wooden door with single glass window	5.2
2	Wooden door with double layer glass window distance between glasses: 6 mm	3.3
3	Wooden door without glass	2.9
4	Wooden door with double layer glass window distance between glasses: 12 mm	3.5
5	Wooden external door without glass	2.6
6	Wooden door with two wing single glass window	2.6
7	Wooden door with framed two wing single glass windows	5.8
8	Metal door with double layer Windows distance between glasses: 6 mm	4.8
9	Metal door with double layer Windows distance between glasses: 12 mm	3.6
10	Metal door with two wing single glass window	3.5
11	Metal door with framed two wing single glass windows	3.3
12	Top single layer window-door metal	5.8
13	Top window with metal double layer door	3.5
14	Plastic door with single layer window	5.0
15	Plastic door with double layer window	2.6

The most importantly a very extensive list of building material thermal properties, density, thermal conductivity and water vapor diffusion coefficients are given in the standard. Presenting of all this extensive list in this paper is not possible, but According to standard, they all measured in the laboratories of Turkish standards Instiute. the given data are compered some of with other data tables and found that results are comparable.

Table 5. Surface thermal resistance value (1/thermal convectivity)

<table>
<tr><td rowspan="2">No</td><td rowspan="2">Type of building structure</td><td colspan="2">Surface Thermal resistance value R=(1/h) (1/thermal convectivity)</td></tr>
<tr><td>R_i internal resistance (m^2K/W)</td><td>R_e External resistance (m^2K/W)</td></tr>
<tr><td>1</td><td>External wall</td><td rowspan="6">0.13</td><td>0.04</td></tr>
<tr><td>2</td><td>External wall where internal part is not heating</td><td>0.08</td></tr>
<tr><td>3</td><td>Wall between separate flats in the same building,wall that opposite section is unheated</td><td>0.13</td></tr>
<tr><td>4</td><td>External wall connected to earth</td><td>0</td></tr>
<tr><td>5</td><td>External horizontal or with some angles</td><td>0.04</td></tr>
<tr><td>6</td><td>Ceiling under attic or ventilated roof shell</td><td>0.08</td></tr>
<tr><td>7</td><td colspan="3">Base between separate flats</td></tr>
<tr><td>7.1</td><td>Heat flux is from down to top</td><td>0.13</td><td>0.13</td></tr>
<tr><td>7.2</td><td>Heat flux is from top to down</td><td>0.17</td><td>0.17</td></tr>
<tr><td>8</td><td>Basement ceiling</td><td rowspan="3">0.17</td><td></td></tr>
<tr><td>9</td><td>Base directly open to external air</td><td>0.04</td></tr>
<tr><td>10</td><td>Base directly located on the surface</td><td>0</td></tr>
</table>

Table 6. Thermal resistance of air gaps in the wall

<table>
<tr><td colspan="4">Air gaps</td></tr>
<tr><td>No</td><td>State</td><td>Thickness (d) mm</td><td>Air gaps thermal resistance (R) (m^2K/W)</td></tr>
<tr><td rowspan="5">1</td><td rowspan="5">Vertical</td><td>≤ 10</td><td>0.14</td></tr>
<tr><td>11-20</td><td>0.16</td></tr>
<tr><td>21-50</td><td>0.18</td></tr>
<tr><td>51-100</td><td>0.17</td></tr>
<tr><td>100></td><td>0.16</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Horizontal (heat flow is from down to up)</td><td>≤ 10</td><td>0.14</td></tr>
<tr><td>11-20</td><td>0.15</td></tr>
<tr><td>>20</td><td>0.16</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Horizontal (heat flow is from up to down)</td><td>≤ 10</td><td>0.15</td></tr>
<tr><td>11-20</td><td>0.18</td></tr>
<tr><td>>20</td><td>0.21</td></tr>
</table>

Eventhough thermal resistance wales on the wall surface is represented by some values in the standard (Table 5), It is preferred to calculate them from basic heat transfer equations. In internal surfaces Natural convective heat transfer is assumed. For external surfaces user defined external temperatures and wind speed is taken. If user is not given any external wind speed, it is assumed to be 2 m/s.

For thermodynamic and thermophysical properties of air ideal gas equation of state is assumed. For specific heat of air cubic spline curve fitting equations are utilized. Cubic spline equations are in form of

$$Cp_k(T_k) = y_k = b_k(T_{k+1} - T_k) + \left[\frac{(T_{k+1}-T_k)^3}{6h_k} C_k\right] = \left[b_k h_k + \frac{{h_k}^3}{6h_k} C_k\right] \quad (2.1)$$

Where

$$h_k = T_{k+1} - T_k \quad 1 \le k \le n \quad (2.2)$$

$$w_k = \frac{Cp_{k+1} - Cp_k}{h_k} = \frac{Cp_{k+1} - Cp_k}{T_{k+1} - T_k} \quad 1 \le k \le n \quad (2.3)$$

$$a_k = \frac{\left[6Cp_{k+1} - h_k^2 c_{k+1}\right]}{6h_k} \quad 1 \le k \le n \quad (2.4)$$

$$b_k = \frac{\left[6Cp_k - h_k^2 c_k\right]}{6h_k} \quad 1 \le k \le n \quad (2.5)$$

$$h_{k-1}C_{k-1} + 2C_k(h_{k-1} + h_k) + h_k C_{k+1} = 6\left[\left[\frac{Cp_{k+1} - Cp_k}{h_k}\right] - \left[\frac{Cp_k - Cp_{k-1}}{h_{k-1}}\right]\right] \quad (2.6)$$

Other thermodynamic properties are calculated from thermodynamic relations by using specific heat data.

The thermophysical properties of air, such as thermal conductivity and viscosity, are calculated with the equations suggested by Kadoya et al [1].

$$\eta(T_r, \rho_r) = H\left[\eta_0(T_r) + \Delta\eta(\rho_r)\right] \quad (2.7)$$

$$\eta_0(T_r) = A_0 T_r + A_1 T_r^{0.5} + A_2 + \frac{A_3}{T_r} + \frac{A_4}{T_r^2} + \frac{A_5}{T_r^3} + \frac{A_6}{T_r^4}$$

$$\Delta\eta(\rho_r) = \sum_{i=1}^{4} B_i \rho_r^i$$

$$k(T_r, \rho_r) = \Lambda[k_0(T_r) + \Delta k(\rho_r)] \quad (2.8)$$

$$k_0(T_r) = C_0 T_r + C_1 T_r^{0.5} + C_2 + \frac{C_3}{T_r} + \frac{C_4}{T_r^2} + \frac{C_5}{T_r^3} + \frac{C}{T_r^4} \quad (2.9)$$

$$\Delta k(\rho_r) = \sum_{i=1}^{4} D_i \rho_r^i \quad (2.10)$$

$\rho_r = \frac{\rho}{\rho^*}$ reduced pressure

$T_r = \frac{T}{T^*}$ reduced temperature

In Eq. (2.7) and Eq. (2.8) "H" is equal to 6.1609 (10^{-6} Pa), "Λ" is equal to 25.9778 (10^{-3} $W/(mK)$, ρ^* is equal to 314.3 kg/m^3 and T^* is equal to 132.5 K. The coefficients of Eq. (39) and (40) are given in Table 3.

Table 7. Coefficients of viscosity and thermal conductivity

i	A_i	B_i	C_i	D_i
0	0.128517	0.465601	0.239503	0.402287
1	2.60661	1.26469	0.006497 68	0.356603
2	-1	-0.511425	1	-0.163159
3	-0.709661	0.2746	-1.92615	0.138059
4	0.662534		2.00383	- 0.020172 5
5	-0.197846		-1.07553	
6	0.007701 47		0.229414	

For internal heat transfer Natural convection is assumed

Grashoff Number: $\mathrm{Gr}_x = \frac{g\beta(T_s - T_\infty)x^3}{\nu^2}$ where

$\nu = \frac{\mu}{\rho}$ $\beta = -\frac{1}{\rho}\left(\frac{\partial\rho}{\partial T}\right)_P$ is the volumetric thermal expansion coefficient.

This term may be approximated as: $\beta \approx -\frac{1}{\rho}\left(\frac{\rho_\infty - \rho}{T_\infty - T}\right)$.

For a perfect gas: $\rho = P/RT$ therefore:

$\beta = -\frac{1}{\rho}\left(\frac{\partial\rho}{\partial T}\right)_P = \frac{1}{\rho}\frac{P}{RT^2} = \frac{1}{T}$ 1/K

Rayleigh Number: $\mathrm{Ra}_x = \mathrm{Gr}_x Pr = \frac{g\beta(T_s - T_\infty)x^3}{\nu\alpha}$ $\alpha = \frac{k}{\rho C_p}$

Critical Rayleigh Number $\mathrm{Ra}_{x,critical} = 10^9$
For vertical walls

Laminar free convection: Coban-2 equation similarity solution [8]

$$\mathrm{Nu}_L = \frac{4}{3}\left(\frac{\mathrm{Gr}_L}{4}\right)^{1/4} \frac{(0.022830145+0.752624416Pr^{\frac{1}{2}}+2.08\mathrm{x}10^{-4}\mathrm{Pr})}{(1.222236219+1.010421489Pr^{\frac{1}{2}}+1.389905434\mathrm{Pr})^{1/4}}$$

$0.01 \le Pr \le 1000 \quad 0 \le Ra_L \le 10^9$ [8]

For horizontal wall assuming internal space is warmer $L_c = \frac{A_s}{P}$ where A_s is the plate surface area and P is the perimeter

$$\mathrm{Ra}_x = \mathrm{Gr}_x Pr = \frac{g\beta(T_s - T_\infty)L_c^3}{\nu\alpha}$$

Upper surface of Hot Plate or Lower surface of Cold Plate

$\mathrm{Nu}_L = 0.54Ra_L^{1/4} \quad 10^4 \le Ra_L \le 10^7$

$\mathrm{Nu}_L = 0.15Ra_L^{1/3} \quad 10^7 \le Ra_L \le 10^{11}$

Lower surface of Hot Plate or Upper surface of Cold Plate

$\mathrm{Nu}_L = 0.27Ra_L^{1/4} \quad 10^5 \le Ra_L \le 10^{10}$

For external heat transfer both horizontal and vertical surfaces) forced convective heat transfer models are assumed

Coban-2 eqn[8] (similarity solution by Runge Kutta method and and least square curve fitting and Gauss integration)

$Nu_x = 0.45584275Re^{0.5}Pr^{0.47294717} \quad 10^{-3} \le Pr \le 10^{-2}$

$Nu_x = 0.35271867Re^{0.5}Pr^{0.40922589} \quad 10^{-2} \le Pr \le 0.5$

$Nu_x = 0.33253715Re^{0.5}Pr^{0.33694685} \quad 0.5 \le Pr \le 1000$

Churchill and Ozoe experimental correlation:

$$Nu_x = \frac{0.332Re^{0.5}Pr^{0.3333333}}{\left[1+\left(\frac{0.0468}{\mathrm{Pr}}\right)^{2/3}\right]^{1/4}} \quad Pe_x = RePr \ge 100$$

3. Experimental measurements

Radiator thermal performance measurements are carried out according to EN 442-2 standard for testing radiators and convectors. According to this standard, Measurements are carried out for three different temperature zones

$$\Delta T = T_m - T_{room} = (30 \mp 2.5)K$$
$$\Delta T = T_m - T_{room} = (50 \mp 2.5)K$$
$$\Delta T = T_m - T_{room} = (60 \mp 2.5)K$$

Where T_m is the arithmetic average temperature between inlet and exit of water

$$T_m = \frac{T_{w\_in} + T_{w\_out}}{2}$$

And T_{room} is the room temperatures. Room temperature and experiment wall temperatures should be set to a constant temperature of 20 ℃. In order to carry out this test, a laboratuary design with the specification of standards is required. Test results will be fit into a simple curvefitting equation in the form of

$$Q = \dot{m}(h_{w\_in} - h_{w\_out}) = K_M \Delta T^n$$

Where Q is the heat transfer, $\dot{m}$ is the mass flow rate of water flowing through radiator, h_w is the water enthalpies at inlet and outlet.

Water enthalpies are calculated from steam tables programs developed by using IAPWS Equation of state[10].

K_M and n are the curve fitting coefficients obtained as a result of experiments. In order to reduce measurements uncertainities, measuremnts of each point should be carried out several times (minimum of three times). A laboratory system according to EN 442-2 is developed and a wide range of radiators are measured by using this facility. Some of the measurement results and curve fitting coefficients are given below.

Table 5. Measure vales and curve fitting coefficients of raditors

No	Sample	75/65°, DT=50K, 20 °C room Measured Thermal output		90/70°, DT=60K, 20 °C room Measured Thermal output		curve fitting coefficient n	Model Constant K_m
		Watt	Kcal/h	Watt	Kcal/h		
1	-PK, size (mm) 300x1000	562	483	711	612	1.302	3.442738
2	-PK, size (mm) 400x1000	722	621	916	788	1.296	4.542272
3	-PK, size (mm) 500x1000	876	753	1108	953	1.289	5.656291
4	-PK, size (mm) 600x1000	1026	882	1296	1115	1.2802	6.858
5	-PK, size (mm) 700x1000	1151	990	1454	1251	1.277	7.795927
6	-PK, size (mm) 800x1000	1280	1101	1615	1389	1.27	8.90958
7	-PK, size (mm) 900x1000	1399	1203	1777	1529	1.3047	8.5079
8	-PKP, size (mm) 300x1000	781	672	994	855	1.33	4.290071
9	-PKP, size (mm) 400x1000	998	858	1267	1090	1.321	5.6744
10	-PKP, size (mm) 500x1000	1193	1026	1517	1305	1.313	7.018701
11	-PKP, size (mm) 600x1000	1389	1194	1761	1515	1.3013	8.5478
12	-PKP, size (mm) 700x1000	1542	1326	1953	1680	1.295	9.725641
13	-PKP, size (mm) 800x1000	1699	1461	2147	1847	1.286	11.09334
14	-PKP, size (mm) 900x1000	1835	1578	2339	2013	1.3267	10.2333
15	-PKKP, size (mm) 300x1000	1001	861	1275	1097	1.321	5.708583
16	-PKKP, size (mm) 400x1000	1273	1095	1618	1392	1.319	7.303746
17	-PKKP, size (mm) 500x1000	1528	1314	1941	1670	1.317	8.83681
18	-PKKP, size (mm) 600x1000	1788	1537	2276	1958	1.3237	10.0782
19	-PKKP, size (mm) 700x1000	2006	1725	2550	2194	1.313	11.79777
20	-PKKP, size (mm) 800x1000	2233	1920	2835	2439	1.312	13.17181
21	-PKKP, size (mm) 900x1000	2452	2109	3112	2678	1.31	14.57782
22	-PKKPKP, size (mm) 300x1000	1448	1245	1846	1589	1.329	8.000871
23	-PKKPKP, size (mm) 400x1000	1810	1557	2305	1983	1.329	9.988665
24	-PKKPKP, size (mm) 500x1000	2149	1848	2737	2355	1.33	11.8142
25	-PKKPKP, size (mm) 600x1000	2486	2138	3171	2728	1.335	13.4073
26	-PKKPKP, size (mm) 700x1000	2791	2400	3556	3060	1.331	15.28534
27	-PKKPKP, size (mm) 800x1000	3091	2658	3939	3389	1.331	16.92893
28	-PKKPKP, size (mm) 900x1000	3391	2916	4340	3734	1.3483	17.3771

In the figures below a radiator measured in the lab is shown.

Figure 1. ECA ELBA Radiator heat capacity measurement system

3. Program development

Several programs in java programming language is developed. In the table below list of classes and their functions are given:

Table 6. Program class list and their functions

Class name	Class type	Class function
odaP2_2022	JFrame	Basic graphic user interface (GUI) to combine all calculations
duvarP4	JPanel	GUI for wall calculations
duvar1		Detailed calculations for the wall, takes wall heat transfer charecteristics from class bina_malzeme1
secP1	JPanel	GUI for the window calculations
secP2	JPanel	GUI for the door calculations
Pencere1		Detailed heat transfer calculations for the window
kapi		Detailed heat transfer calculations for the door
bina_malzeme1		All wall material and heat transfer characterisation from vector of bina_malzeme_veri1 class
bina_malzeme_veri1		Data for single wall material
radyatorisi_2022		
pictureP	JPanel	Graphic output for Picture plus text
demo1		Display JFrame with static plot method
FrameGraphic	JFrame	Graphic User Interface
SteamIAPWS_IF97	class	Thermosynamic and thermophysical properties of steam
Air_PG_SP	class	Thermodynamic and thermophysical properties of air as perfect gas by using cubic spline Cp formulation

Building wall materials and their density plus thermal conductivity data is input into bina_malzeme_veri1 class. Actual data is entered into bina_malzeme1 class as a dynamic vector of built in java Vector class. An array of bina_malzeme1 class is entered into duvar1 class. Duvar1 also contains information such as the direction of the wall, and whether its an internal, external wall, floor or ceiling. Actual wall material information is entered in GUI class duvarP4 which includes class duvar1. In this class user can build new wall structures layer by layer or alternatively user can select walls from a predefined list of wall structures. In pencere1 class window heat transfer charecteristics and window area is defined. This class is integrated with GUI class secP1. User can input the window type and area of the window. In kapi class heat transfr characteristics and area of the door is defined. This class is integrated with GUI class secP2. User can input the door type and area of the door.

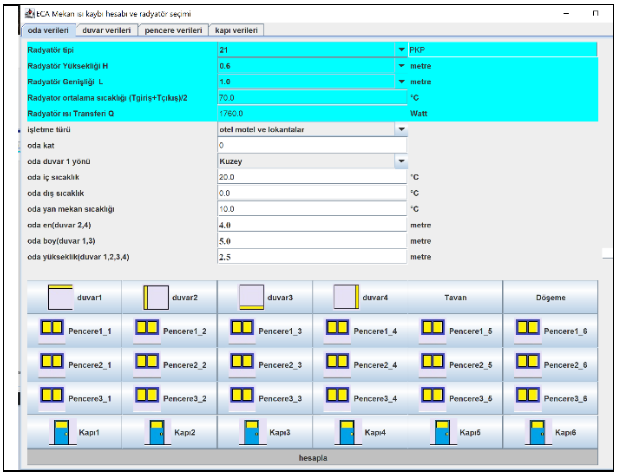

Figure 1. Main Graphic user interface (GUI) odaP2_2022

Figure 2. An information pop-up window odaP2_2022

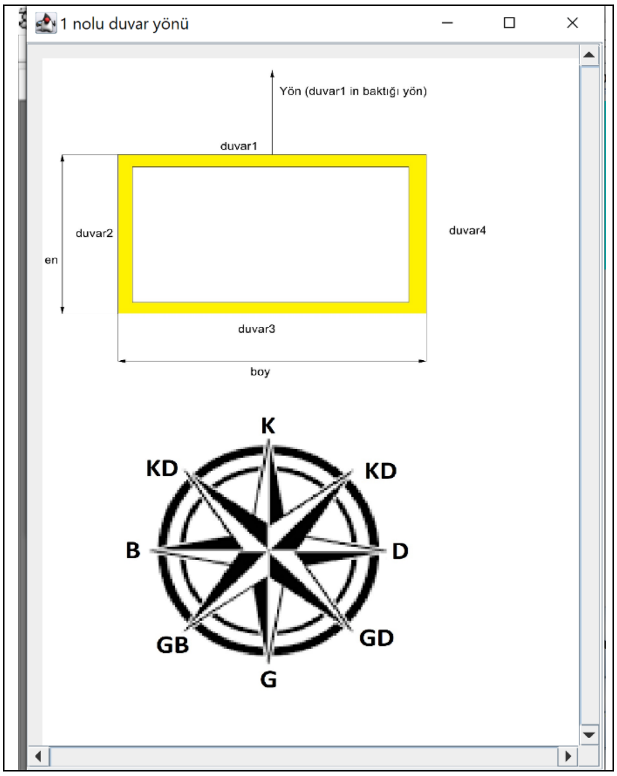

Figure 3. An information pop-up window odaP2_2022

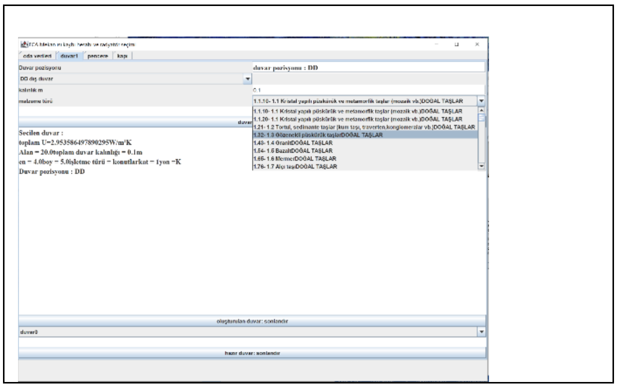

Figure 4. An entry GUI for wall design & selection duvarP4 (selecting wall layers & structure by the user)

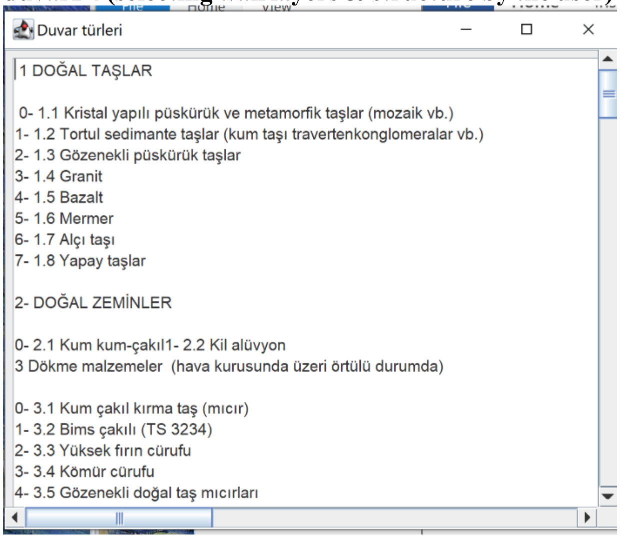

Figure 5. An information pop-up window for GUI duvarP4

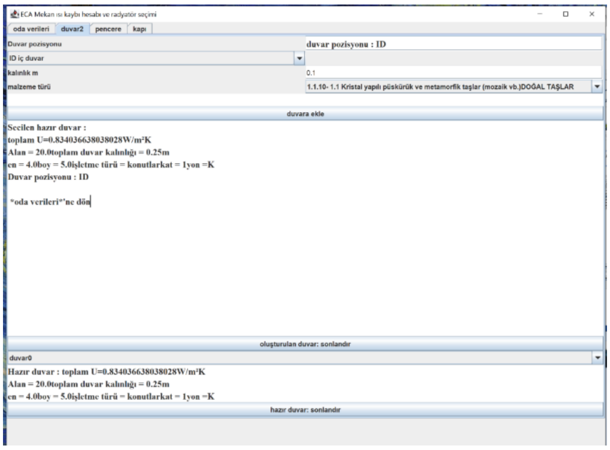

Figure 6. An entry GUI for wall design & selection duvarP4 (selecting walls from predefined wall list)

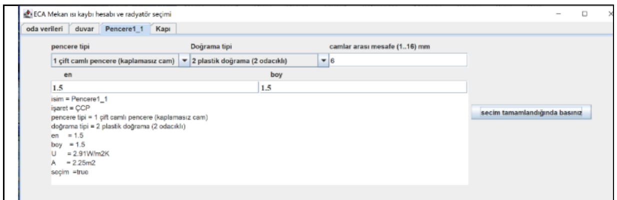

Figure 7. An entry GUI for window design & selection secP1

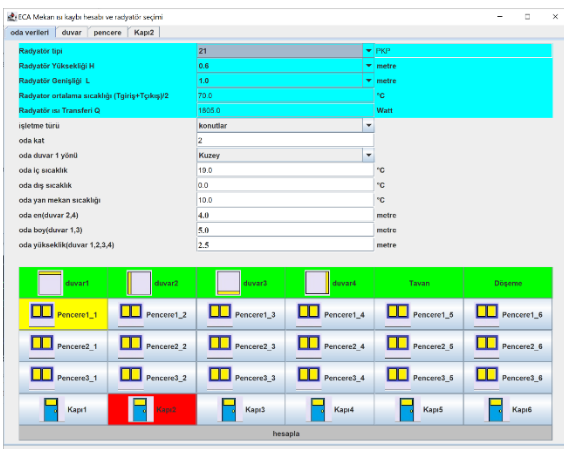

Figure 8. An entry GUI for door design & selection secP2

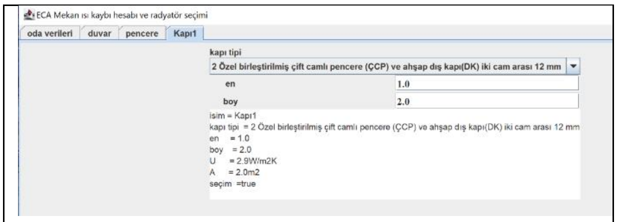

Figure 8. An entry GUI for door design & selection secP2 , an output for radiator heat output

All information for walls, Windows and doors combined as a room in one main GUI class odaP2_2022. In this class four side walls, one ceiling an done floor plus several doors and Windows in each wall is defined acording to above defined classes. In addition information such as building type, floor of the room, internal and external temperature profiles, including temperature of the neighbour rooms and room size (width, length and height) is defined. The program also adds up air renewal rates and additional heat requirements according to air refreshment process. In addition to this odaP2_2022 GUI is also included input data for the class radyatorisi_2022. By combining all this information total room heat loss is calculated. This class calculates heat generated from radiator according to size and types of selected radiator. Information about heat transfer charecteristics of radiators are measured in laboratory and curve fitting values are used to claculate the heat transfer output. Details of this is given in experimental measurements section of this paper.

Program codes are presented at www.turhancoban.com address.

4. Conclusions

A model for heat loss for buildings is prepared. Also another model for radiator heat transfer based on curve fitting data of experimental measuremets are prepared. The basic aim here is to supply a means of optimal radiator selection for a selected room in buildings. Models are intended fort he users of small constructers to select appropriate radiators and approximate room heat loss with an appropriate tools.

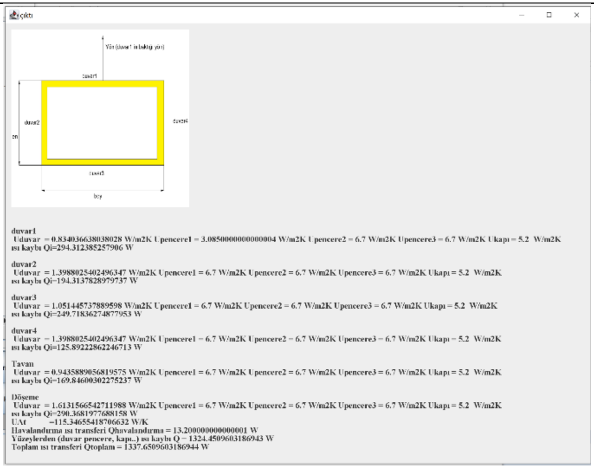

Figure 9. An output GUI window wall design & selection odaP2_2022 (Room heat loss values)

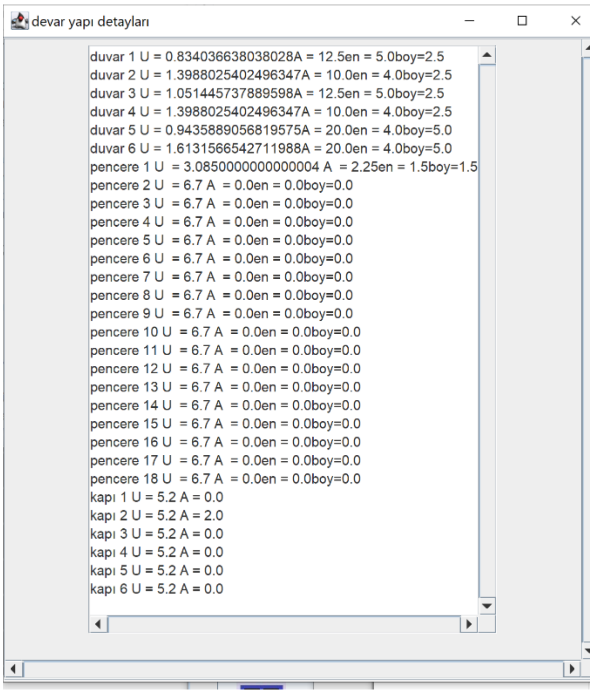

Figure 10. An output GUI window wall design & selection odaP2_2022 (Room heat loss values in details for each wall, window and doors)

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Acknowledgments

This study is carried out as an ECA ELBA company research and development project, and all radiator performance measurements are carried out their lab environment.