Proceedings World Geothermal Congress 2005
Antalya, Turkey, 24-29 April 2005

Average Heat Load of District Heating System of Balcova

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Keywords: District heating system, peak load, average heat load

ABSTRACT

In this study, to estimate the average heat load of buildings within the Balcova district heating system, the data of 40 buildings whose heating system were installed after sound projects were taken into account. The average peak load per unit area of the buildings that are situated within Balcova district heating system is calculated on the basis of design heat loads of 40 buildings with heating system projects and the change of heat loads with respect to several parameters is investigated. The weighted average load per unit area is found 54.9 kCal/m^{2}h for a design temperature differential of 22^{o}C from the data pertinent to 40 buildings. The weighted average load per unit volume is calculated 18.3 kCal/m^{3}h.

1. INTRODUCTION

One of the main data in designing district heating systems and calculating of annual energy loads is the peak load of the outdoor temperature design of the buildings. The most correct way of peak load estimation is to compute heat losses of buildings through heat loss projects or energy consumption. However, at the beginning of this sort of projects, heat loss calculations of hundreds of buildings that would be inside of the system would not be practically possible. Especially, at the start of the geothermal projects, it will be essential to have information on the peak load and the change of heat load within the heating season for technical and economical feasibility studies. Once peak load is estimated, if climate data is known the change of the heat load with time and the annual energy load would be estimated. One of the methods used for estimation of peak load is, calculate average load, using heat loads of buildings that are previously computed, and calculate total heat load of the all buildings within the system with this average value

As far as it is known, peak load for a house of 100 m^2 in Balcova was assumed as 5320 kCal/h, when the district heating system project was prepared. Heat loss calculations for individual houses were not necessarily carried out at that time, and the system design was based on that assumed value of peak load. Although later on, heat loss calculations became mandatory, very few heat loss calculations were conducted. These 40 buildings that are used for this study are the ones for which the calculations were carried out.

2. BUILDING DATA AND ASSUMPTIONS

The data pertinent to forty buildings whose number and height of stories are taken into account are shown in Table 1. As illustrated in Fig. 1, 25 buildings have 4 stories, 8 buildings have 3 stories, 3 buildings have 5 stories, 3 buildings have 2 stories and one building has 9 stories.

Table 1: Building's Data (Toksoy and Canakci, 2000)

Building No.	Heat Load, Project	Floor, (m2)	Volume, (m^3)	Story No.
1	23.100	408,0	1224	4
2	37.620	644,0	1932	4
3	22.475	465,0	1395	4
4	22.116	400,0	1200	4
5	27.808	416,6	1250	4
6	45.392	883,2	2650	4
7	56.675	825,0	2475	4
8	29.290	576,0	1728	4
9	19.042	252,0	756	4
10	27.347	416,0	1248	4
11	46.114	588,0	1764	4
12	26.021	513,0	1539	4
13	47.278	1080,0	3240	4
14	39.936	560,0	1680	4
15	32.317	1036,0	3108	4
16	81.819	1934,4	5803	4
17	63.826	1543,1	4629	4
18	28.078	510,3	1531	4
19	27.808	405,0	1215	4
20	30.934	528,0	1584	4
21	44.082	768,0	2304	4
22	27.808	252,0	756	4
23	37.992	649,8	1949	4
24	23.596	420,0	1260	4
25	38.803	900,0	2700	4
26	11.120	165,0	495	3
27	37.592	666,0	1998	3
28	46.000	347,7	1043	3
29	18.297	324,9	975	3
30	32.084	387,0	1161	3
31	17.370	313,5	941	3
32	20.627	357,0	1071	3
33	22.241	357,0	1071	3
34	17.317	171,6	515	2
35	21.150	400,2	1201	2
36	14.005	148,5	446	2
37	30.377	869,3	2608	5
38	35.000	525,0	1575	5
39	28.879	380,0	1140	5
40	250.000	2943,0	8829	9

If the nine-story building is not considered, the buildings that are taken into account from the number of story viewpoint represent the average Balcova buildings. The gross story height of the buildings considered is taken as 3 meters.

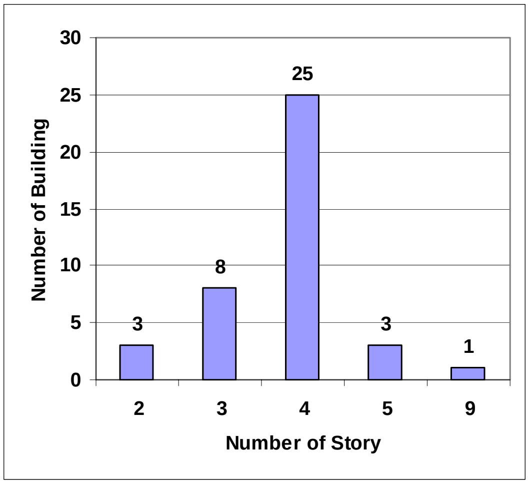

Figure 1: Story numbers distribution of the buildings (Toksoy and Canakci, 2000).

3. DESIGN TEMPERATURES

Outdoor design temperature of Izmir is taken as zero in the heat loss calculations for the projects prepared according to the criteria stated in the Bulletin No. 84 of the Chamber of Mechanical Engineers. On the other hand, local temperatures are differently chosen with respect to scope of the work. By assuming the heat loads taken from the projects are calculated with an average temperature differential of 22-0°C, average heat loads of unit area and unit volume for different temperature differentials are computed (Table 2).

Table 2: Unit Area and Unit Volume Heat Loads for Different Temperature Differentials.

Temperature Differentials,°C	Heat Load for Unit Area, (kcal/m^2)	Heat Load for Unit Area, kcal/m^3
22	54.9	18.30
20	49.91	16.64
18	40.83	13.61
16	29.70	9.90

4. RESULTS OF THE STUDY

4.1 Heat Loads for Unit Area and Volume

Average heat load distributions per unit area and volume, which are obtained from the ratio of peak heat loads of buildings over total area or total volume, are given in Fig. 2. The arithmetical average and weighted average of this distribution are 62.1 kcal/m^{2}h and 54.9 kcal/m^{2}h, respectively. The arithmetical average and weighted average of heat load distribution per unit volume are 20.7 kcal/m^{3}h and 18.3 kcal/m^{3}h, respectively.

The numbers, areas and volumes of the dwellings that formed the database of buildings are different. As shown in Fig. 2, while the heat load per unit area ranges from 31.2 kcal/m^{2}h to 110.3 kcal/m^{2}h, the heat load per unit volume changes between 11.6 kcal/m^{3}h and 36.8 kcal/m^{3}h. The plots of area vs. unit area heat load, area vs. unit volume heat load and number of stories vs. unit area heat load are shown in Fig. 3 and Fig. 4, respectively, to be able to observe the effect of building geometry upon heat load on the basis of area. It can be observed from Fig. 3 that as expected, heat loads of buildings with smaller area are greater. On the other hand, it is also observed from Fig. 4 that greater heat loads are arisen in some of 3, 4 and 5 storied buildings. But, it is impossible to reach general conclusions from both graphs. The plot of Unit area heat loads vs. total peak load of buildings, shown in Fig. 5, is also inconclusive.

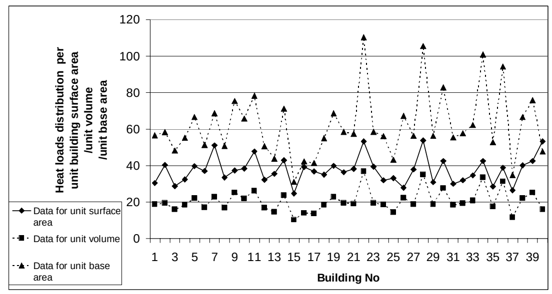

Figure 2: Distribution of heat loads of unit outdoor-flour areas and unit volume.

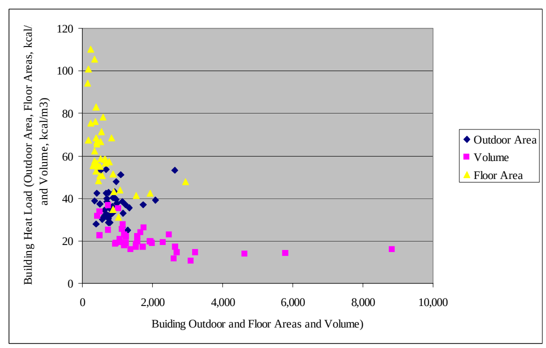

Figure 3: Change of heat load with unit area and unit volume, respectively.

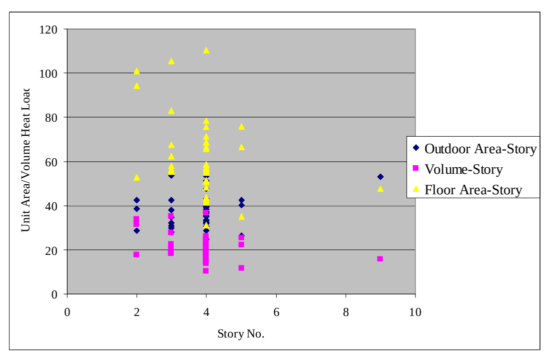

Figure 4: The relationship of outdoor area-story, volume-story and floor-story.

4.2 The Change of Unit Loads with Respect to Design Temperature Differential

If it is assumed that the peak loads in heat loss projects of the buildings are calculated on the basis of temperature differential of 22-0°C, as specified earlier, heat loads per unit area and unit volume for different temperature differentials are shown in Fig. 6.

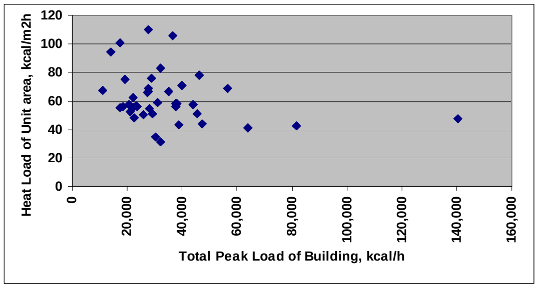

Figure 5: Distribution of unit area heat loads with respect to total peak load of building.

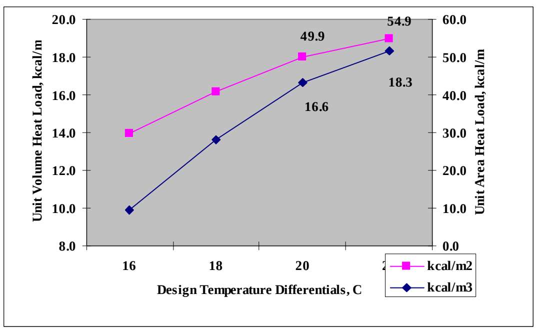

Figure 6: Change of unit area and unit volume heat loads with average design temperature differentials (Toksoy and Canakci, 2000).

4.3 Total Load

In case that climatic data are known, the change of heat load with time and total energy load could be directly calculated. According to temperature data of year 1993, Fig. 7 indicates heat load values and hours above 4715 kcal/h sublimit, which is calculated by subtracting 775 kcal/h of hot water load from the weighted average heat load (5490 kcal/h). In other words, if the heat design of dwellings is done by using weighted average heat loads per unit area without taking into account the hot water load, total loads will surpass the weighted average value of 5490 kcal/h in a total of 268 hours indicated in Fig 7, and therefore, the system will be insufficient. Although the majority of time when the system will be insufficient is in the 0-9 hour period during which hot water usage is low, the highly loaded hours in the living time period are too much.

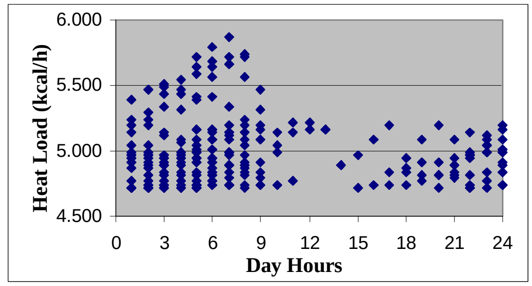

Figure 7: Change of calculated heat loads for 100 m² of the dwellings during day time (Toksoy and Canakci, 2000).

5. CONCLUSIONS

- Heat loads per unit area ranges from 31.1 kcal/m²h to 110.3 kcal/m²h, with a weighted average of 54.9 kcal/m²h, and standard deviation of the distribution is very high (17.9 kcal/m²h). Therefore, in geothermal energy system projects instead of calculated statistical values from the sampled building groups, the values obtained from heat loss projects should be taken into account.
- Heat loads per unit volume changes between 11.6 kcal/m³h and 36.8 kcal/m³h, with an arithmetical average of 20.7 kcal/m³h.
- The value of the weighted average load per unit area, 54.9 kcal/m²h does not contain hot water load of the dwellings.
- As seen from the Fig.7, instead of the weighted average value calculated from heat loss (5490 kcal/m²h), the value obtained by adding hot water load (775 kcal/m²h), 6265 kcal/m²h should be used in the analysis of total average loads. kcal/m²h

ACKNOWLEDGEMENTS

Authors express their gratitude to the manager of Balçova Jeotermal Ltd. Fasih Kutluay, his permission to publish is appreciated.

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