Requirements energy estimate of heating & cooling for a dwelling in the site of Tlemcen

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Abstract - *In order to utilise naturally stored heat or cold from the ground, seasonal temperature variations are required. The ground temperature, which is equal to the annual mean temperature, is then always warmer than the air temperature during winter and colder during summer. In the north of Libya the mean temperature difference between the coldest and warmest month is about 20 °C. In Algeria this difference is even greater, which is favourable.*

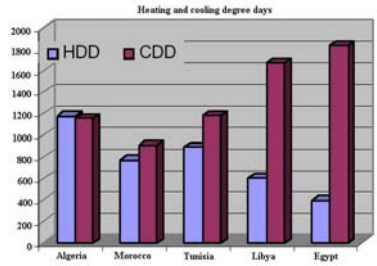

Fig. 1: Heating and cooling degree days in North African countries

The heating and cooling demand in northern Africa varies considerably in the different countries, with the greatest cooling demand in Egypt and the greatest heating demand in Algeria. In Algeria the heating demand is actually greater than the cooling demand, (Fig. 1). In this work, we are interested more particularly in heating or cooling energy requirement estimation for a good dwelling optimisation in the site of Tlemcen, (Fig. 1).

Keywords: Temperature measurements - Heat storage - Heating and cooling demand.

INTRODUCTION

The environmental and energy new preoccupations related to thermal comfort in buildings and the quality of air require on precise knowledge of temperatures and air movements inside buildings. In this context, we attempt to determine the energy needs for heating in winter and cooling in summer for a building in which the maintenance of an ambitious and acceptable interior temperature approaching: 15°C in winter and 25°C in summer.

In order to have a fuel consumption approximate estimation, which can be interesting to define the volume of storage of fuel or propane gas, it is necessary to know the annual requirements for heating. For this, several parameters are useful:

- Calorific losses of building (kW);
- The number of unified day degrees DJU;
- The intermittence or factor of intermittence;
- Fatal losses.

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The building

On the architectural plan the building is designed in the following way (Fig. 3) where the livable surface is of 165 m^2. It is necessary to take here into account, on the one hand the livable volume V_h (m^3), and on the other hand the volumic coefficient of loss G taking account of the thickness of the walls, materials used and the number of the openings (**Table 1**), [1].

Fig. 2: Geographical situation of the Tlemcen site

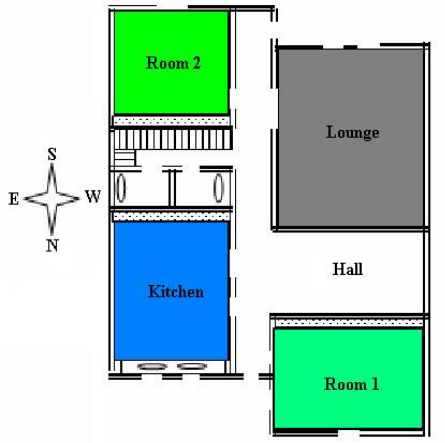

Fig. 3: Sight of the building plan

Table 1: Total losses

Losses	Lounge			Hall		Room 1		Room 2		Kitchen		Passageway		Bathroom	
	k	S (surface)	kS	S	kS	S	kS	S	kS	S	kS	S	kS	S	kS
Walls	3.5	62.1	217.3	36.4	127.4	52	182	50.2	175.7	52.9	185.15	52.4	183.4	31	108.5
Windows	5.8	6.8	39.5	11.2	64.96	4	23.2	5.9	34.22	8.7	50.46	32	185.6	4.2	24.36
Floor	4	35	140	20	80	25	100	25	100	30	120	15	60	15	60
Roofing	4	35	140	20	80	25	100	25	100	30	120	15	60	15	60
Total losses			536.36		352.36		405.2		409.92		475.61		489		252.86

Then the total sum of losses (for $\Delta T = 1°C$) of building is $P = 2921.75\ W/°C$, where the volumic coefficient G of loss:

$$G = \frac{P}{V_h} = 6.52\ W/m^3\,°C \tag{1}$$

After the total loss coefficient determination as well as the volumic coefficient G of loss and for simplifying the problem one considers primarily ***the daily ambient temperature average and the temperature on the ground*** such as they appear in the readings taken by the services of national meteorology during three years of measurement. The knowledge of these temperatures is necessary for an adequate dimensioning of the thermal photo generators, agricultural greenhouses and for the heating and cooling of the site. In order to determine the number of degree day of the site of Tlemcen, we present the results of a processing data methodology of the national office of the weather (three years results of measurement) [2].

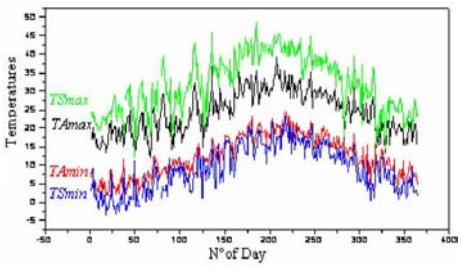

Fig. 5: Daily temperature variation (maximal and minimal) ambient and in the ground for Tlemcen site

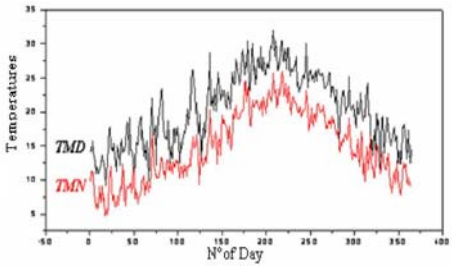

Fig. 6: Daily ambient temperature variation diurnal (TMD) and nocturnal (TMN) for Tlemcen site

According to the results of measurement shown in the figure 5, the difference between the maximum and minimal temperatures of the site of Tlemcen does not exceed 10°C whatever the season of the year. The knowledge of the daily ambient temperatures average takes a very significant role for the study of the insulation as well as the needs energy calculation for the heating in winter period or cooling in summer [3].

TMD: The daily average temperature ambient diurnal. TMN: The daily average temperature ambient nocturnal. (Fig. 6)

It is necessary to calculate the number of degree-days during all the year for our building which is located at Tlemcen with a volume of 448 m^3. The following table presents:

Table 2: Calculation of the monthly number of degrees – days (Dj)

Month	Ambient average temperatures	Dj for heating		Dj for cooling	
		15 °C	18 °C	22 °C	25 °C
January	10.43	-141.41	-234.41		
February	12.01	-83.54	-167.54		
March	13.9	-50.06	-127.88		
April	15.2	-24	-92.48		
May	17.89	-5.24	-33.82		
June	22.46			30.13	3.48
July	24.46			77.98	12.52
August	24.19			68.93	12.33
September	22.38			18.183	1.53
October	18.5	-12.91			
November	15.56	-19.13	-76.31		
December	12.95	-65.31	-156.54		

Although it is more difficult to take into account of the inhabitants thermal requirements in the building, do they agree not to use certain rooms in winter for the heating or summer for cooling ? Taking all into account, one can then evaluate:

$$C = 24 \times G \times V_h \times Dj \quad (2)$$

• Annual requirements in heating :

- For a temperature of comfort of 15 °C, October to May: Dj = 401.6 where C = 2815.33 kWh
- For a temperature of comfort of 18 °C, November to May: Dj = 888.98 where C = 6232.02 kWh

• Annual requirements in cooling:

- For a temperature of comfort of 22 °C, June to September: Dj = 195.22 where C = 1368.55 kWh
- For a temperature of comfort of 25 °C, June to September: Dj = 29.86 where C = 209.32 kWh

CONCLUSION

This project goal is to have buildings with surplus energy balance to maintain a stable interior temperature. The present study concentrates on the energy needs calculation for a building situated in Tlemcen, and which gave:

- Maximum energy requirements for heating is about 6232.02 kWh.
- Maximum energy requirements for cooling is about 1368.55 kWh.

In order to lead to low yearly consumptions, an objective accessible in the shorter term is to set up solids bases on the envelope (walls, grounds and roofs). In particular, it will be interesting to introduce the positive energy which fits fully in the current context of control of energy, use of renewable energies and sustainable development.

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