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Using Groundwater for heating purpose in Kirkuk /Iraq – Technical College

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Abstract: This research is the extension of the research (Studying the thermal performance of a Geothermal heat exchanger placed underground in Kirkuk city) [1] and was done to be compared with a result of the same research was conducted in the south of Iraq [2] to explore the differences in reading the temperature of the groundwater Because the soil in the south is a salty soil and the weather there is hotter than in the north of the Iraq. The basic element of the research is well of one hundred depth and PVC pipes long of 20 to 30 meters which was buried in the ground in order not dissipate the temperature of the flowing water to the atmosphere, a water pump to pump the water from the well to the outdoor unit inside the room, one way valve to control the flow rate of the water pumped by the water pump, a digital thermocouples to measure the temperature of the water at four places in the outlet of the well and inlet and outlet of the heat exchanger, also to measure the temperature of the surrounding air outside the room and the temperature of the air forced by the fan of the heat exchanger inside the room , the obtaining results were fascinating comparing to the previous mentioned research in the south, the advantages of this research is, it is environmental and healthy comfortable air for cooling and heating, the only disadvantage is the cost of digging a hundred meters well .

Keywords: Groundwater, Kirkuk, Geothermal, Heat Exchanger, Salty Water.

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1. Introduction

There are many types of research written about this subject especially in the hot places and cold places in the world where the electricity is hard to be supplied for them, therefore, the geothermal energy raised to be the alternative renewable energy instead off the conventional energy. Dr. Abdulkadum Jafar Alyasri [3] for example is one of the first pioneers in Iraq who conduct a research in the north of Iraq and have obtained great results. Another scientist in Egypt like Fargally et al 2010 [2]. make his study about using the geothermal energy for heating, and in Europe, Jon Are 2011 [4] study the performance of the heat exchanger under the ground. Fenlon et al. 2008 [5] held a theoretical study for facilities heating by using the geothermal energy in Tinian city in China.

Our study has been done in the north of Iraq, where the climate of this city is different than in the south. In this research the Geothermal [6] energy was chosen to the alternative of the fuel energy, because the temperature down in the earth is relatively constant, there is a change but big along the year, and because it is available, therefore we can use this good feature for cooling and heating, and so we choose a well which is located in the technical college in Kirkuk –Iraq. The well is one hundred deep, we measure the temperature on this depth in the winter and found it 23 C̊ in the noon, and the temperature of the atmosphere is 16 C̊, and this a perfect degree for heating. The

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building of our research chosen to be about thirty meters from the well and the pipe of conveying is selected to be polyvinyl chloride or PVC pipes they are cheap and available, the only disadvantage of pvc pipes they have very poor thermal of conductivity [7] those pipes were isolated and buried under the ground in order not to affected by the atmospheric temperature, the rooms dimensions is 9x6x4x m3, the heat exchanger where water should be circulated is selected to be a split outdoor unit, water salinity were tested in the laboratories and found nearly the same salinity exists in the drinking water which is 0.6 which will not cause any clog for the pipes.

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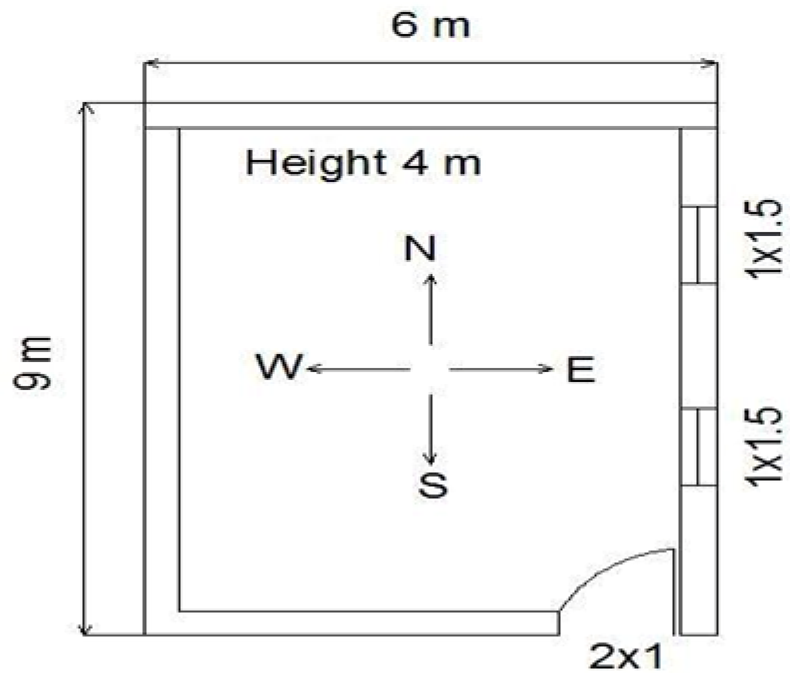
2. Literature review

1 - Rooms Thermal Load

The scheme below the dimension of the room where the research was applied



figure(1) shows the dimension of the room to conduct the research

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$T_{room\text{-}in} = 22\mathring{C}$

$T_{room\text{-}out} = 10\mathring{C}$

$H_i = 7.75\ w/m^2.k$

$H_o = 23.3\ w/m^2.k$

h_i : Surface of heat transfer

h_o: Coefficient of heat transfer

U : Over all heat transfer($w/m^2.k$)

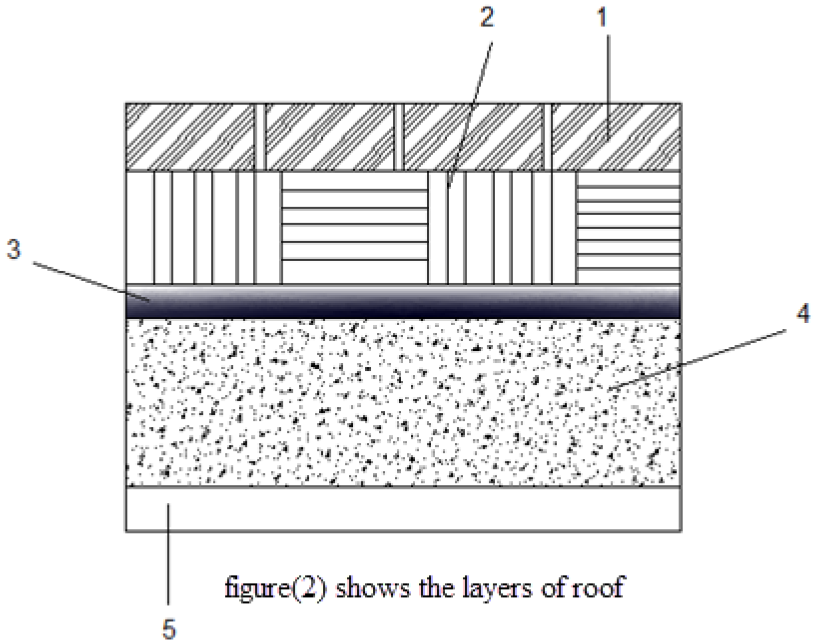
A : Surface Area (m^2)

ΔT_m : log mean temperature difference (c)

F ; face factor (correction factor)

2. **Roof of the room**

Figure (2) below shows the materials of roof components



figure(2) shows the layers of roof

1. Layer of 4cm Cement
2. Layer of 10cm of Soil
3. Layer of 1cm Asphalt
4. Layer of 15cm Concrete
5. Layer of 2cm Marble

$Q_{roof} = U.A.(T_i - T_o)$ --(1)

$U = 1/R_t = 1/\ 1/\ h_i + R_5 + R_4 + R_3 + R_2 + R_1 + 1/h_o$ ----------------------------- (2)

$w/m^2.k$ 2.174 =

$A = 9x6 = 54\ m^2$

$Q_{roof} = 1408.7$ w

3. Wall

Figure (3) shows the elements of wall components

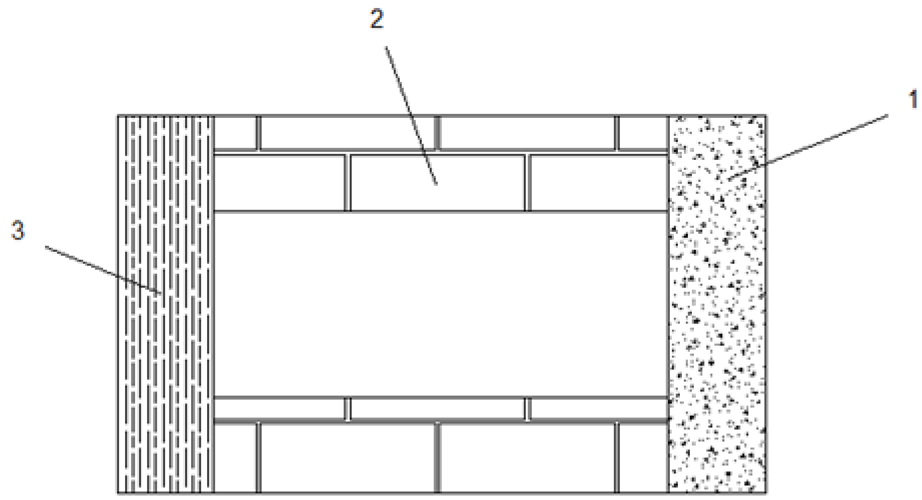


figure (3) elements of wall components

1.

Layer of
1. 2cm Marble
2. Block of 20cm width
3. Layer of 2cm Cement

a- North –Wall

$\mathbf{U = 1 / R_t = 1 / 1 / \ h_i + R_1 + R_2 + R_3 + 1 / h_o}$

= W/m^2.k 2.505

A= 6 x 4 = 24 m^2

Q = 721.44 W

b- <u>East -Wall</u>

U = 2.505 w/m^2.k

A= 9x4 – (2x1x1.5) = 33 m^2

Q = 991.98 W

The table (1) below shows the total thermal load for all the components of the room

NO	U $w/m^2.k$	A m^2	c (Ti – To)	Q w
Roof	2.174	54	12	1408.7
N-Wall	2.505	24	9	541.08
E- Wall	2.505	33	12	991.98
S-Wall	2.505	22	12	661.32
W-Wall	2.505	36	12	1082.16
Glass	4.49438	3	12	177.9775
Door	5.79844	2	12	139.1627
In filtration				2.6136

Table (1) thermal temperature load for each rooms components

c- - South -Wall

$U = 2.505\ w/m^2.k$

$A = 6x4 – (1x2) = 22\ m^2$

$Q = 661.32\ w$

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d- West-Wall

$U = 2.505\ w/m^2.k$

$A = 9x4 = 36\ m^2$

$Q = 1082.16\ w$

4. Glass

$U = 4.49438\ w/m^2.k$

$A = 2x1x1.5 = 3\ m^2$

$Q = 177.97752\ w$

5. Door

$U = 5.78944\ w/m^2.k$

$A = 1x2 = 2\ m^2$

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Q = 139.1627 w

6. Infiltration

V = room volume x air change per hr/ 3600

$V_{room} = 9 \times 6 \times 4 = 216\ m^3$

Air change = 1.5

$V = 0.09\ m^3/s$

Outside condition

$Td_i = 10$ C̊

$Tw_i = 5$ C̊

$W_o = 0.0034$ kg H2O / kg dry air

Inside condition

$Td_i = 22$ C̊

$Tw_i = 15.3$ C̊

$W_i = 0.0082$ kg H2O / kg dry air

$$Q_{infl-sen} = 1.22\ V\ (T_i - T_o)$$

= 1.3176w

$$Q_{infl-L} = 3000\ V\ (W_i - W_o)$$

= 1.296 w

$Q_{total-infl} = Q_{infl-sen} + Q_{infl-L} = 2.6136$ w

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7. Thermal load of water

The table (2) below shows the inlet and outlet temperature of the water to the heat exchanger

Water	
T_{in}	T_{out}
21.9	19.8
22.3	20
22.1	19.8
22.5	20.5
21.5	19.6

Table (2)

First reading:

Cp_w = 4.2 kj/kg

$Qw = m\ cp\ (T_{in} - T_{out})$

=3.4398kj/s

Second Reading:

Q_w = 3.7674 kj/s

Third reading :

Q_w = 3.7674 kj/s

Fourth reading:

Q_w = 3.276 kj/s

Fifth reading:

Q_w = 3.1122 kj/s

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8. Heat Exchanger

The table (3) shows all the important factor of the heat exchanger we need

K	292.22
D	2.4cm
Thick	3cm
F	0.8
L	20.5m

Table (3)

Table (4) shows different reading

Water		Air	
T_{in}	T_{out}	T_{out}	T_{in}
21.9	19.8	19.6	16.9
22.3	20	19	16
22.1	19.8	19	16
22.5	20.5	19.5	16.6
21.5	19.6	19	16.2

Table (4)

temperature for air and water

r_1 = 0,012 m

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Thickness = 0.6/100 = 0,006 m

r_2 = 0.012+0.006 = 0.018m

h_i & h_o

$N_u = h_i L/ k$

$N_u = 0.023 R^{0.8} Pr^{0.4}$

$R_e = 4m/3.14 D\mu$

11075 =

N_u = 34.3

h_i = 488 w/m^2.c

$R_e = \rho u do / \mu$

581 =

N_u = 41.5

h_o = 591 w/m^2.c

μ = 1.87 x 10^{-5} kg/m.s

The velocity of the air where measures by using anemometer, which is 3.02 m/s

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First reading:

$Q = U A \Delta T_m F$

$A_o = 2\pi r2 L$ = 2.31732 m^2

$A_i = 2\pi r1 L$ = 1.54488 m^2

$U = 1 / (1 / hoAo + \ln ro / ri /2\pi kL + 1 / hiAi)$

w/ m^2. k 904 =

1.5c

Q = 2094.8 w

Second reading:

U = 904 w/m^2.k

A = 1.5448 m^2

$\Delta T_m = 2.879c$

$Q = 4020.7\ w$

Third reading:

$U = 904\ w/m^2.k$

$A = 1.5448\ m^2$

$\Delta T_m = 1.4328c$

$Q = 2001\ w$

Fourth reading:

$U = 904\ w/m^2.k$

$A = 1.5448\ m^2$

$\Delta T_m = 2.76c$

$Q = 3854.5\ w$

Fifth reading:

$U = 904\ w/m^2.k$

$A = 1.5448\ m^2$

$\Delta T_m = 1.691c$

$Q = 2361.4\ w$

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4. Practical Part

Figure (4) shows the scheme of research and how the heat exchanger which exist in the room is connected to the well which far away about 30 m the figures also shows the location of the heat sensors between the well and the heat exchanger Figure (4) research's scheme

4-1 The main component of the research

a. Outdoor unit

In figure (5) shows the outdoor unit without the compressor which was used as a heat exchanger

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Figure (5) outdoor unit

4-2 PVC plastic pipes

In figure (5) shows the pvc pipes used in the research , it shows the pipes

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before burring them under ground.

Figure (5) pvc. pipes

4-3 water pump and flow meter

In figure (6) shows a regular water pump and flow meter to measure the flow rate of the water pumped by the motor

Water pump *Flow meter*

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Figure (5)

4 - 4 Measurement devices

a. Heat Exchanger Fan speed control

I n figure (6) shows ceiling fan speed control , it was used to control the speed of the fan of the heat exchanger to direct air to the pipes of the heat exchanger

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Figure (6) speed fan control

b. Heat sensors

I figure (7) shows the heat sensors which are they a digital thermo couples located in different places to measure the heat of the outlet and inlet temperature of the air and the water

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Figure (7) digital thermo couple

c. Manometer

A digital manometer in figure (8) is used to measure the velocity of the air pushed across the heat exchanger at different speeds by the fan

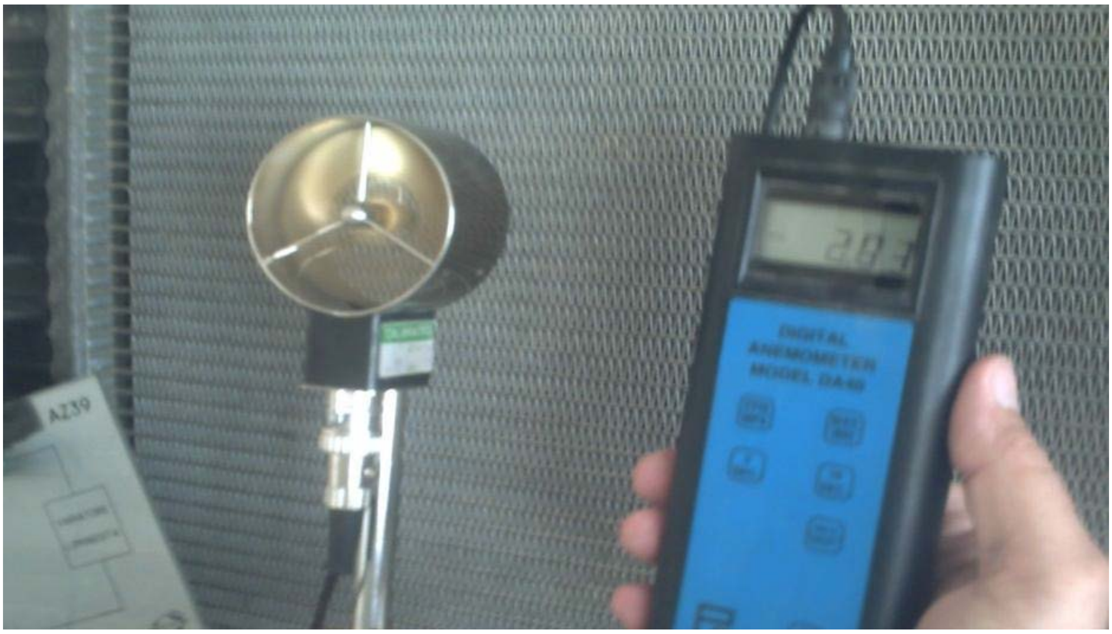

Figure (8) digital manometer place in front of the heat exchanger

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5. Results & Discussion Conclusion

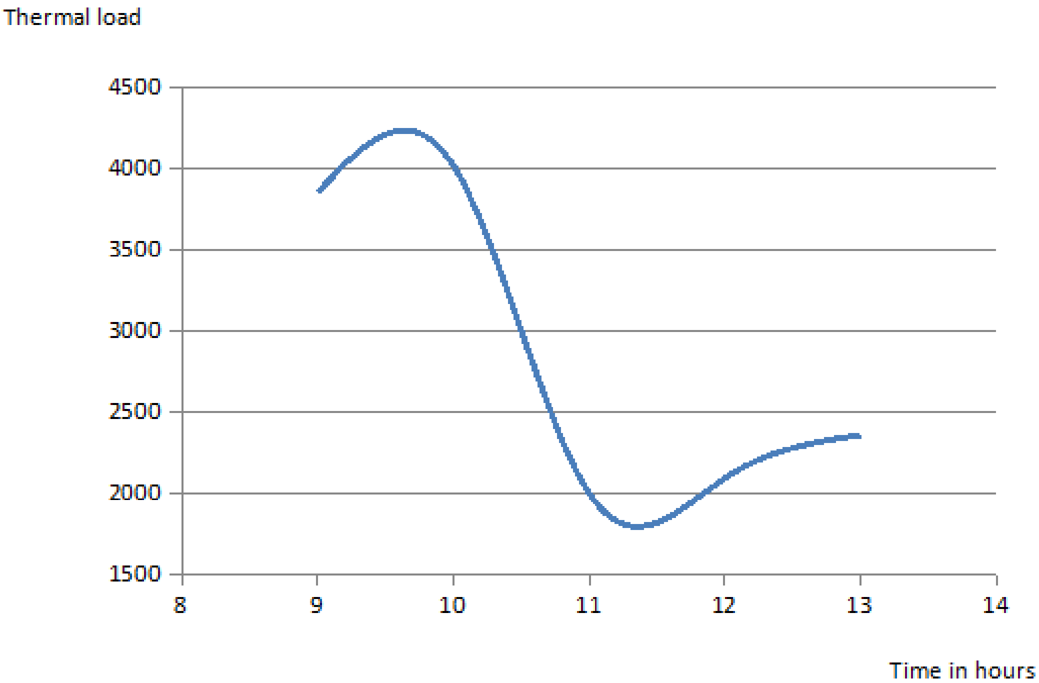
The temperature of the water in the well (Groundwater) and the atmospheric were measured in the winter season in January and, and it was found that the water of the well in the winter is very convenience cooling, as following:

Rate of Groundwater temperature in January on 100 m is equal to 23.7 C̊

Rate of atmospheric temperature in January in 16 C̊

The table (4) shows the thermal load for different time interval in winter

Time	Thermal load
9am	3854.5
10am	4020.7
11am	2001
12pm	2094.8
13pm	2361.48



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6. Conclusion

Groundwater represent a renewable energy for heating the facilities, where the design of the heat exchanger and calculating all the thermal loads, and all the practical measurement for temperature and the velocity of flow rate demonstrate the efficiency of the energy and as a secondary or helpful clean energy but not an alternative energy, moreover the results showed that it can be possible to use larger heating units in order to reach the best comfortable temperature in the winter.

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