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Research Article – Atmospheric Sciences

Assigning optimum time period for using evaporation cooling systems in Iraq

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Abstract

Increasing demand on electricity power during summer in Iraq because of increasing averages of temperature reached 47 ºC and continuous to increase and the problems facing Iraq is the increasing in peak load for the electrical system because of using cooling and air-conditioning operated by compressed gases, according it is obliged to search for alternative methods to activate electrical power consumption and one of solutions and processing is using application of cooling by evaporation (evaporation coolers) consumed less electrical and power compared with other cooling devices which provide power of amount (80%) and for what Iraq characterized by climate conditions such as scarcity of relative humidity among the research results, the general average of monthly average of relative humidity in Iraq during the summer season (the study period) for 36 years for the period (1980-2015) not exceeded (42%) as for the general average of the monthly average of temperature for the same period was higher average for it (31 ºC) and for these two elements are the core to identify the cooling efficiency, according Iraq is considered one of the good area to use the evaporation cooling applications, where the general average of monthly average of cooling efficiency for the same period was higher average(51%) and the optimum time period for using the evaporation cooling applications in Iraq in July at Salahddin city center with monthly efficiency average (60%).

Keywords: Temperature, Relative humidity, Evaporation, Efficiency, Iraq

Introduction

Every organismtries to adapt them self with the surrounding environment and to innovate what make the nature meet its requirements and increasing temperature during summer effects on daily human activity accordingly, he starts attempting for best methods to reach optimum cooling and air conditioning methods (Watt, 1986). Cooling is the science specialized with lowering temperature and retain it at low temperature from the surrounding temperature in the place intend to cool it and considered the most important requirements of life, as for air conditioning is control in air characteristics including humidity and temperature and distributing it in the place wanted to be conditioned (Palmer, 2002).

The evaporation cooling is considered as impeland active method and it is the ancient method used by man to air conditioning and to temperature change via cooling of air and moisture it by evaporation, and this method requires a great amount of power, and it is obtained via conversion the sensible heat air to potential power working to evaporate air, consequently leading to lowering air temperature to certain limits (Bucklin, 2000). The evaporation cooling method is considered one of the natural methods used by anumber of organisms to cool themselves, animals used them when going out of water to air, the plants in evaporation process-transpiration process, also man eliminating from excess temperature in his body as aresult of the biological processes by evaporation method of sweat leading to lowering his body temperature which is depending on the same idea of evaporation cooling (Essa, 2002).

The climate conditions such as increasing temperature drove human methods and means by cooling as a type of these solutions and treatments is using various technologies amongst evaporation cooling for the availability of comfort factors for human being and increasing the plant and animal production. As Iraqi climate characterized by vast range of daily and annual temperature for non-existence of water which increase temperature in summer which is hot and dry, also less and warm winds (Mosa, 1994). Where average of temperature in summer in Iraq between (26-47 ºC) and the relative humidity average not exceeded 60%, and these environmental and climate conditions of Iraq are not consistent with comfort criteria reached via a number of performed studies on human being, from which it has discovered that the optimum criteria of human comfort is when the dry temperature between (21ºC-28ºC) and relative humidity ranged between (40%-60%) accordingly using evaporation cooling technologies (evaporation cooling) in Iraq is considered the most common to cool buildings and provision of comfort factors, and it is used in poultry fields and some of agricultural utilities in dry areas (Aldulimi, 1990; Alonso *et al.*, 1998; Ahmad *et al.*, 2013; Liao and Chiu, 2002; ASHRAE, 2000; Al-badri, 2009; Mosa, 1986; Al-samaraee, 2008; CLIMAS, 2004; FAO, 1999a; FAO, 1999b; Bothcher*et al.*, 1991; Wallace and Hobbs, 2006; Al-samararee, 2008a).

There are three evaporation cooling methods and two systems

A- Evaporation cooling method (Alonso *et al.*, 1998; Ahmad *et al.*, 2013)

1. Direct evaporation cooling (open circuit) DEC
2. Indirect evaporation cooling (close circuit) IEC
3. Cooling in two stages

B- Evaporation cooling system (Liao and Chiu, 2002)

1- Cooling system with spray and fog
2- Cooling system with fans and cooling pads and the most

common evaporation systems in Iraq is the evaporation cooler.

The reason behind being familiar of these evaporation associated with a number of reasons (ASHRAE, 2000).

1- Provide electrical power reaching 80% and this is considered currently good percentage in Iraq because of the problems facing it represented by decreasing in electric power provision.
2- Considered friend to the environment for not using harm gases compared with other cooling systems.
3- Cheap and easy maintained.
4- Iraqi climate conditions including temperature and relative humidity for their work for the evaporation cooling efficiency increases as the temperature is higher and the relative humidity is less.

Work of these systems is affected by a number of factors effect on their efficiency amongst:-

- Design factors such as the type and thickness and mass also cost of filling
- Operating factors such as average of water drainage and air speed outside from evaporation cooling system (Al-badri, 2009)
- Climate factors such as relative humidity and temperature and they are the most effective factors on cooling efficiency of evaporation systems (Mosa, 1986)

Iraqi climate is characterized by, in general, decrease of relative humidity averages not more than 60% because of broaden of desertification areas and most of the agricultural areas lost their productive ability and scarcity of natural plants also scarcity of rain and dry air (Aldulimi, 1990).

Relative humidity is divided globally as follow (Al-samaraee, 2008b)

100%-80% high humidity
80%-65% wet
65%-50% medium wet
Less than50% low wet

There are a number of factors led to difference in special and time relative humidity are: (FAO. 1999a; FAO. 1999b; CLIMAS, 2004).

1. Fixed local factors
   A. Water spaces
   B. Plant cover
2. Dynamic factors
   A. Low air
      1. Low temperature
      2. frontal downs
   B. Air Heights

Iraqi climate is characterized in summer in severe increase in temperature degrees. which increases this temperature is coupling with high humidity in which the human being during high humidity feels that the temperature degree is more than its actual temperature due to decrease of evaporation process in human body (Aldulimi, 1990).

Temperature degree is regarded the second factor which affects the systems efficiency of cooling by evaporation because of its direct effectiveness upon the other elements of the climate that affect relative humidity and its differentiation during day time in which relative humidity average will be higher than the time before sun rise because of reduction of temperature degrees and less effect after noon because of the increasing in average s of temperature degrees. The higher the temperature and the lower the humidity, the more cooling efficiency will be Temperature degree affects average s of evaporation when the existence air over any bodies of water contains little humidity , the average of evaporation will be great because of increase in a capacity of the air which leads to increase of quantity of required water evaporation to saturate the certain size of air , then the humidity will be reduced , but when the air is cold and consists of great quantity of humidity it will lead to reduction in the average s of evaporation (Wallace and Hobbs, 2006).

There are several factors affect temperature degree as in the following points (Al-samararee, 2008b):-

1. Distribution of land and water.
2. Terrain
3. Type of the wind blowing
4. Location regarding latitudes
5. Vegetation

Because of geographical and climate varieties of the regions of Iraq and the differentiation of averages of temperature degrees and relative humidity from one region to another from time to time;therefore the research is made to identify the best time of the periods for working of cool systems by evaporation in Iraq .

Material and Methodology

The study includes the whole Iraq country. Europe – center data were used in this study by taking the monthly average of daily average for both elements; temperature degrees (T) and dew point(Td) within height of two meters (2M) from the surface of the earth for the period from month of April -spring equinox - till month of September – autumn equinox for the period of (36) years from the year (1980 till 2015).

Meanwhile, we used panoply program in order to open the data and files of Europe – center and (Microsoft Excel) program to separate plenty of data and treat them after using origin program for maps drawing for cooling efficiency in which we identify though it the best time period to use cooling through evaporation in Iraq .

The calculation for cooling efficiency was made through the following equation (Bothcher*et al.*,1991):

$$\eta = \frac{To - Tin}{To - Td} \times 100 \qquad \ldots\ldots\ldots (1)$$

Whereas:

η: Cooling Efficiency (%)
T_o: Outside air temperature degree (°C)
T_d :Dew point (°C)

Tin: Air temperature of external air from the cooler (°C) which was extracted from specified tables made by the manufacturer of the coolers. We selected (6) six table for six companies randomly. Then taking general average for theses tables in which every company makes its own practical account of air temperature degree which comes out from the cooler that they manufacture depending upon cross section of relative humidity and temperature of the air entered into the cooler .

Results and Discussion

The general average for monthly average for cooling efficiency for each month of the months of the study with the months of summer season (April May , June , July, August and September) for (36) thirty six years for the period of (1980 – 2015)as it is illustrated in the fig. 1.

The general average for monthly average of cooling efficiency with the general average for monthly average of relative humidity and the general average for monthly average of cooling efficiency with the general average for monthly average of temperature degree for six months (April, May , June , July, August and September) for (36) thirty six years for the period of (1980 – 2015)as it is illustrated in the fig. 2 and 3 respectively.

Also the monthly averages of cooling efficiency for six months (April, May , June , July, August and September) for (36) thirty six years for the period of (1980 – 2015)as it is illustrated in the figs. (4,5, 6,7 ,8 and 9) respectively.

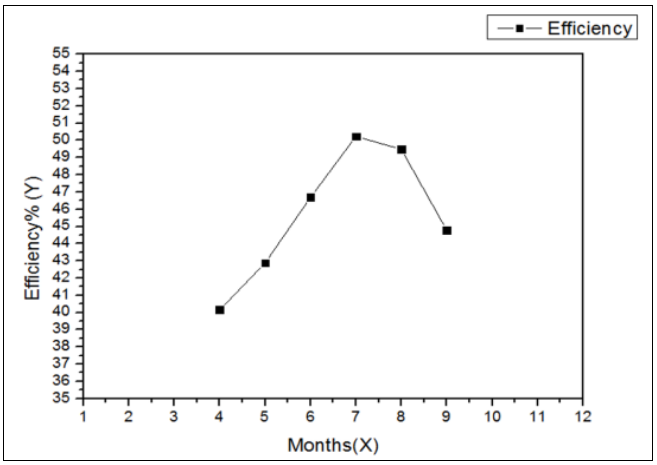

Fig. 1. represents the relationship between general average of monthly average for cooling efficiency for each month from months of the study along with months of summer season (the months of the study) (April, May, June, July, August and September) for the period of (36) thirty six years (1980 – 2015).

The figure illustrates that the general average for the average of monthly efficiency starts in increasing gradually from month of April in which recorded the less average of efficiency (40%) till reaching the highest degree in month of July with an average of (51%) , then return after that to decrease during months of August and September.

The figure illustrates that the general average for the average of monthly efficiency starts in increasing gradually and in the same time general average of relative humidity starting in reduction, then the general average of efficiency starts in reduction with increase the general average of relative humidity for the same time period. The highest rate of general average for efficiency is (50%) against general average of relative humidity about (24%). The less general average for efficiency is (40%) against average of relative humidity at (42%). This means that the relationship is reverse between cooling efficiency and relation humidity.

The figure illustrates that the general average for the average of efficiency starts in increasing gradually with increase of general average of temperature in the same time period. Then the general average of efficiency starts in reduction with the reduction of temperature degrees in the same period and time The highest general average of the efficiency is (50%) in month of July against general average of the temperature of (31°C) for the same period. The less general average of efficiency is (40%) in month of April against less general average of temperature about (19 °C) for the same period This means that the relationship between cooling efficiency and temperature is positive relationship.

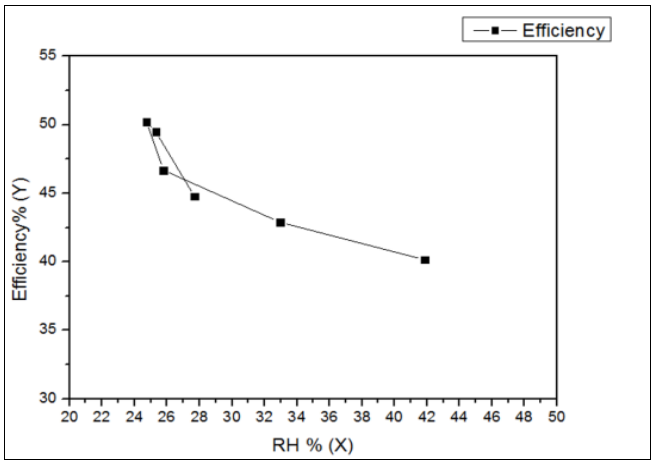

Fig. 2. represents the relationship between general average of monthly average for cooling efficiency for each month from months of the study with general average of relative humidity (RH) for each month of the study (April, May, June, July, August and September) for the period of (36) thirty six years (1980 – 2015).

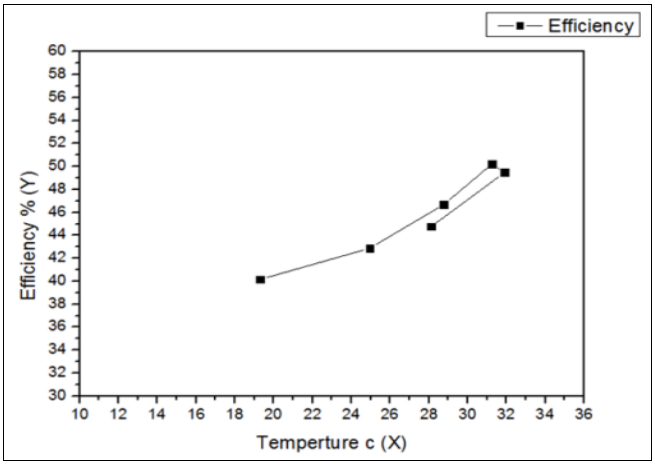

Fig. 3. represents the relationship between general average of monthly average for cooling efficiency for each month from months of the study with general average of the temperature for each month from months of the study (April, May, June, July, August and September) for the period of (36) thirty six years (1980 – 2015) .

Fig. 4 represents the monthly average of the efficiency for April show that average of the efficiency in City Centre of (Al-Qadisiyah) was (55%), that represent upper average of efficiency, in City Centre of (Al-Muthana, Nainawa and Wasit) was (50%), in City Centre of (Najaf and Maysan) was (45%), in City Centre of (Basra, Karbalaa, Baghdad, Babil, Diyala, Al-Tameim, Sulimaniyah, and Erbil) was (40%), in City Centre of (Thi-Qar and Saladdin) was (35%), and in City Centre of (Anbar and Dihook) was (30%), this represent lesser average of efficiency.

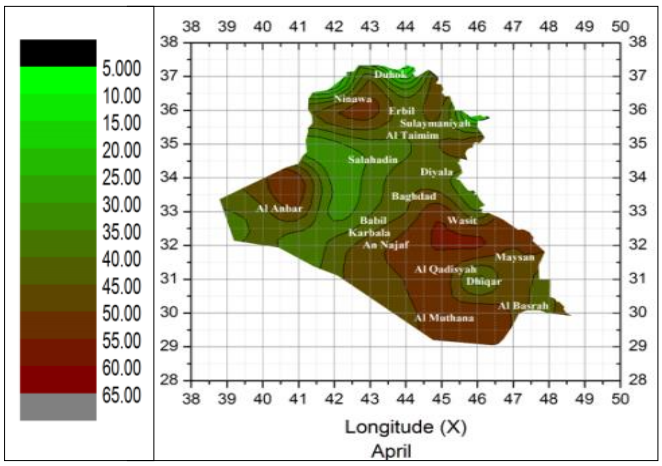

Fig. 4. The monthly average of the efficiency for month (April) for 36 years from (1980-2015).

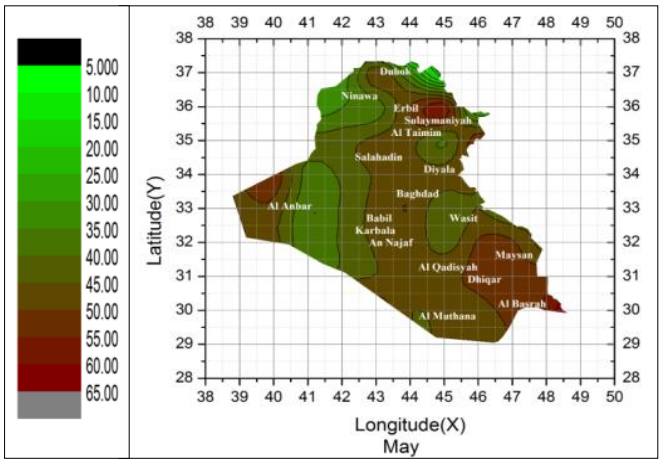

Fig. 5. The monthly average of the efficiency for month (May) for 36 years from (1980-2015)

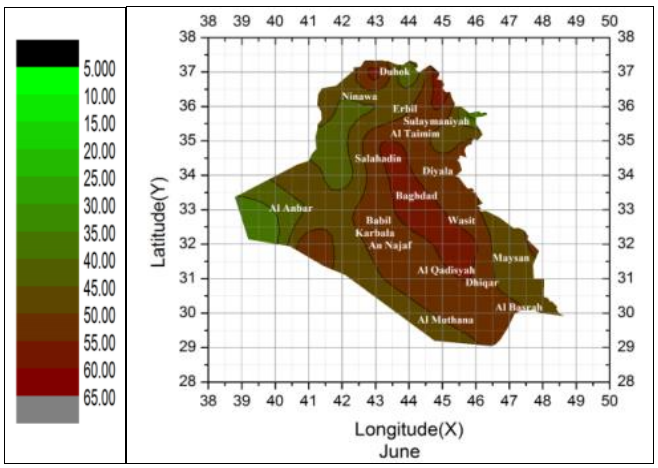

Fig. 6. The monthly average of the efficiency for month (June) for 36 years from (1980-2015).

Fig. 5 represents the monthly average of the efficiency for May show that average of the efficiency in City Centre of (Basra and Thi-Qar) was (50%), that represent upper average of efficiency, and in City Centre of (Maysan, Al-muthana, Al-qadisiyah, Najaf, Babil, Baghdad, Diyala, Saladdin, Erbil and Al-tameim) was (45%), in City Centre of (Karbalaa, sulimaniyah and Wasit) was (40%), in City Centre of (Nainewa and Al-anbar) was (35%), in City Centre of (Dihook) was (30%), this represent lesser average of efficiency.

Fig. 6 represents the monthly average of the efficiency for June show that average of the efficiency in City Centre of (Babil, Baghdad and Thi-Qar) was (55%), that represent upper average of efficiency. And in City Centre of (Al-Tameim, Al-Muthana, Najaf, Diyalah, Wasit, Salahddin and Dihook) was (50%), in City Centre of (Basra, Maysan, Karbalaa, Al-Qadisyah, Al-Anbar and Erbil) was (45%) and in City Centre of (Sulimaniyah and Nainewa) was (40%), this represent lesser average of efficiency.

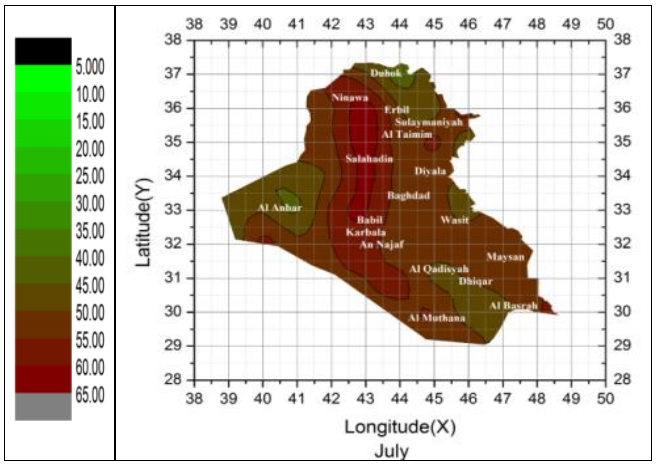

Fig.7. The monthly average of the efficiency for month (July) for 36 years from (1980-2015)

Fig.7 represents the monthly average of the efficiency for July show that average of the efficiency in City Centre of (Salahddin) was (60%), that represent upper average of efficiency. And in City Centre of (Najaf, Nainawa and Karbalaa) was (55%) and in City Centre of (Basra, Maysan, Al-Qadisiyah, Al-Muthana, Thi-Qar, Al-Anbar, Sulimaniyah , Al-Tameim, Diyala , Babil and Baghdad) was (50%), in City Centre of (Erbil, Wasit, and Dihook) was (45%), this represent lesser average of efficiency .

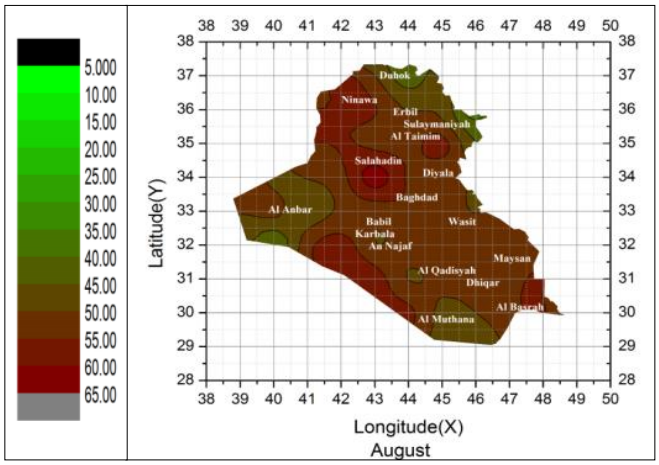

Fig. 8. Average of monthly efficiency for month (August) for 36 years from (1980-2015).

Fig. 8 represents the monthly average of the efficiency for August and show that average of the efficiency in City Centre of (Salahddin, Basra and Nainawa) was (55%), that represent upper average of efficiency. And in City Centre of (Najaf, Al-Tameim, Karbalaa, Babil, Baghdad Thi-Qar, Maysan, Wasit, Diyalah, Anbar was Al-Qadisiyah) was (50%), and In City Centre of (Erbil, Dihook and Al-Muthana) was (45%), in City Centre of (Al-Sulimaniyah) was (40%), this represent lesser average of efficiency

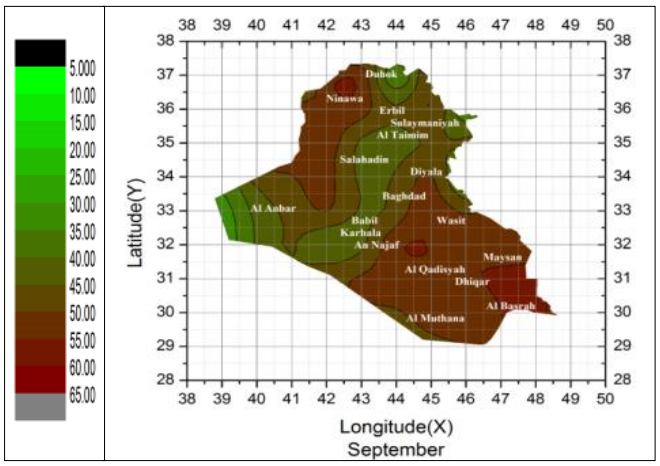

Fig. 9. Average of monthly efficiency for month (September) for 36 years from (1980-2015).

Fig. 9 represents the monthly average of the efficiency for September show that average of the efficiency in City Centre of (Basra and Al-Qadisiyah) was (55%), that represent upper average of efficiency. And in City Centre of (Al-Muthana,Thiqar, Maysan, Wasit, Najaf, Anbar and Nainawa) was (50%) , in City Centre of (Babil , Diyalah and Baghdad) was (45%) , in City Centre of (Sulimanayah, Erbil , Salahddin, Al-Tameim,Karbalaa and Dihook) was (40%),this represent lesser average of efficiency.

Conclusions

1. The highest general average for monthly average for temperature degree is (31°C) at the month of July. The less general average for monthly average of temperature degree is (19 °C) at the month of April.
2. The highest general average for monthly average for relative humidity is (42%) at the month of July. The less general average for monthly average of relative humidity is (24%) at the month of April.
3. The highest general average for monthly average for cooling efficiency is (51%) the month of July.The less general average for monthly average of cooling efficiency is (40%) the month of April.
4. The highest for monthly average for cooling efficiency in Iraq during summer season was at month of July in the city center of Salahuddine with an average of (60%).The less for monthly average of cooling efficiencyin Iraq during summer season is at the month of (April and May) in the city center of (Dihook and Anbar) (Dihook) respectively with an average of (30%) .
5. In general, Iraq is regarded very suitable for using applications of cooling by evaporation.

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