ISSN: 0976-3104
SUPPLEMENT ISSUE
Zangeneh and Karimi.

ARTICLE OPEN ACCESS

ARCHITECTURE FACULTY DESIGNING BY THE USE OF EVAPORATION COOLING SYSTEM BY RELIANCE ON THE SPRING HOUSE MODEL TO REDUCE THE ENERGY CONSUMPTION

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ABSTRACT

Today the environmental pollution danger, energy consumption saving and stable development are changed to the important and frequent issues at the international level. Of the important solutions to deal with these issues is the conform designing with the climate. Because the main part of Iran land is located in the warm and dry weather, the need for the space cooling has high importance, also using the cooling stable systems in Iranian architecture has the old background, as in the traditional buildings, different elements are used in the thermal comfort providing. One of these techniques is the spring house. On the other hand agitation in the architectural training space and avoiding the student mental concentration in architectural designing learning is considered as the main subject of discussion in the architecture training. As the result the necessity to improve the training space and improving the architects toward the architectures which is adaptive to the country climate has led to designing an architectural faculty in the dry and warm climate by the use of efficient element of spring house to make thermal comfort and increase of training space quality. This research at first collected the related information in accordant to warm and dry climate and spring house and training space by the laboratory studies, then bythe fieldstudying method and by the use of temperature and humidity measurement, the spring house different data logger points are evaluated. According to the obtained results from this study, application of spring house in the complex designing will provide suitable model to inspire the architecture students to obtain the climate designing in addition to energy consumption reduction in high degree and providing the comfort climate condition.

Published on: 12st- Aug-2016

KEY WORDS

Architectural faculty, passivecooling system, spring house

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INTRODUCTION

The physical environmental climate and mental condition have inevitable effect on the building designing that based on the cold and warm condition, they are taken in to consideration. The building natural systems designing will assist the energy consumption saving according to the natural energies usage as the wind, sun, etc. in addition to make comfort condition in the environment. The Iranian traditional architecture in the desert regions has the deep background in different aspects. Evaluation of these specifications could be assigned in the programming, designing and popularization of the modern life environment [1].

The main purpose
Application of the renewable energies which is obtained by the spring house cooling and ventilation system lead to the energy consumption reduction in the warm and dry climate architectural faculty designing

The detail targets
By realization of the spring house system and proving the proper bed with the similar application through using the new technology in reliving the spring house in the training space, the environmental and mental comfort is provided in the climate.

Information gathering method
This research first is prepared by the use of laboratory studying in the relation with the climate and spring house and modern training spaces and then by the use of field studying method and based on the observations by the use

THE IIOAB JOURNAL
ISSN: 0976-3104

of humidity and temperature measuring tools, the spring houses are evaluated that such process is done frequently 3 times every day and after the note taking, the obtained scores are modeled by the software and finally the standards are provided that by the use of these scores we can proceed to reduce the energy consumption. In this research to measure the humidity and temperature, the data logger instruments are used and finally the Energy plus software or the design winder is applied to model these data.

The research method

Because the main purpose of this research is to evaluate the practical knowledge development in the special field, and from the purpose it is categorized in the practical studies cluster. The information gathering method at first is the laboratory method and then in the second phase it is the field study. The variables include the architectural factors in the architecture faculty as the independent variables and the applied variable of spring house to reduce the energy consumption is considered as the dependent variable. This research is the correlated type research. To respond to the research questions, data logger was realized as the most proper tool to collect data.

MATERIALS AND METHODS

Types of passive systems

The passive systems are considered as the most practical methods that are applied in the building thermal provision without using the fossil energies and mechanical power and by applying the renewable energies source like sun, wind and etc. [2], the passive systems are divided in to two categories of cooling and heating systems that in this research the applied cooling systems is intended, the passive cooling system itself includes the cooling through the ventilation , vaporization cooling and reflection cooling that in this research the evaporation cooling systems are discussed [3].

The vaporization cooling systems specifications

The vaporization cooling systems is categorized as the cooling systems that due to the low price, low maintenance cost and proper application have wide use in the warm climate. The vaporization cooling system compared to other cooling systems is described as below[4].

- Low energy consumption compared to compressing cooling system (about 1/4) and its accessibility that cause the energy consumption reduction and the fossil fuel consumption deceasing
- Using water as the coolant that due to safety and accessibility is one of the vaporization systems benefits
- The vaporization cooling systems simple construction and lack of necessity to design and construct with complexity and as the result avoiding the high costs
- Proper price and low maintenance compared to compression coolant systems.

The vaporization cooling system relation with the necessity of its application in the architecture faculty

The Iran traditional architecture without the using the modern technology managed to provide the safe region in every climate,[5], In the modern societies the Iran traditional principals that is due to the stable architecture is forgotten and because the architecture faculty has the duty to train the architecture training, the form and its essences should also be the representation of its duties and it is better that its essence and form is regarded as the model and lesson for young architects, [6]. The necessity to apply the architectural correct principal to make cooling space and on the other hand architects tendency toward the past stable architecture that is matched with the climate has led that in this faculty the efficient and prominent element of spring house is used in the warm and dry climate of Shiraz city to make space cool.[7]

The traditional architecture elements to make stable cooling system

According to matter, that the Iran land is categorized in the warm climate, the land traditional architecture has more important and the traditional architects has used various architectural elements in making comfort stably. [8], assumed that of these elements we can point out to the spring house, wind louver, trench, garden and central yard that is intended in this research.

Spring house

The spring house is the covered space with the pool in the middle that is usually at higher level and it takes light from the roof. The innovation and establishment of pools in the dry and warm regions is due to freedom from hot weather in summer and it is the result of the local talent architects. The spring house performance was on a way that through the water spraying by the fountain, it caused the cool atmosphere in the place and in some of the spring house, by building the wind louver in high stature at the end of the building, the cold air was entered to the spring house, [9].

ISSN: 0976-3104

Spring house typical specifications

- from two to four rooms were constructed around the pool that was connected to the spring house by the wooden doors
- the rooms' floor was at higher lever about 1 meter from the springhouse space
- the spring house light was provided by the windows and sometimes the roof holes
- the openings toward the yard [**Figure- 1]**.

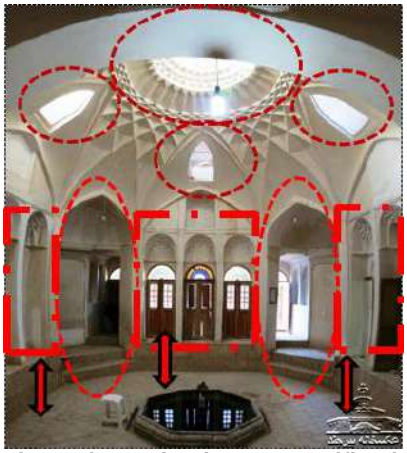

Fig: 1. the spring house specification

Analytical sample introduction

One of the Shiraz city historical regions is the Black Stone region. In the Black Stone region, there are 3 houses among the Qhajar era traditional buildings which have spring house. In this research among these houses, Foroqh Almolk was selected due to having required conditions of building and in order to analyze and measure the humidity and temperature.

Foruqh Almolk house

The forouqh almolk house is belonged to the late Qhajar era and one of the Shiraz old textures is the Black Stone region and it is located at the Bi Bi Dokhtaran shrine. The Forough Almolk building was established in 1930 by Forouqh Almolk Qhavami in the land at the area of 1020 square meters. This structure was built for the inhabitance purpose in three steps of underground, the surface and the first step and it has two sections of internal and external parts with two separate yards and the alcove, spring house, bath and kitchen. The external part was the living place for family and the internal part was considered for the servant use. One of the most magnificent parts of this building is the beautiful spring house that is located in the west north corner. The spring house plan has the eight angled shape and also the pool is located at the center in the form of octagonal shape. This spring house has two alcoves with two pillars and it has connected the external part to the internal part.[**Figure- 2]**.

Fig: 2. Foruqh Almolk house

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Analysis of Foruqh Almolk spring house

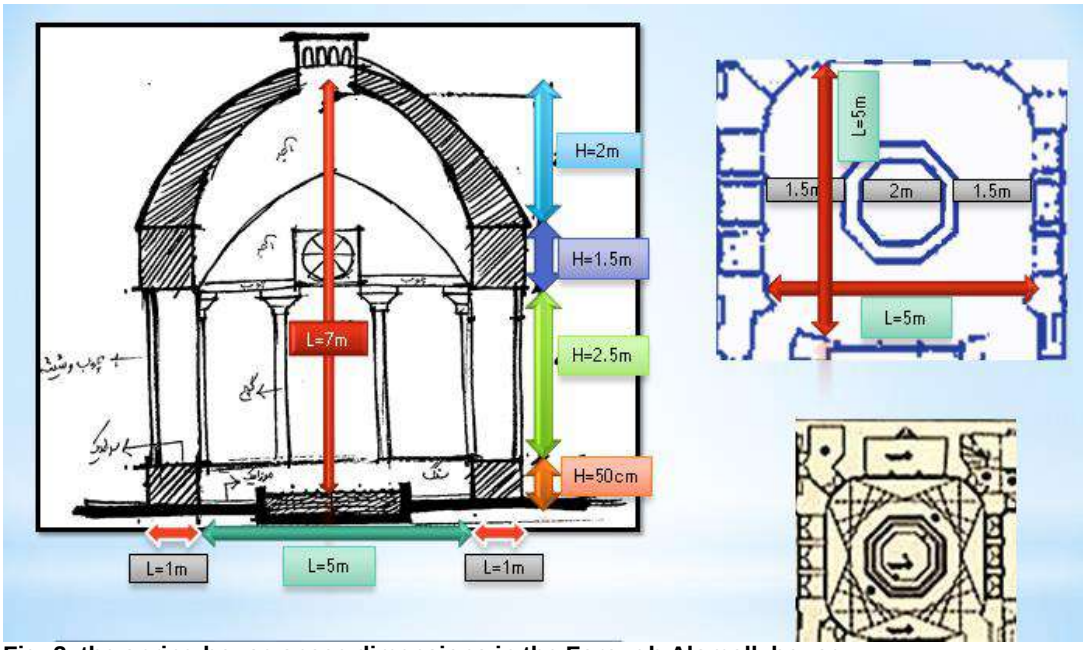

Fig: 3. the spring house space dimensions in the Forouqh Alomolk house

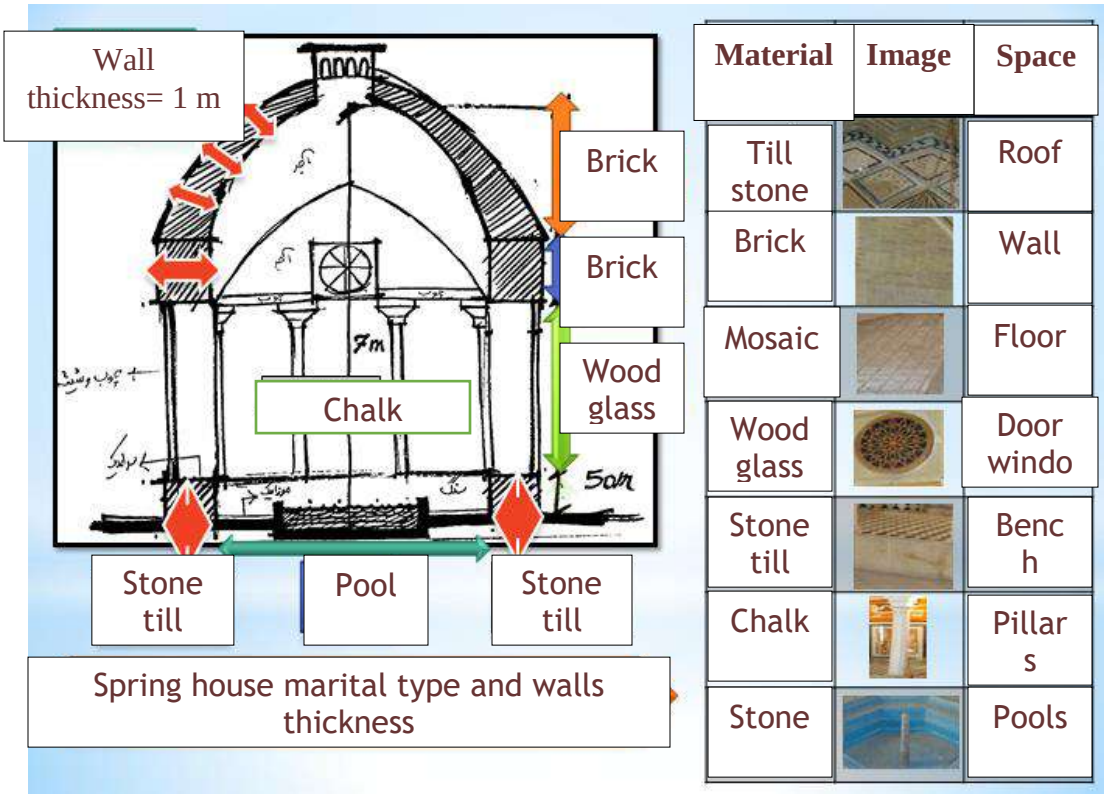

Fig: 4. the applied materials in Forouqh Almolk spring house

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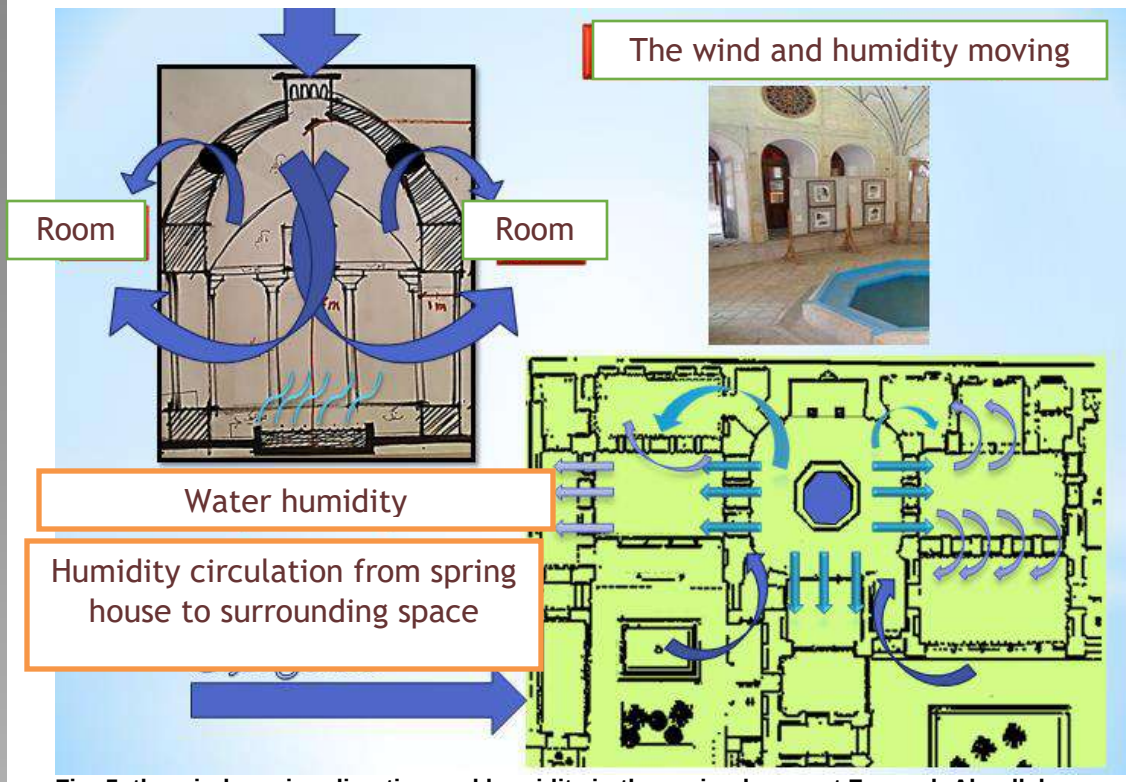

Fig: 5. the wind moving direction and humidity in the spring house at Forouqh Almolk house

The working method

The working method is done by the data measuring during two days by the temperature and humidity at the same level and every 3 days once the process is repeated.. As in the first day the humidity and temperature is evaluated in three times at morning, midday and evening with empty pool and then in the second day with the full pool and again in three steps in selected points the evaluation is done in different parts of spring house,[**Figure- 6]**, the data measuring method for the humidity and temperature is done by the data logger instrument. The using method of this instrument is one a way that it must be located in the stature within 1.5 meters and without any contact with hand, the temperature and humidity is measured in different parts of plan[**Figure- 7].**

Fig: 6. the full and empty pool in the Forouqh Almolk

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Fig: 7. the applied instrument to measure the temperature and humidity

Arrangement of points for measuring temperature and humidity in the spring house and the spaces around it

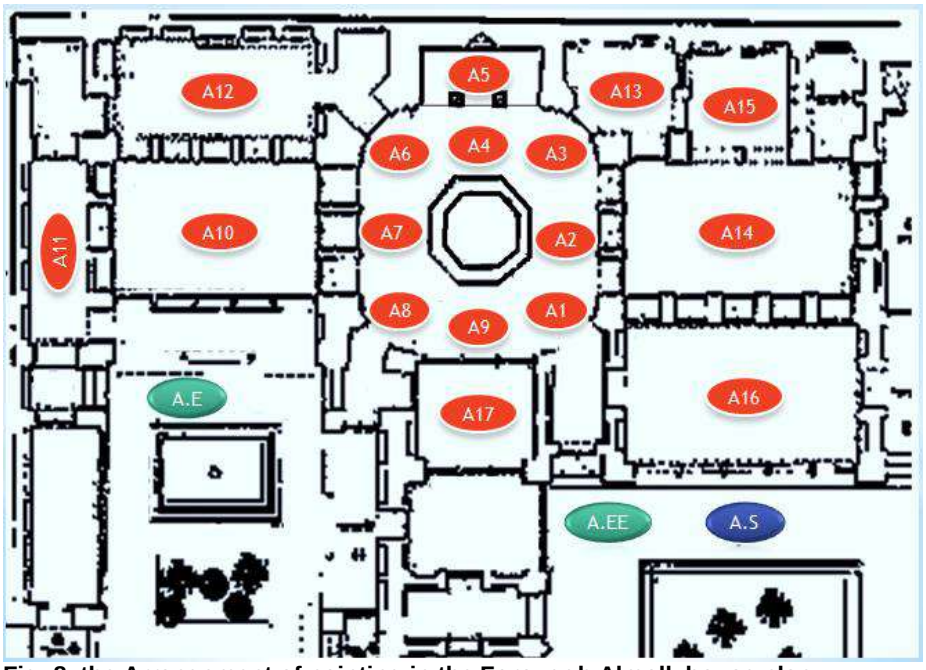

Fig: 8. the Arrangement of pointing in the Forougqh Almolk house plan

The weather condition in the spring house measurement days

Table: 1. the Shiraz city temperature and humidity condition in the measurement days

First day: the measurement with empty pool					
Date of measurement		month	Weather condition	Temperature in aerology	Humidity in aerology
AD	2015/10/14	January	Sunny	7-15c	24-26 RH
Helical	1393/10/24	Day			

Second day: the measurement with full pool					
Date of measurement		month	Weather condition	Temperature in aerology	Humidity in aerology
AD	2015/10/16	January	Sunny	8-16	25-28 RH
Helical	1393/10/26	Day			

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ISSN: 0976-3104

Temperature data comparison and analysis

1-Analysis and comparison of temperature rate in the morning

Table: 2. temperature data in different points of spring house with full and empty pool, in the morning

	Points and hours	First day	Second
	External yard-going	Empty pool	Full pool
		8.3	8
3	A1- 8:28	11	7.5
4	A2- 8:29	10.5	8.1
5	A3- 8:30	10.2	8.3
6	A4- 8:32	9.5	7.3
7	A5- 8:33	9	7.5
8	A6- 8:34	9.5	7.7
9	A7- 8:35	9.7	7.6
10	A8- 8:35	10	7.2
11	A9- 8:37	9.7	7.3
12	A10- 8:38	10	8.7
13	A11- 8:39	9.3	7.4
14	A12- 8:40	9.6	7.8
15	A13- 8:41	9.3	7.8
16	A14- 8:42	9.3	7.8
17	A15- 8:45	9.1	8
18	A16- 8:47	9.6	8.2
19	A17- 8:50	9.7	8.3
20	Internal yard	8.8	7.3
21	External yard-return8:53	9.6	8.3

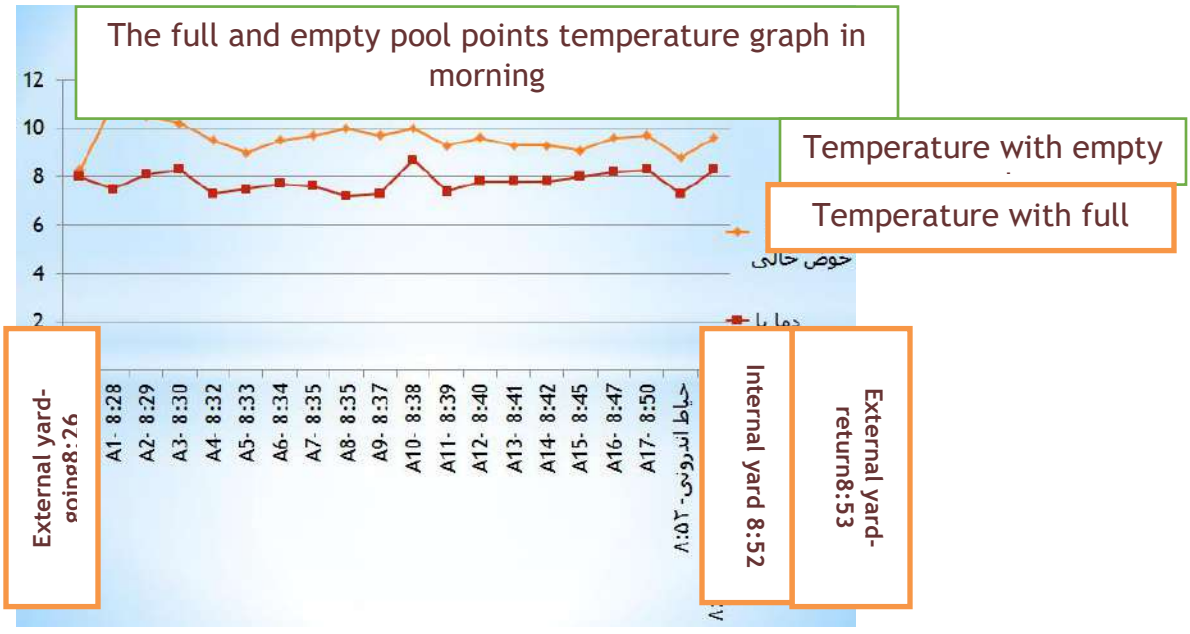
Morning

Between hour 8:30 to 9

Shiraz aerology
First day: 8c
Second day: 7c

Forouqh almolk
Empty Pool temperature average: 9.5
Full pool temperature average: 7.5

Graph: 1. the obtained graph from the above table data, in the morning



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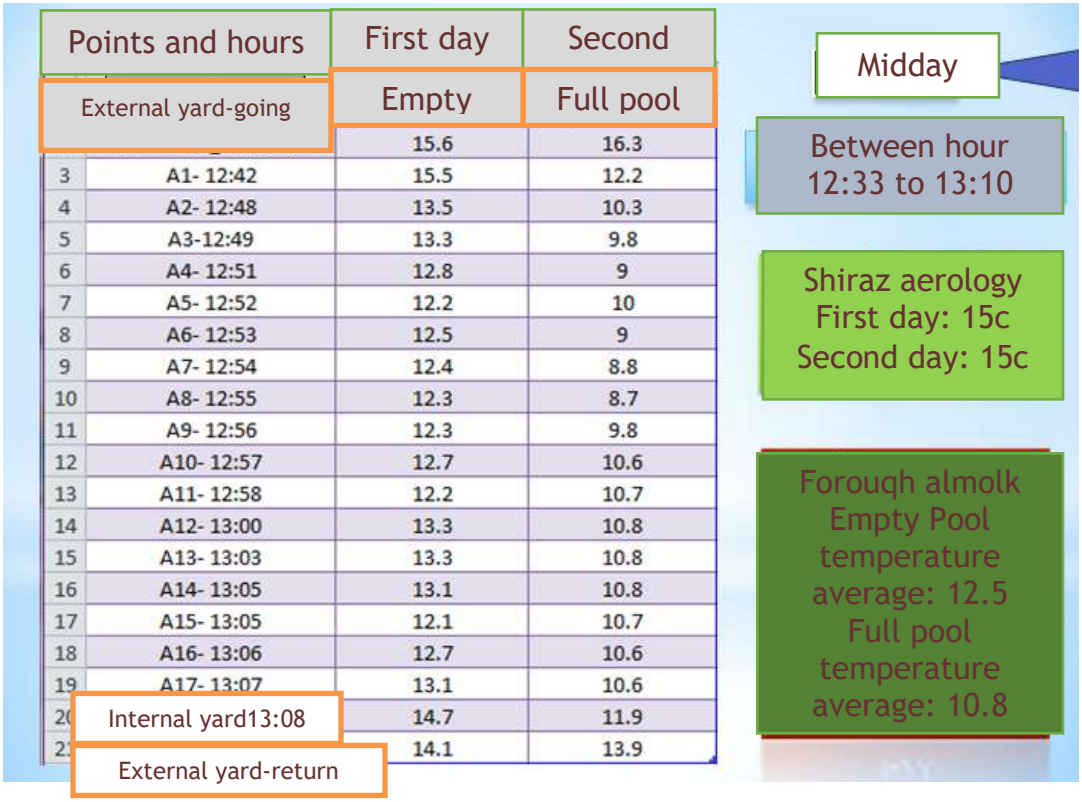
Analysis and comparison of temperature rate at midday

Table: 3. temperature data in different points of spring house with full and empty pool, midday part

	Points and hours	First day	Second
	External yard-going	Empty	Full pool
		15.6	16.3
3	A1- 12:42	15.5	12.2
4	A2- 12:48	13.5	10.3
5	A3-12:49	13.3	9.8
6	A4- 12:51	12.8	9
7	A5- 12:52	12.2	10
8	A6- 12:53	12.5	9
9	A7- 12:54	12.4	8.8
10	A8- 12:55	12.3	8.7
11	A9- 12:56	12.3	9.8
12	A10- 12:57	12.7	10.6
13	A11- 12:58	12.2	10.7
14	A12- 13:00	13.3	10.8
15	A13- 13:03	13.3	10.8
16	A14- 13:05	13.1	10.8
17	A15- 13:05	12.1	10.7
18	A16- 13:06	12.7	10.6
19	A17- 13:07	13.1	10.6
20	Internal yard13:08	14.7	11.9
21	External yard-return	14.1	13.9



Graph: 2. the obtained graph from the above table data, midday part

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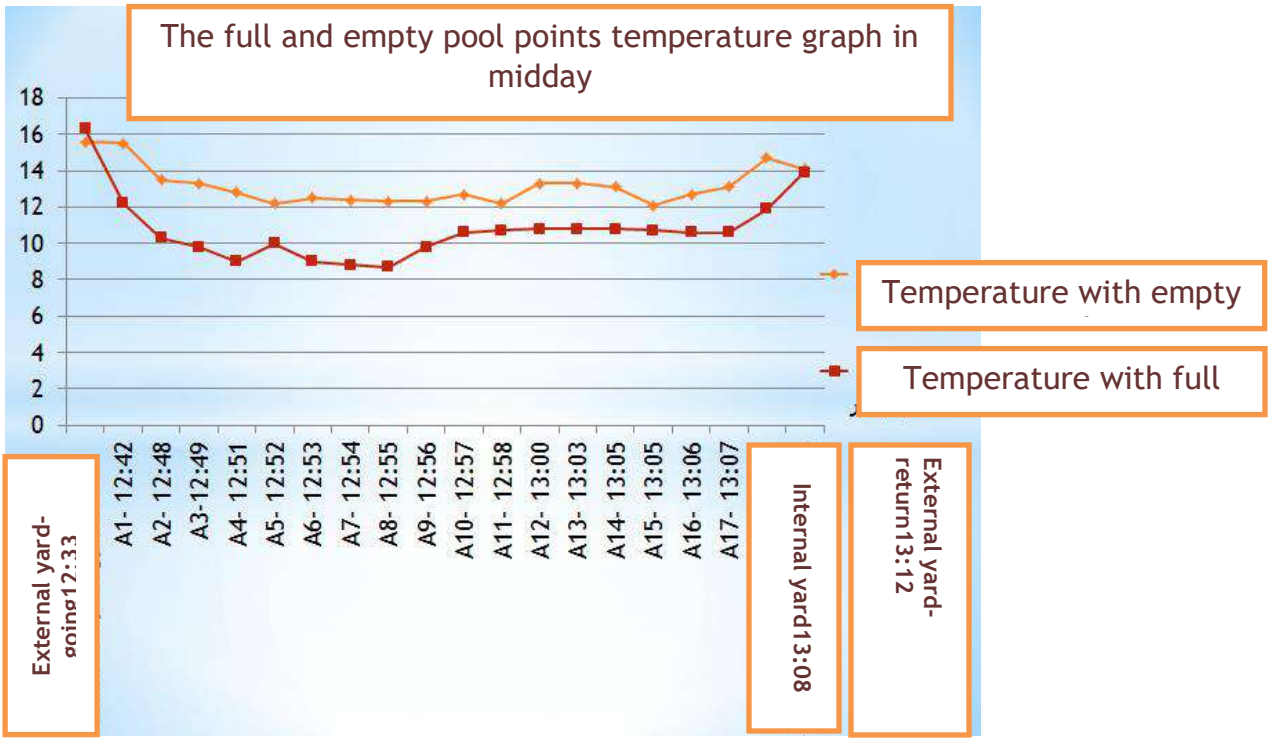
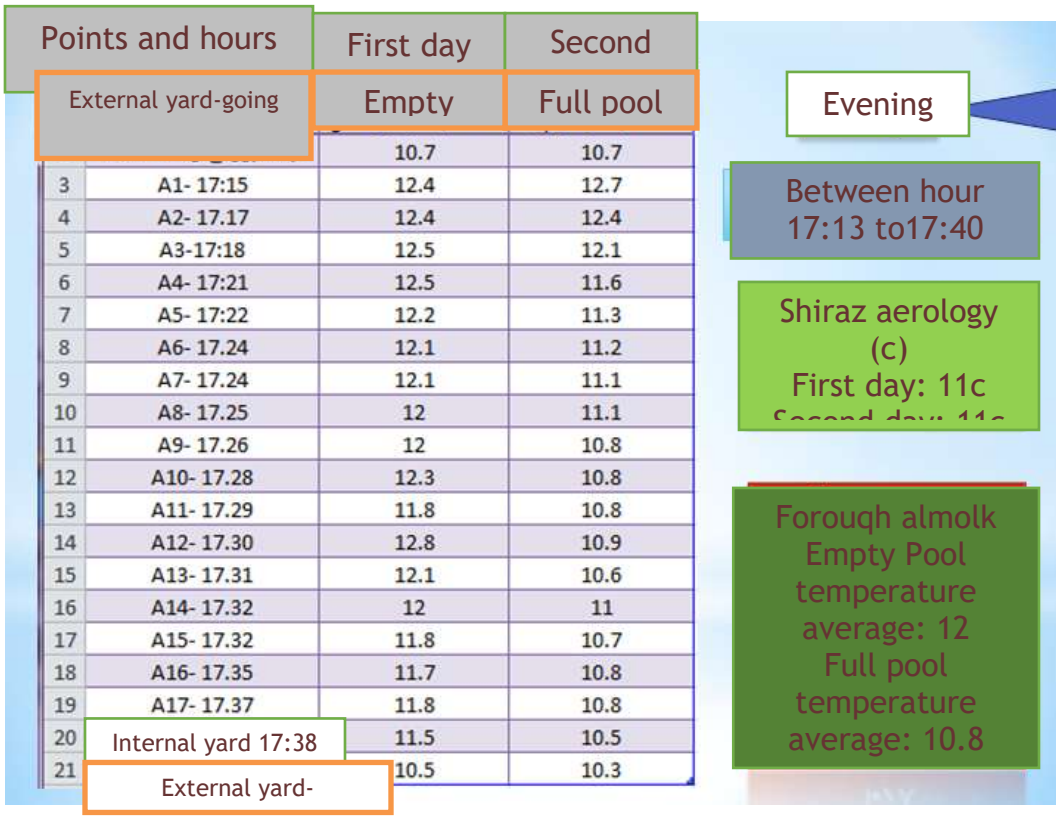


3-analysis and comparison of temperature rate in the evening time

Table: 4. temperature data in different points of spring house with full and empty pool, evening time

Points and hours		First day	Second
External yard-going		Empty	Full pool
		10.7	10.7
3	A1- 17:15	12.4	12.7
4	A2- 17.17	12.4	12.4
5	A3-17:18	12.5	12.1
6	A4- 17:21	12.5	11.6
7	A5- 17:22	12.2	11.3
8	A6- 17.24	12.1	11.2
9	A7- 17.24	12.1	11.1
10	A8- 17.25	12	11.1
11	A9- 17.26	12	10.8
12	A10- 17.28	12.3	10.8
13	A11- 17.29	11.8	10.8
14	A12- 17.30	12.8	10.9
15	A13- 17.31	12.1	10.6
16	A14- 17.32	12	11
17	A15- 17.32	11.8	10.7
18	A16- 17.35	11.7	10.8
19	A17- 17.37	11.8	10.8
20	Internal yard 17:38	11.5	10.5
21	External yard-	10.5	10.3



Graph: 3. the obtained graph from the above table data- evening time

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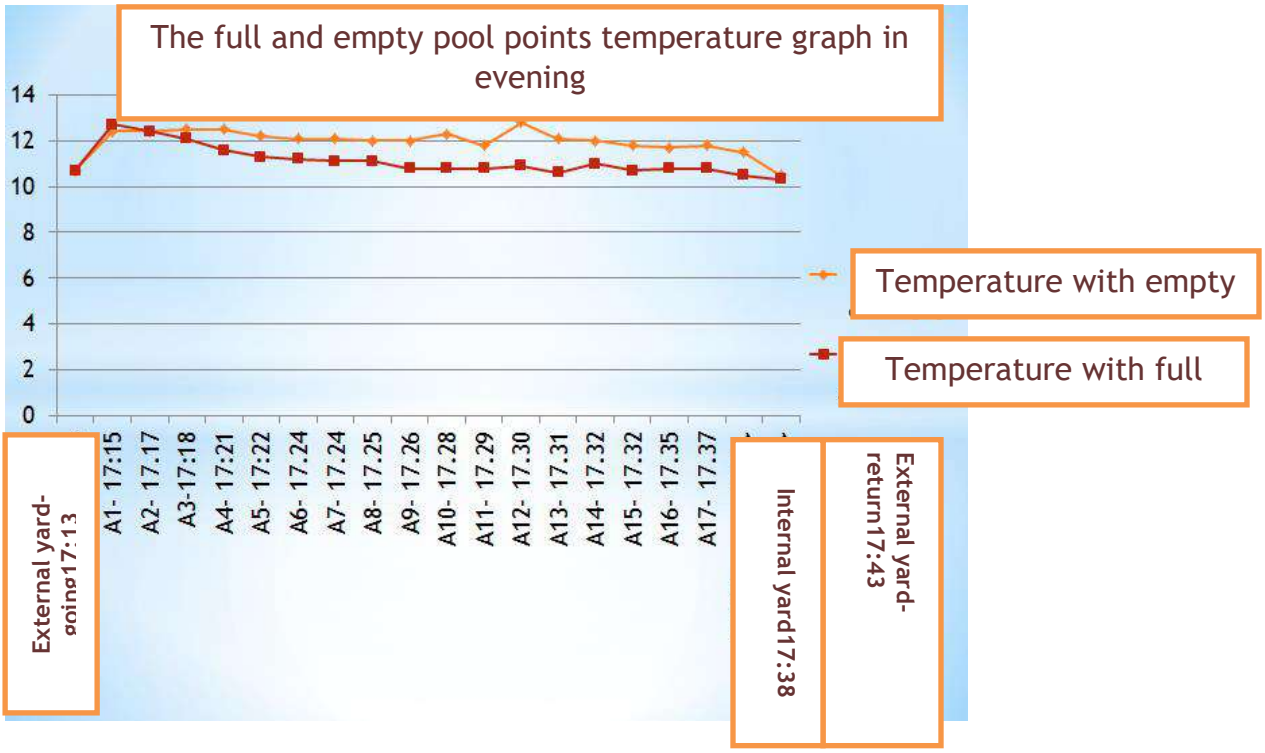

Humidity data comparison and analysis

Analysis and comparison of the humidity rate in the morning time

Table: 5. the humidity data in different points of spring pool with the full and empty pool- in the morning time

	Points and hours	First day	Second
	External yard-going	Empty	Full pool
		21.3	28.8
3	A1- 8:33	24.2	46.3
4	A2- 8:34	24.5	46.4
5	A3- 8:36	24.5	45.3
6	A4- 8:37	24.7	43.6
7	A5- 8:39	24.9	43.4
8	A6- 8:40	25.1	44.7
9	A7- 8:40	25.3	46.4
10	A8- 8:43	25.5	46.6
11	A9- 8:44	25.5	48.3
12	A10- 8:48	25.7	44.3
13	A11- 8:50	25.4	48.1
14	A12- 8:53	26.4	47.6
15	A13- 9:00	26	47.8
16	A14- 9:02	26.2	45.4
17	A15- 9:05	26.5	45.3
18	A16- 9:06	26.7	45
19	A17- 9:07	26.7	44.3
20	Internal yard 9:10	26.2	35.2
21	External yard-	21.6	28.5

Morning

Between hour 8:30 to 9

Shiraz aerology
First day: C20
Second day: C25

Forouqh almolk
Empty Pool humidity average: 25
Full pool humidity average: 46

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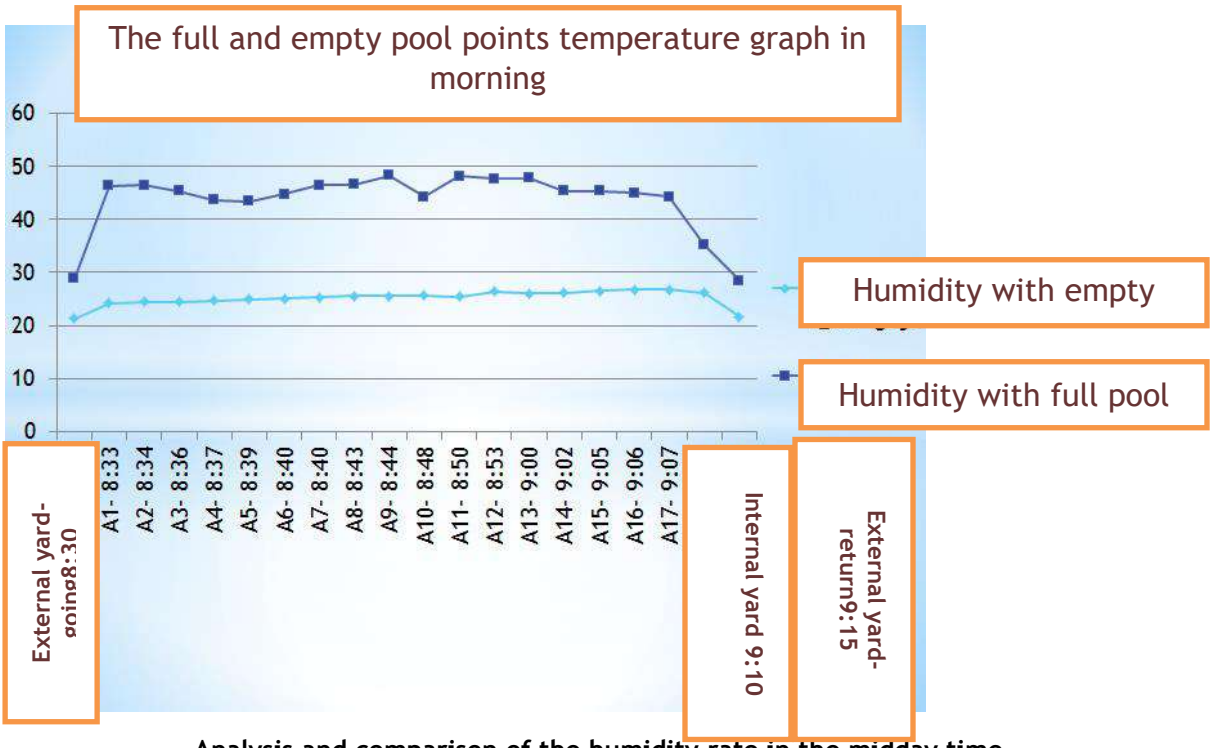
Graph: 4. the obtained graph for the above table in the morning time



Analysis and comparison of the humidity rate in the midday time

Table: 6. the humidity data in different points of spring house with the full and empty pool in the midday time

	Points and hours	First day	Second day
	External yard-going	Empty	Full pool
		21.3	26.3
3	A1- 12:31	24.2	26.1
4	A2- 12:33	24.5	28.2
5	A3-12:35	24.5	30.7
6	A4- 12:37	24.7	34.3
7	A5- 12:39	24.9	35
8	A6- 12:40	25.1	35.7
9	A7- 12:41	25.3	35.9
10	A8- 12:42	25.4	36
11	A9- 12:44	25.5	36.3
12	A10- 12:45	25.7	37
13	A11- 12:46	25.4	37.3
14	A12- 12:48	26.4	36.5
15	A13- 12:50	26	37.3
16	A14- 12:51	26.2	37
17	A15- 12:52	26.5	36.8
18	A16- 12:54	26.7	36.5
19	A17- 12:55	26.7	37.7
20	Internal yard	26.2	36.3
21	external yard-return13:00	26.3	30

Midday

Between hour 12:33 to13:10

Shiraz aerology
First day: C19
Second day: C 25

Forouqh almolk
Empty Pool humidity average: 25.5
Full pool humidity average: 35.5

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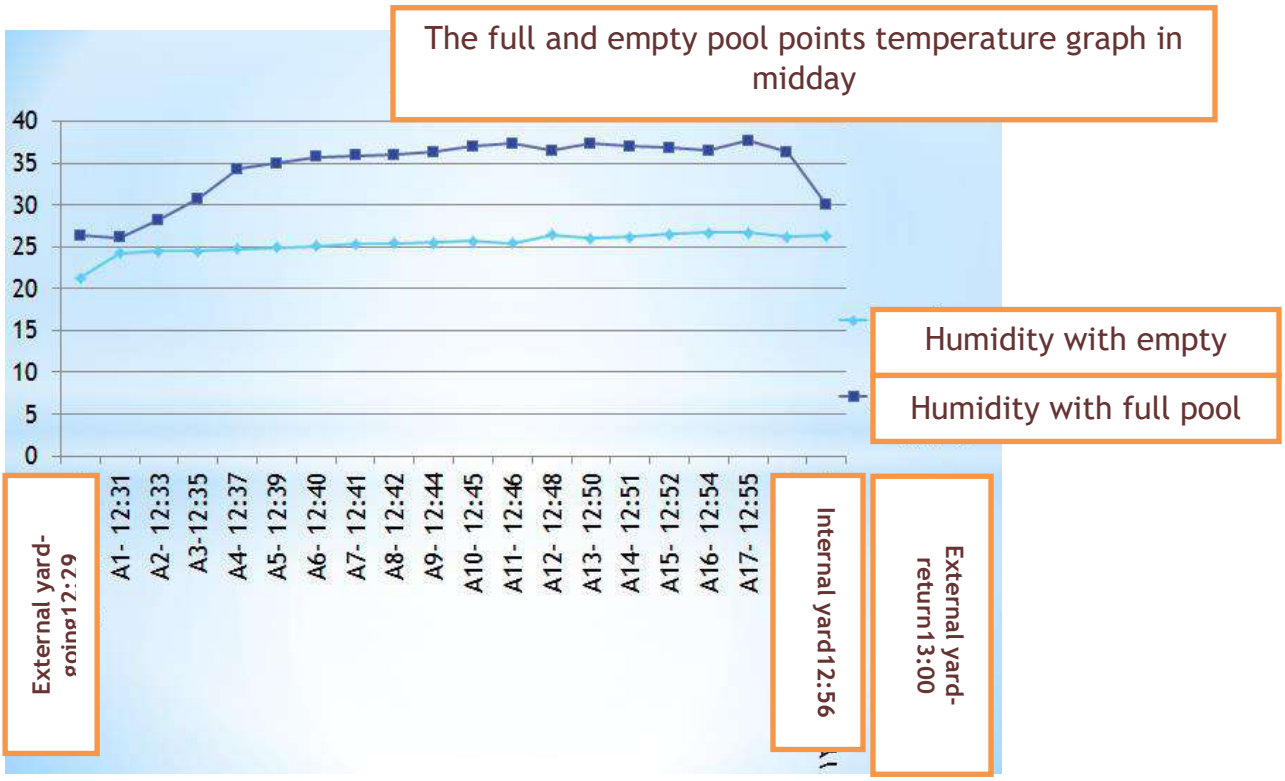
Graph: 5. the obtained graph for the above table in the midday time



Analysis and comparison of the humidity rate in the evening time

Table: 7. the humidity data in different points of spring house with the full and empty pool in the evening time

Points and hours	First day	Second
External yard-going	Empty pool	Full pool
	24.1	24.1
A1- 17:24	25	28.8
A2- 17.25	24.3	31.6
A3-17:26	24.3	32.1
A4- 17:28	25.4	34.9
A5- 17:29	24.8	36
A6- 17.30	24.6	36.9
A7- 17.32	24.7	37.4
A8- 17.33	24.7	38
A9- 17.34	24.9	38.3
A10- 17.35	25.3	38.8
A11- 17.36	25.6	39.1
A12- 17.37	27.6	38.5
A13- 17.38	26	39.4
A14- 17.40	26.2	39.2
A15- 17.41	25.7	39
A16- 17.42	26.3	38
A17- 17.43	26.6	38
Internal yard17:45	27	35
External yard-return17:50	25.8	25

Evening

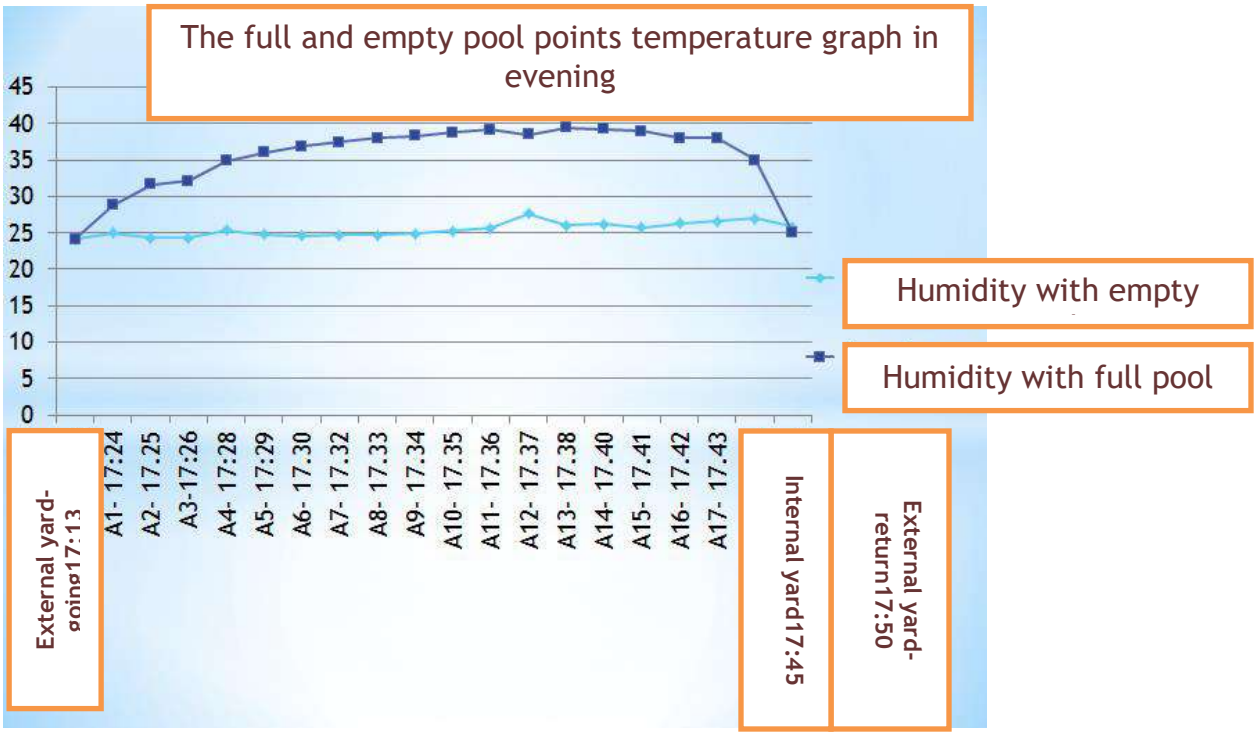
Between hour 17:13 to 17:40

Shiraz aerology
First day: 22 c
Second day: 25c

Forouqh almolk
Empty Pool humidity average: 25.5
Full pool humidity average: 36

ISSN: 0976-3104

Graph: 6. the obtained graph for the above table data- evening time



CONCLUSION

Analysis and comparison of the temperature rate conclusion

The results of tables analysis and temperature graphs in three times of morning, midday and evening is as below:

- Generally the temperature at the time of full pool in all points and in all hours is lower than the temperature with the empty pool
- As we close to the midday the spring house temperature either in the full pool or in the empty pool is more compared to the morning temperature.
- spaces which are in the direct sun shine both in the full pool and empty pools have more temperature
- points which are in the great yard surrounding, have more temperature compared to the beside small yard points

Analysis and comparison of the humidity rate conclusion

The result of humidity graphs and tables analysis in three times of morning, midday and evening is obtained as below:

- The humidity at the time of empty pool in all times of morning, midday and evening do not have considerable changes, but at the time of full pool, the humidity of all points in all hours has been increased
- The opening and holes existence to the yard assist the wind turbulence and it has effect on the humidity rate
- In every point of full pool, the humidity is more at the morning and it is decreased in midday due to the temperature increasing and in the evening due to the temperature reduction , it is increased again, so the temperature variation effects the humidity variation in every point
- Humidity in all rooms which are beside the spring house is more at the full pool compared to the time the pool is empty.

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ISSN: 0976-3104

The finally analysis conclusion and temperature-humidity comparison in all points

According to the below table when the pool is full of water, the air temperature is reduced and the humidity is increased in all hours of day, so we can conclude that the dry and warm regions without the use of using the energy consumption and only by the presence of full pool we can achieve the favorable air in the space that could assist the students of this course in the architectural faculty (who are the future constructors) in order to apply the designing proper model in accordant to the dry and warm climate in making the space cooling condition and reduction of the energy consumption.

Table: 8. the humidity and temperature data average when the pool is empty or full

Temperature	Morning	Midday	Evening
Empty pool	9.5	12.5	12
Full pool	10.8	10.8	10.8
Humidity	Morning	Midday	Evening
Empty pool	25	2.5	25.5
Full pool	46	35.5	36

THE APPLIED STRATEGIES IN DESIGNING

According to the obtained results from the observations and humidity and temperature measurement in Forouqh Almolk house in Shiraz and also the performed studies in this field, a general plan was achieved that proved the inquiry of a main spring house and also using the smaller spring house in the required locations. Spring houses is this complex are similar to the Foroqh Almolk spring house on a way that they are located in the main spaces and other spaces as students classes are around because students spend more time in them. This space also could be changed to the beating heart of architecture facility for the students correspondences and it could have other applications in the essential occasions as the fairs, congress holding and etc. as it is observed in the spring house designing, one side of spring house is usually is opened to the external space due to the opening air circulation and in this project also it is attempted that the complex is connected to the yard by the windows and doors, so it will both has the relation with the green space and nature directly and the air ventilation is done properly. The spring house roof similar to the Forouqh Almolk spring house has the higher stature compared to the spaces and some wind louvers are located in the proper direction to enter the external air to the internal space and through passing the pool water, it will provide the surrounding space cool air and this model leads to make a void on the spring house space that assist the air regulation in higher steps. It is expected that according to the performed observations and experiments and measurements, we can achieve the proper thermal comfort and better space by application of designed spring pools capabilities.

THE FINAL DESIGN PROJECT

The designing documents including the furniture plan and D-D, C-C, B-B, A-A section and the project volume is presented.

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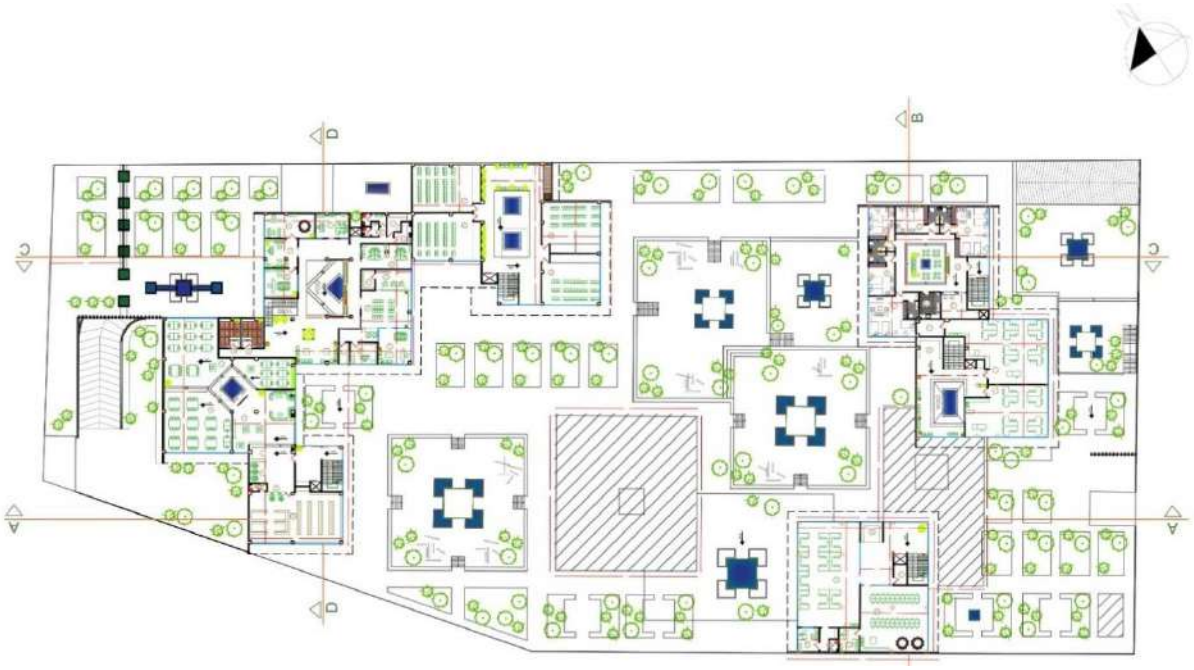
Plan: 1. Ground floor plan



Plan: 2. First floor plan

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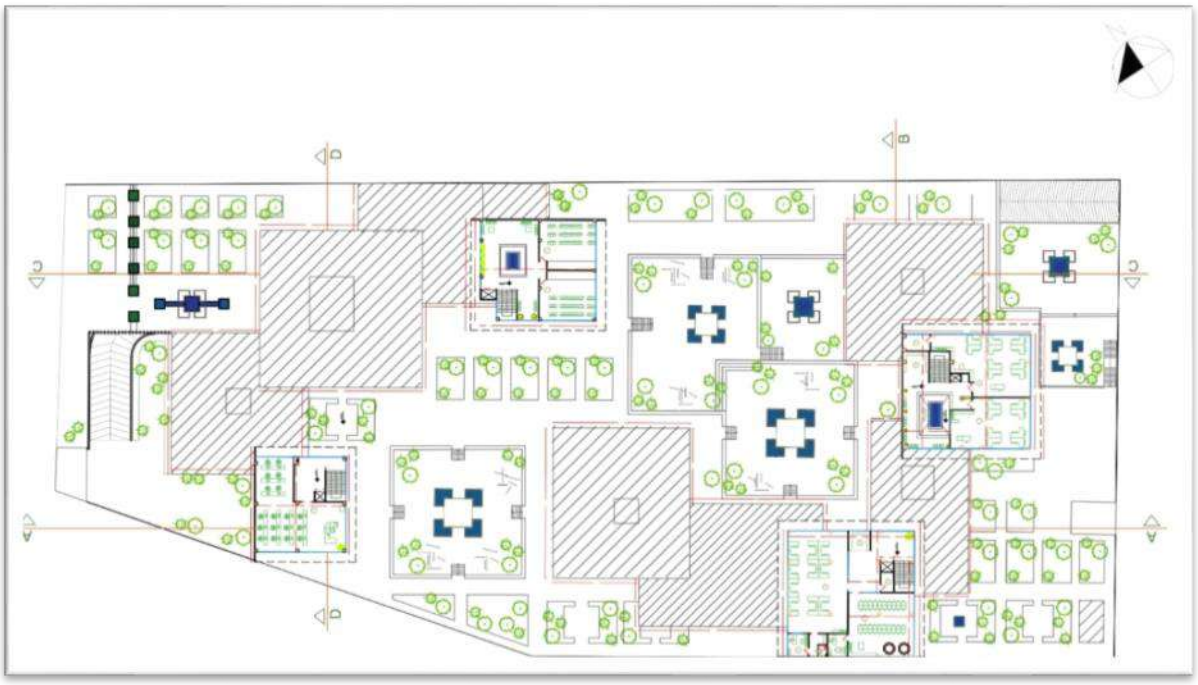
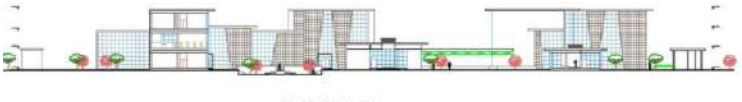


Plan: 3. second floor plan

The project sections



SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

The final volume of the project

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ISSN: 0976-3104

Fig: 9. The final volume of the project

CONFLICT OF INTEREST

Authors declare no conflict of interest.

ACKNOWLEDGEMENTS

None.

FINANCIAL DISCLOSURE

None declared.

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