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Research Article

THE PROMBLEM OF COOLING TOWER EFFECT TO ENERGY LOSS IN AIR CONDITIONNING SYSTEM USING CHILLER (CASE STUDY IN THE UPPER NORTHEASTERN REGION)

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ABSTRACT:
This report was the study result of energy loss in air conditioning systems using all types of chiller effect to energy loss. This report shows the finding about problems from cooling tower from the 32 building in the upper northeastern region of Thailand. We found that the 81 cooling tower in 32 building had the runtime not over 5 years and we can divide the main group of energy loss to 4 groups consistant with the problem of the cooling not as designed. The problem of electrical power of cooling fan is lower than specification, the problem of water drop spray return back and the problem of the cooling tower door is open. The percentage of the problem is 36, 33.9, 11.3 and 18.8 respectively it makes to the energy loss in chiller because the cooling is not at full performance about 720,049 kWh/year this between the study process we can solve the problem to saving the energy 318,870 kWh/year

Keywords: *Cooling tower, Problem, Energy conservation, Chiller*

1. INTRODUCTION

The energy consumption of business building sector more than 48% will used in the air-conditions system [1], The most of air-conditions system is using the chill water to cooling in the air condition area, the cooling tower will have used to remove the heat from the system to surrounding. The one factor to impact to the chiller performance is the heat removed by cooling tower, every 1 Fahrenheit degree of cooling water temperature decreased will save the energy about 1.5 – 2% [2], there are 2 types of cooling tower: Cross flow cooling tower and Counter flow cooling tower. Both types are different. There will be different problems. It was found that the general problem is the design valve, the recycling of humid discharge air, Blocked spray nozzles, which is an overall problem. Therefore [3], the research team wanted to know the real problem that caused less cooling efficiency. By using the tool is the Approach Temperature in the analysis And then find the reason that the high approach to temperature will eventually analyze energy consumption and Energy saving potential.

This report is the study of the causes of problems that effect the low performance of heat removed by the cooling tower. The building in this case study is in the upper northeastern region of Thailand, we found the 81 of cooling tower is used in the air-conditions system.

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2. GENERAL INFORMATION OF THE SAMPLE GROUP

The business building consists of 18 department store, 9 hotels and 6 hospitals as the Table 1.

Table 1: The quantity of cooling tower

Type of cooling tower	The quantity of cooling tower			
	Hospitals	Hotels	Department Store	Total
Counter flow	6	10	12	28
Cross flow	8	7	38	53
Total	**14**	**17**	**50**	**81**

3. MEASURE AND ANALYZE

3.1 Process

1. The interview for keeping the data and the sizing of cooling tower.
2. Read the name plate and search data from manual of cooling tower.
3. Cooling tower can be divided into 2 groups: cross flow and counter flow cooling towers.
4. The cooling tower Approach temperature and dividing the temperature into groups is less than 4 F, 4-6 F, 6-8 F, 8-10 F and more than 10 F.
5. Measurements and Calculations.
6. Compare data from the measurement and the specifications or standard [2].
7. If the data from the measurement is different from the specifications or standard, we will be looking for the cause and check and follow the distribution of cooling water, Clean, water leak, electrical power of fan, doing follow the suggestion in manual [2].
8. Estimation of the energy saving potential base on the cooling water temperature, every 1 Fahrenheit decease will save the electrical consumption in chiller's compressor by 2%.

3.2 Measurement and data analysis

3.2.1 Measurement positions and value

The measurement of values and position of cooling tower show as Fig. 1 and Table 2.

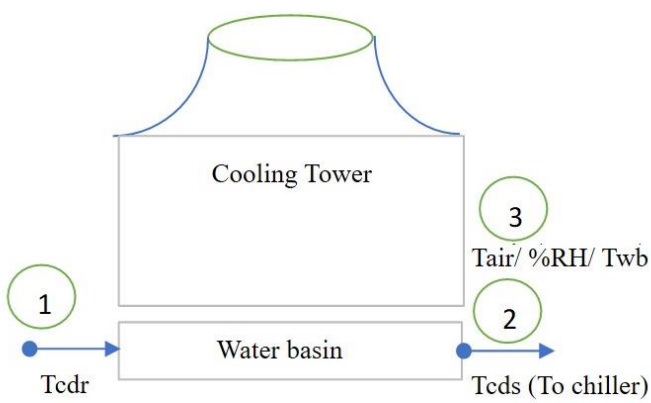

Fig.1. cooling tower measurement point

Table 2: Cooling tower measurement

Point	Measurements	Symbol	Unit
1	Water temperature (cooling tower water return)	T_{cdr}	F
2	Water temperature (cooling tower water supply)	T_{cds}	F
3	Air status include		
	1.air temperature.	T_{db}	F
	2.relative humidity.	%RH	%RH
	3.wet bulb temperature.	T_{wb}	F

3.2.2 Data analysis and standard value

Data analysis of Cooling tower will be analyzing heat cooling on Approach temperature (Appr.t) form and cooling tower efficiency as follow

$$Appr.t = T_{cds} - T_{wb} \quad (1)$$

when
Appr.t is Cooling tower approach temperature, the suitable value not over 5 F for cross flow cooling tower and not over 6 F for counter flow cooling tower [2] average approach temperature of less than 5 F [4] or specification from factory.
** The instrument used
1. Temperature data logger Testo 175
Accuracy ±0.5ºC (-50 to 70ºC)
2. Relative humanity data logger Testo 174H mini
Accuracy ±3 %RH (2 to 98 %RH)

4. RESULT

4.1 Cooling tower type

From the study we found the 81 cooling tower as follow

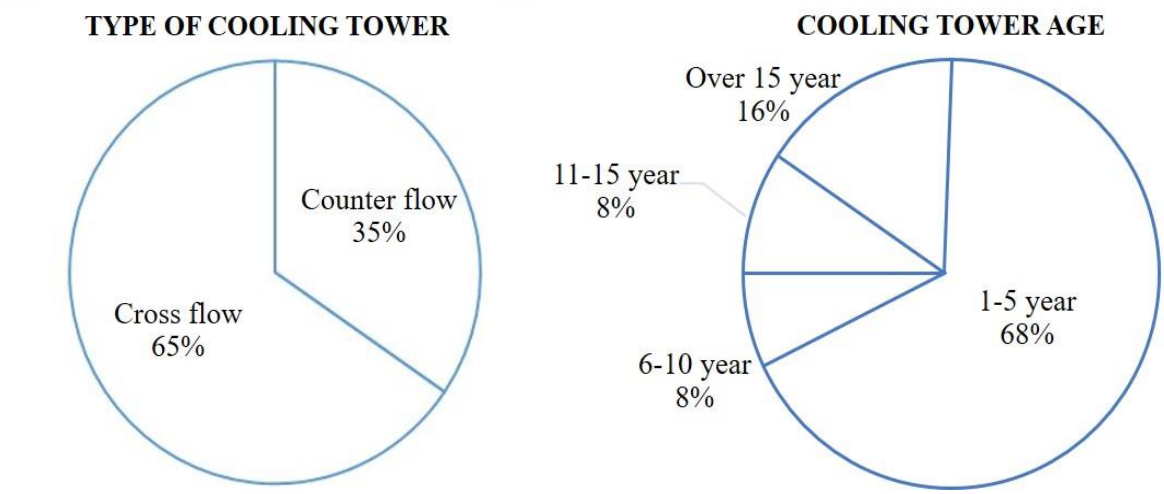

Fig.2. The proportions of cooling tower type and age group of cooling tower

From Fig. 2 most of cooling towers are square shape and the age not over 5 years, because most of them will change the new set or some building use the old cooling tower structure but change the new heat exchanger or fin.

4.2 Approach temperature measurement and analysis

4.2.1 Cross flow cooling tower Approach temperature measurement and analysis

The results of the 53 approach measurement of the cooling flow of the cross flow cooling tower are as follows:

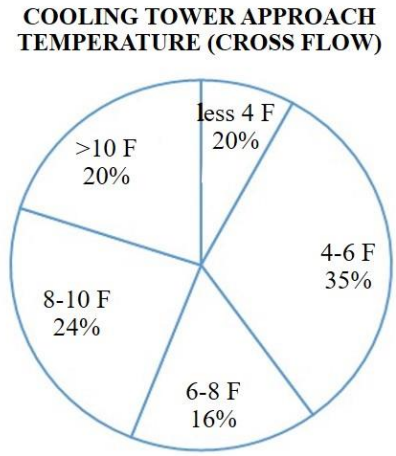

Fig. 3. Approach Temperature of cross flow cooling tower analysis

From the results of the measurement and analysis of data in Fig. 3, it is found that the temperature is within the standard range of not more than 4 F and range 4-6 F, with only 32% fresh. The remaining total amount is 68%. And more importantly, the temperature is more than 10 F to 20%**.**

4.2.2 Counter flow cooling tower Approach temperature measurement and analysis

The result of 28 Approach temperature measurements of the cross flow cooling tower are as follows:

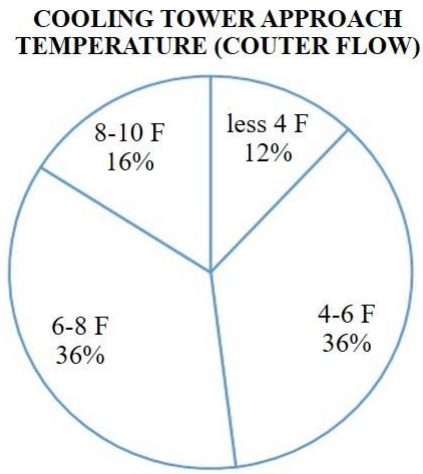

Fig. 4. Approach Temperature of counter flow cooling tower analysis

From the results of measurement and analysis of data in Fig. 4 showed the temperature is within the standard range of no more than 4 F and 4-6 F accounted for only 36%. The remaining total amount is 64%, with the temperature of the Approach Temperature greater than 6 F.

From the measurement it was found that the Approach temperature was quite high. The results of the survey can group problems into the following.

4.3 The Problem of cooling tower

4.3.1 Definition of problem

We divide the problem to 4 groups as follow the Table 3.

Table 3: Definition of problem of cooling tower

Problem	Definitions
Water flow or Heat Exchanger	Cooling tower has a problem of cooling, it not good when compare with the standard value. The cause of problem in this case is the cooling water distribute flow pass the cooling tower fin is not good and not spread evenly, fin blocked, dirty, and fin damaged.
The door opened	The cooling tower especially the square shape type what is installation contiguous will divided to section room by the door, the most of square shape type cooling tower has a problem with door damage or being open all the time causing the air from the shutdown section room to be sucked to the running section room, it's effect to the running section room has the air flow pass the fin of heat exchanger is decreased.
Water spray surrounding	When the cooling tower fan sucks air, it will take the water spray out to surrounding of the cooling tower and spread around the cooling tower. It's effect to the air before heat exchanging will be moisture increased, thus the cooling efficiency will be decreased.
Electrical power of cooling tower fan less than specification	The cause of this problem is the belt is slacking, the modification of blade angle of fan to suck the air decreased.

4.3.2 The problem of cooling tower

From the measuring and analysis allow the topic 3 lead to problem finding and we found that as the table.

Table 4: The problem of cooling tower

Problem	Times
Water flow or Heat Exchanger	19
The door opened	10
Water spray surrounding	6
Electrical power of cooling tower fan less than specification	18
Total	**53**

From the Table 4 most of problem of energy loss in cooling tower more than 36% is "cooling", the cause of this problem is the cooling water distribute flow pass the cooling tower fin is not good and not spread evenly, fin blocked, dirty, and fin damaged. (There are 81 sets but there are 53 sets are high Approach temperature).

4.3.3 The problem of counter flow cooling tower

The counter flow cooling tower from the study has 28 sets (17 sets are high approach temperature), the result from this study as table.

Table 5: The problem of counter flow cooling tower.

Problem	Times
Water flow or Heat Exchanger	5
Water spray surrounding	6
Electrical power of cooling tower fan less than specification	6
Total	**17**

From the Table 5 the energy loss problems in the counter flow cooling tower are nearby times, the problems consist of cooling, water spray surrounding and electrical power of cooling tower fan less than specification.

4.3.4 The problem of cross flow cooling tower

The cross flow cooling tower from the study has 53 sets (36 set are high approach temperature), the result from this study as table.

Table 6: The problem of cross flow cooling tower.

Problem	Times
Water flow or Heat Exchanger	14
The door opened	10
Electrical power of cooling tower fan less than specification	12
Total	**36**

From the Table 6 we found that the many problems are nearby times but the obviously increasing is the door opened problem. The door opened problem caused from the damage to the door, or forgot to close.

4.4 The result from energy saving measure and the potential of energy saving

From the study we found the 4 groups of problems and presented to the establishment for taking the energy saving measure, some buildings follow the measures but some buildings do not. We measured the energy saving and determined the potential of energy saving.

4.4.1 The energy saving

From the study, the establishment take the energy saving 16 case and it effect to energy saving as table.

Table 7: The result from the energy saving measure of cooling tower was done

No.	Measure	Energy saving	
		kWh/year	Baht/year
1	Cleaning and prevent the waterspray surrounding.	87,600.00	320,616.00
2	Close the door and repair the door.	232,270.40	844,421.60
3	Adjust angle of fan blade, water flow control.	-	-
4	Repair the fan to fully work	-	-
	Total	**318,870.40**	**1,165,037.60**

From the Table 7 the total of energy saving from the measure was done about 318,870 kWh/year or 1,165,037 baht/year. The easiest measure and most effect to energy saving is close the door and repair the door for completely closed to prevent the air leak from the shutdown room of cooling tower.

4.4.2 The potential of energy saving in cooling tower

From the study we found that 65 sets of cooling towers were not taking the energy saving measure and we are assessing the potential of the energy saving if the establishment take the energy saving measure they will saving the energy as the Table 8.

Table 8: the potential of energy saving in cooling tower

No.	Measure	The potential of energy saving	
		kWh/year	Baht/year
1	Cleaning and prevent the water spray surrounding.	405,714.44	1,500,870.27
2	Close the door and repair the door.	64,268.18	238,650.11
3	Adjust angle of fan blade, water flow control.	83,395.20	315,960.94
4	Repair the fan to fully work	166,672.14	626,101.20
	Total	**720,049.95**	**2,681,582.52**

5. CONCLUSION

This research is to study the problems that cause energy consumption in the chiller by focusing on cooling of the cooling tower because the cooling capacity directly affects the energy consumption. In analysis Cooling tower this reserch used Approach cooling tower temperature in data analysis of all 81 sets, divided into 53 cross flow cooling towers and 28 counter flow cooling towers.

5.1 Conclusion of cross flow cooling tower

A total of 53 sets of studies showed that the cross flow cooling tower, most of which had a Approach temperature temperature higher than 6 F, was the main cause of low heat dissipation due to the flow of water through the fins, fin dirt and less fan problems coordinates And leaving the door open. Therefore, for cross flow cooling tower should focus on the easiest problem. Is to fix the problem of leaving the door open Fin cleaning and water distribution check Both on the water tray And water distribution through Fin.

5.2 Conclusion of counter flow cooling tower

A total of 28 sets of studies found that the counter flow cooling tower, which had a maximum approach temperature of 6 F, was the main cause of the water flow. The power of the fan is less than the rated coordinates. Due to belt and VSD of fan problems And the electrical power of the fan to work according to the VSD mounting rating of the fan, saving energy But causing poor cooling and check the problem of clogging of Springer.

5.3 Energy savings

From the results of the study found that There were 23 improvements already, especially the door repair. Resulting in overall saving results 318,870 kWh / year .The part that has not yet been found has the potential to save overall energy 720,049 kWh / year

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