Development of Cooling Demand by Computerize

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Abstract—Air conditioning is mainly use as human comfort cooling medium. It use more in high temperatures are country such as Malaysia. Proper estimation of cooling load will archive ideal temperature. Without proper estimation can lead to over estimation or under estimation. The ideal temperature should be comfort enough. This study is to develop a program to calculate an ideal cooling load demand, which is match with heat gain. Through this study, it is easy to calculate cooling load estimation. Objective of this study are to develop user-friendly and easy excess cooling load program. This is to insure the cooling load can be estimate by any of the individual rather than them using rule-of-thumb. Developed software is carryout by using Matlab-GUI. These developments are only valid for common building in Malaysia only. An office building was select as case study to verify the applicable and accuracy of develop software. In conclusion, the main objective has successfully where developed software is user friendly and easily to estimate cooling load demand.

Keywords—Cooling Load, Heat Gain, Building and GUI.

I. INTRODUCTION

AIR conditioning is mainly use as human comfort medium. Generally, air conditioning defined as a system to cooling surrounding in the room to achieve design thermal comfort level. In single season country like Malaysia, air conditioning system only comes with cooling system to overcome heat gain. Air-conditioning usually consumes higher energy cost especially during peak hour [1].

Heat gain refers to heat from all sources that produce in the room or building. Heat gain increase within a given space resulted from direct heating by radiation and conduction from walls, windows, doors, and roof. The other sources of heat gain are from lights, equipment, or people. While cooling load is the total amount of heat energy that be remove from the room.

Cooling load for some building is varying, it depending on surrounding condition. In order to maintain the comfortable temperature in the room, total heat gain and cooling load of space should be estimate accurately. Higher cooling load will let room temperature reduce. Over estimated cooling load will. Most of this air-conditioning always over size, which will causes low efficiency and high cost. Underestimated will affect energy consumption cost too. Ideal estimations of cooling load will lead high efficiency air conditioning system unit. Some energy consumption can save by applying proper estimation of cooling load demand

II. REVIEW

Cooling load is the amount of heat energy to remove from a space by air-condition unit to maintain the indoor design temperature. There are two types of cooling loads; sensible cooling load and latent cooling load. The sensible cooling load refers to the dry bulb temperature of the building and the latent cooling load refers to the wet bulb temperature of the building.

Many factors influence the cooling load; they are windows, doors, skylights, walls, partitions, ceilings, roofs, floors, open crawl space, air infiltration, people, equipment, process and appliances [2],[3]. Fig. 1 shown illusion factor which influence to cooling load estimation.
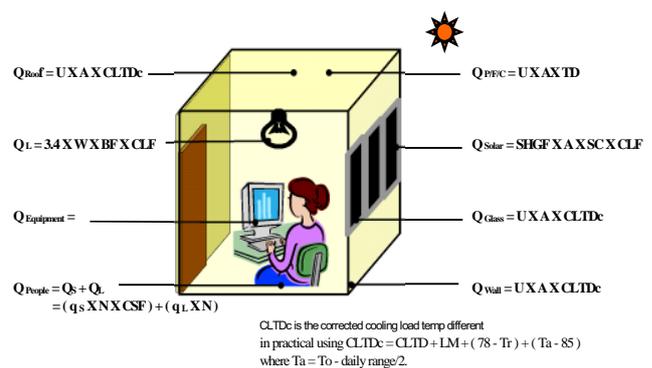

Fig. 1 Heat gain components into an enclosed space

Two programs of cooling load demand were develops by previous researcher. Both programs were creating by using Matlab software integrated with graphic user interface [4]. However, there are many rooms to improve the previous program. Previous cooling load program quit complicated to

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new user especially to the person who not familiar or have a basic general knowledge in cooling load demand estimation method. There are many parameter or table need to be refer and fill up in the program.

III. METHODOLOGY

Cooling load estimation are complicated to new user especially who not familiar or have a basic general knowledge in heat gain and cooling load. There are many parameter and table need to be refer. A cooling load program was creating by using Matlab software integrated with graphic user interface [5].

Few steps were introduce to develop new cooling load program which more convenient and user friendly. The steps are separate into four steps such as, study of present cooling load, develop basic cooling load program in Matlab, identified common parameter, and simplified program cooling load program Fig. show the illusion flow of each step.

First step is important part because cooling load estimation related to several principles [6],[7]. This step is beginning step where programmer was expose to several heat transfer rules and principles. In this step programmer familiar with building specification, surrounding condition, comfort level and user trend. In additional knowledge in Matlab and GUI software is necessary before start develop basic program.

Second step, develop basic cooling load estimation programs according data and information gathered from first step. The program integrated with GUI and displayed result on screen. Program layout was arrange follow excel program which was develop in previous research. Screen display layout separated into few panels; design condition, conduction, solar, internal heat gain and result.
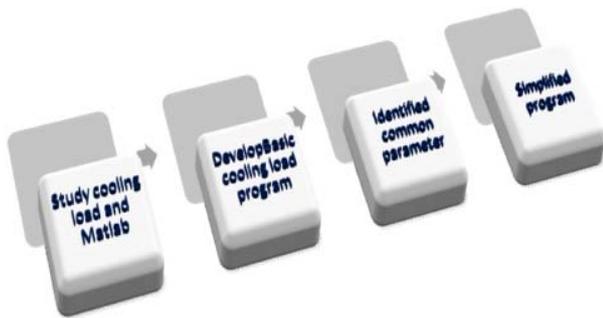

Fig. 2 Cooling load program development flow

Design panel is a portion where all the parameter related to building location, design condition and surrounding condition recorded. All this information are collected from building owner and whether data information. Conduction panel is a portion where all the information refers to building specification was record. This panel recorded U value base to direction and material. Cooling load was calculated base with area and CLTD. Solar panel functions as same as conduction panel where it recorded glass material U value and glass area seize. Internal panel is a part where the entire internal factor such as light, people, equipment and ventilation was record.

Cooling load panel is a part where all the cooling load result tabled.

Third step is to identify common parameter required in the present cooling load program. The parameter of first step program divided into few types. There are latitude, outside temperature, inside temperature, type of wall, type of glass, degree of activity, type of appliance, and other interaction. Each of this parameter may influence the cooling load calculation. To develop this program these factors have to be identifying to simplify program and calculation without affecting the outcome of the result. Furthermore, these indicate part of the parameter that can be auto select. At figure below show some of the parameter that be identified and simplified. Due to make the process of identification easier the box are color to indicate the function.

Forth step is simplified the basic cooling program. Simplify the program after identified the common parameter will have to consider about variable and not convertible factor. This is only valid for Malaysia office building condition only. The latitude also been simplified to Malaysia. This is to ensure the parameter been fixed. There are common or standard building parameters for hot and humid country like Malaysia. As an example, the wall speciation can be limited to standard or common wall material for normal building in Malaysia.

IV. RESULTS

Table I shown the total summarize of comparison of the cooling load estimation by using manual calculation and Matlab-GUI calculation. The highest errors contribute from the radiation from glass solar, which is 1.28×10^{-7} %. This total of cooling load error is 2.22×10^{-8} % Overall, all the error is less than 0.001 %.

TABLE I
RESULT OF MANUAL AND COMPUTERIZE COOLING LOAD

Bil	Cooling Load	Manual Calculation (BTU)	Calculation By Matlab-GUI (BTU)	% Error
1	Wall Conduction	21792.156	21792.1860	1.38×10^{-8}
2	Glass Conduction	10236.855	10236.8550	0
3	Glass Solar	77936.112	77936.1119	1.28×10^{-7}
4	Interior	25306.100	25306.1000	0
5	Internal Heat Gains	316016.400	316016.4000	0
	Total Cooling Load	451287.653	451287.6529	2.22×10^{-8}

Small number percentage of error makes this Matlab-GUI calculation valid and accurate after comparison with the manual calculations. The error is due to the number of decimal point that been taking while manual calculation. In addition,

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the total numbers of decimal points were round to three decimal points. Meanwhile for calculation of Matlab-GUI can be reach up to five decimal points. In other word the calculation using Matlab-GUI are more accurate and precise.

V. Conclusion

In conclusion, calculations of cooling load using Matlab-GUI are user friendly and easily. It will helps user early to calculated cooling load demand and improved efficiency. Users just have to select and key in required data of the building. Users also able compare the cooling load by hourly and monthly. The percentages of the error indicate that calculation using Matlab-GUI is more accurate than manual calculation. This develop program is applicable in Malaysia as well as the same country that have similar weather and building specifications.

Some improvements can do to improve this cooling load estimation program; expand program application to four-season country and difference building specification, display plotting graph at GUI window, and capable to convert multi unit. In addition, this calculation via Matlab-GUI also saves user time.

References

[1] Z. Noranai and M. Z. Md Yusof, (2011), Study of energy efficiency opportunities in UTHM, Proceedings of World Academy of Science, Engineering and Technology, vol. 77, pp. 745-751.

[2] Prof Ir. Mohammad Zainal, "Lecture Note – Air Condition System Design Manual", UTHM, Unpublished, 2003.

[3] N. Shamsidin, (2010), Development of Auto Calculation of Cooling Load Rate Demand Using Matlab Software. Bachelor Degree. Thesis. UniversitiTun Hussein Onn Malaysia.

[4] Dayang Siti Zainab Binti Abang Bujang. Calculation of Cooling Load for Lecture's Room at C16 By using Matlab Software. Bachelor Degree. Thesis. UniversitiTun Hussein Onn Malaysia. (2012)

[5] Z Noranai, DSZA Bujang, R Asmawi, H Salleh, MZM Yusof, (2011), Development of Cooling Load Demand Program for Building in Malaysia, Proceedings of World Academy of Science, Engineering and Technology, vol. 63, pp. 166-169

[6] Z. Noranai, H. Salleh, MZM Yusof,(2011), Energy cost reduction by partially operation of thermal energy storage based on building load profile, International Conference on Environment Science and Engineering , vol. 8, pp. 55.

[7] Z. Noranai and M.Z. Md Yusof, (2011), Economical Analysis of Thermal Energy Storage by Partially Operation, World Academy of Science, Engineering and Technology, Vol. 59, pp. 2567-2571.

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