Calculation of Air Conditioning Cooling Load on 1st Floor of Class III Inpatient Building at X Hospital

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Abstract

Air conditioning in a building is needed to provide environmental comfort in terms of thermal for each occupant. Air conditioning also serves to maintain and protect equipment or machinery in a building, building or factory. The building consists of rooms that have their respective functions. Then there should be a system for regulating air temperature, ventilation and others for each group of rooms according to their needs. The condition of a building is influenced by external conditions and is also influenced by additional heat (heat gain) from inside the room, so that each room has a load that requires cooling. The purpose of this research is to regulate the temperature and humidity of the air at MCC Building Architectural GA according to their respective functions and to calculate the cooling load of the room at MCC Building Architectural GA. The results of this study are the total cooling load for the air conditioning system for GSH 129774.2 Watt, GLH 12946.89 Watt and GTH 142721.09 Watt.

Keywords*-cooling load, air conditioning system design*

INTRODUCTION

Air conditioning in a building is needed to provide environmental comfort in terms of thermal for each occupant. Air conditioning also serves to maintain and protect equipment or machinery in a building, building or factory. The building consists of rooms that have their respective functions. Then there should be a system for regulating air temperature, ventilation and others for each group of rooms according to their needs. The condition of a building is influenced by external conditions and is also influenced by additional heat (heat gain) from inside the room, so that each room has a load that requires cooling. For setting the condition of the room, we must first calculate the thermal load either from inside or outside the room so that the capacity and work energy needed can be determined[1].

To keep the air in the room still meeting the health criteria for residents, in the sense of the word that the air contains enough oxygen and is free from pollutants, attention must be paid to good air circulation so that dirty air can be replaced with fresh and clean air, which is usually done through the vent.

To overcome the heat gain that causes uncomfortable air conditions and to get healthy air circulating in the room, it is necessary to design the correct air conditioning and ventilation system for each room.

LITERATURE STUDY

A. *Air Conditioning*

Air conditioning is a process of treating air to regulate temperature, humidity, cleanliness, and air distribution simultaneously to achieve the comfortable conditions required by occupants in a room[2].

Air conditioning systems are generally divided into two main groups, namely:

1. Air conditioning for comfort

Air conditioning from the room to provide work comfort for people who carry out certain activities in the room.

2. Air conditioning for industry/process

Air conditioning of the room because it is required by the process, materials, equipment or goods that are in it.

Comfortable environmental conditions are needed by humans both at rest and at work. When resting, these comfortable conditions will help speed up the return of a fresh body condition. Meanwhile, comfortable conditions in the work environment will increase work efficiency and productivity.

B. ***Types of Air Conditioning***

Based on the method used to condition the air with a cooling machine, the air conditioning system can be divided into several categories, namely:

1. Direct Expansion System

This system is related to direct cooling of the room air, meaning that the air to be conditioned is flowed directly through the evaporator, fan, condenser, and electrical control, or in the form of separate units (split units), namely the fan coil (evaporator) located in the indoors and condensing units located outdoors.

2. All Air System

This system uses air as a medium to pick up sensible and latent heat loads from the room to be condensed, which is then discharged into the environment through an air treatment unit. The condition of the cooled air is completely regulated by the air that has been processed by the central air conditioning unit, in this case there is no additional cooling.

3. *All Water System*

This system uses water as a secondary cooling medium. The installed evaporator does not directly cool the air, but cools the intermediate medium, namely water. The cooled water is then circulated to the fan coil unit through a pipe. Then the room air is flowed through the fan coil unit so that heat exchange occurs between the two[3].

4. *Air-Water System*

A system in which the condition of the room is fully regulated by air from the central air system, including the full air group (all air system). In the air-water system, the fan-coil unit or induction unit is installed in the room to be refreshed. Cold water (cooling) or hot water (heating) is flowed into the unit, while room air is flowed through the unit so that it becomes cold or hot. Furthermore, the air circulates in the room.

II. RESEARCH METHODOLOGY

A. *Design Data*

1. Building Location

2.

The building to be designed is the MCC Building Architectural GA which is a motor control center building located off the coast of Ujung Pangkah Development which functions to export gas to the PLN power station in Gresik which is located on the coast to produce and export LPG and crude oil.[4] Ujung Pangkah Field is located between 2 and 10 KM off the coast and the distance from East Java to the north of Gresik is about 35 KM. This building overlooks WSW.

The parts of the room in the MCC Building Architecture GA building are:

Table 1

Transformer	29.73	320.01
switchboard	121.72	1310.18
battery room	14.40	155.00
telecom	29.14	313.66
A/L	3.48	37.46
workshop	50.51	543.69
store	9.15	98.49

Table 2

General data on the MCC Building Architecture GA

Properties	Value	unit	Value	unit
To max =	37.80	0 C	100.04	oF
RHi =	50.00	%		
DR =	20.60	0 C	69.08	oF
To =	28.00	0 C	82.40	oF
RHo =	56.00	%		
Tr =	24.00	0 C	75.20	oF
Month =	December			
Time =	3:00 PM			
Latitude =	0.00			
H wall =	2.40	meter		
Hdoor =	2.00	meter		
Uwall & door =	0.45	W/m² ºc		
Uroof =	0.57	W/m² ºc		

Table 3

Transformers Room	1
Switchboard	2
Battery room	1
Telecom Room	1
A/L	1
Workshop Room	4
Store Room	1

B. *Flow Chart*

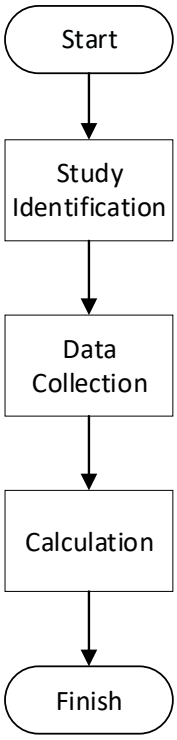

Fig. 1. Work Flowchart

III. RESULT AND DISCUSSION

Calculation of the cooling load for the MCC Building Architectural GA which is a motor control center building located offshore, where the function of this building is as a control panel room, transformer room, battery room, tetekom room, mechanical workshop and store. The load source is divided into two load sources, namely:

1. External Load

Exterior wall, floor, roof, door etc.

2. Internal Load

Lights, people, equipment, fresh air etc.

A. *External Walls*

	CLTD	LM	CLTD corr
SSW	51.00	6.00	37.25
WNW	46.50	-5.00	27.18
NNE	25.50	-5.00	13.53
ESE	31.00	0.00	20.35

The total load for the outer wall load exposed to sunlight is: 1962.78 btu/hr

Room	U	A (m2)	CLTD corr	Q	
Transformers Room					
SSW		6.94	37.25	116.33	btu/hr
WNW		9.14	27.18	111.77	btu/hr
NNE		8.70	13.53	52.95	btu/hr
Switchboard Room					
SSW		27.40	37.25	459.29	btu/hr
NNE		41.52	13.53	252.70	btu/hr
Battery Room					
SSW		2.81	37.25	47.10	btu/hr
Telecom Room					
SSW		2.81	37.25	47.10	btu/hr
ESE	0.45	14.88	20.35	136.26	btu/hr
A/L					
WNW		0.94	27.18	11.50	btu/hr
ESE		6.64	20.35	60.81	btu/hr
Workshop Room					
SSW		7.95	37.25	133.26	btu/hr
WNW		17.04	27.18	208.38	btu/hr
NNE		2.81	13.53	17.10	btu/hr
ESE		12.95	20.35	118.59	btu/hr
Store Room					
SSW		7.44	37.25	124.71	btu/hr
ESE		7.09	20.35	64.93	btu/hr
Total				1,962.79	btu/hr

B. Floor Load

Room	U	A (m2)	CLTD corr	Q	
Transformers Room	0.45	29.73	13.85	185.29	btu/hr
Switchboard Room		121.72		758.62	btu/hr
Battery Room		14.40		89.75	btu/hr
Telecom Room		29.14		181.62	btu/hr
A/L		3.48		21.69	btu/hr
Workshop Room		50.51		314.80	btu/hr
Store Room		9.15		57.03	btu/hr
Total				1,608.80	btu/hr

The total load for the floor load is: 1608.80 btu/hr.

C. Exterior Door Load

	CLTD	LM	CLTD corr
SSW	51.00	6.00	37.25
WNW	46.50	-5.00	27.18
NNE	25.50	-5.00	13.53
ESE	31.00	0.00	20.35

Room	U	A (m2)	CLTD corr	Q	
A/L (ESE)	0.45	1.76	20.35	16.12	btu/hr
A/L (WNW)		2.93	27.18	35.83	btu/hr
Workshop (SSW)		3.81	37.25	63.87	btu/hr
Transformers (WNW)		10.54	27.18	128.89	btu/hr
Total				244.70	btu/hr

The total load for the outer door load exposed to the sun is: 244.70 btu/hr.

D. Roof Load

Room	U	A (m2)	CLTD corr	Q	
Transformers Room	0.57	29.73	21.77	368.98	btu/hr
Switchboard Room		121.72		1,510.69	btu/hr
Battery Room		14.40		178.72	btu/hr
Telecom Room		29.14		361.66	btu/hr
A/L		3.48		43.19	btu/hr
Workshop Room		50.51		626.89	btu/hr
Store Room		9.15		113.56	btu/hr
Total				3,203.70	btu/hr

The total load for the roof load is: 3203.70 btu/hr

E. Lamp Load

Wattage = Approx. (15 Watt/m²) x Floor Area x 3.41

Room	A (m2)	Watt/m2	Wattage	Q	
Transformers Room	29.73	15.00	445.95	1,824.83	btu/hr
Switchboard Room	121.72	15.00	1,825.80	7,471.17	btu/hr
Battery Room	14.40	15.00	216.00	883.87	btu/hr
Telecom Room	29.14	15.00	437.10	1,788.61	btu/hr
A/L	3.48	15.00	52.20	213.60	btu/hr
Workshop Room	50.51	15.00	757.65	3,100.30	btu/hr
Store Room	9.15	15.00	137.25	561.63	btu/hr
Total				15,844.02	btu/hr

The total load for the lamp load is: 15844.02 btu/hr

F. Man Load

Room	No of People	Q (btu/hr)		
		Sens	Latent	Sum
Transformers Room	1.00	255.75	187.55	443.30
Switchboard Room	2.00	511.50	375.10	886.60
Battery Room	1.00	255.75	187.55	443.30
Telecom Room	1.00	255.75	55.00	310.75
A/L	1.00	255.75	187.55	443.30
Workshop Room	4.00	2,318.80	3,478.20	5,797.00
Store Room	1.00	579.70	255.00	834.70
Total		4,433.0	4,725.95	9,158.95

The total load for the load of people in each room is: 225.75 btu/hr

G. Equipment Load

Room	Equipment Type	No	Wattage	Q	
Mechanical Workshop	Hacksaw	1.00	993.00	3,386.13	btu/hr
	Fume Ext	1.00	993.00	3,386.13	btu/hr
	WeldingM	1.00	1,887.00	6,434.67	btu/hr
	Drill Press	1.00	993.00	3,386.13	btu/hr
	Hyd.Press	1.00	993.00	3,386.13	btu/hr
	Grinder	1.00	993.00	3,386.13	btu/hr
	P. Supply	1.00	500.00	1,705.00	btu/hr

I/E Workshop	Osciloscop	1.00	150.00	511.50	btu/hr
	Drill Press	1.00	993.00	3,386.13	btu/hr
	PC	1.00	390.00	1,329.90	btu/hr
Batery Room			5,000.00	17,050.00	btu/hr
Switchboard Room			25,000.00	85,250.00	btu/hr
Transformers Room			50,000.00	170,500.00	btu/hr
Total				303,097.85	btu/hr

Total load for equipment load is: 303097.85 btu/hr

H. Fresh Air

Room	Fresh Air (L/S)		
	Ventilation	ACH	Door Inf.
Transformers Room	8.30	19.82	0.50
Switchboard Room	16.60	81.15	0.00
Battery Room	8.30	9.60	0.00
Telecom Room	8.30	19.43	0.00
A/L	8.30	2.32	0.50
Workshop Room	33.20	33.67	0.50
Store Room	8.30	6.10	0.00
Total	91.30	172.09	1.50

Room	Q Fresh Air Sensibel (Watt)			Q Fresh Air Laten (Watt)		
	Ventilasi	ACH	Inf.	Ventilasi	ACH	Inf.
Transformers Room	140.88	336.42	8.49	362.25	865.04	21.82
Switchboard Room	281.77	1,377.38	0.00	724.51	3,541.65	0.00
Battery Room	140.88	162.95	0.00	362.25	418.99	0.00
Telecom Room	140.88	329.75	0.00	362.25	847.88	0.00
A/L	140.88	39.38	8.49	362.25	101.26	21.82
Workshop Room	563.54	571.57	8.49	1,449.01	1,469.67	21.82
Store Room	140.88	103.54	0.00	362.25	266.23	0.00
Total	1,549.73	2,921.00	25.46	3,984.79	7,510.72	65.47
	5,284.57	9,960.61	86.82	13,588.13	25,611.56	223.24

The total load for fresh air load is: 223.24 btu/hr

I. Sensible and total latent load

GSH	GLH	GTH	unit
442,530.01	44,148.89	486,678.90	btu/hr
129774.20	12946.89	142721.09	watt
129.77	12.95	142.72	Kwatt
37.08	3.70	40.78	TR
GSH	GLH	GTH	unit
442,530.01	44,148.89	486,678.90	btu/hr
129774.20	12946.89	142721.09	watt
129.77	12.95	142.72	Kwatt
37.08	3.70	40.78	TR

CONCLUSION

1. The condition of the design room is 24^{o} C with 50% RH.
2. The conditions for the outside air are:

Tdb : 28^{0} C
DR : 20.6^{0} C
RH : 50.00 %

3. The MCC Building Architectural GA has a peak load at 15.00
4. The total load:

RSHG	RLHG	RTHG	unit
330,394.85	4,725.95	335,120.80	btu/hr
96889.99	1385.91	98275.90	watt
96.89	1.39	98.28	Kwatt
27.68	0.40	28.08	TR

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