Design and Performance Evaluation of SLDAC System

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Abstract

Human comfortness is essential now a day because of the improvement in life style and increasing atmospheric temperature. Electrical air conditioning machines are not most suitable for large buildings because of the higher power consumption and shorter life. Central air conditioning or chilled water system is more reliable for easy operation with a lower maintenance cost for large building. With large buildings such as commercial complex, auditorium, office buildings are provided with central air conditioning system. Educational and research institutions, Hotels, Hospitals, malls etc. are also need human comfortness, as the population of student community increase year by year. The effective design of central air conditioning or a chiller system can provide lower power consumption, capital cost and improve aesthetics of a building. This paper establishes the results of cooling load calculation of different climate conditions by installing dehumidifier. By using CLTD method and Carrier program then the results are compared for a single-story building which is a part of an institute. Cooling load items such as, Electrical equipments, people heat gain, lighting heat gain, infiltration and ventilation heat gain can easily be putted to the MS-Excel programme. The programme can also be used to calculate cooling load due to walls and roofs. And results were compared with the standard data given by ASHRAE and CARRIER Fundamental Hand Books, hourly analysis programme and results are satisfactory. It is also seen that in this paper cooling requirement of without dehumidifier is about 20 % more as compare to with dehumidifier for climate condition of Thiruvanathapuram, Kerala in India. It will be a significant for a large commercial building.
Keywords- HVAC, CLTD, Desiccant wheel, solar energy, Ducting, HAP

I. INTRODUCTION

When thinking about energy efficiency, one of the most important decisions to be made regarding a new home is the type of heating and cooling system to install. Equally critical to consider is the selection of the heating and cooling contractor. The operating efficiency of a system depends as much on proper installation as it does on the performance rating of the equipment

The desiccants are strong saltwater solutions. In high concentrations, desiccants can absorb water from air and drive dehumidification processes; thus, evaporative cooling devices can be used in novel ways in all climates. Thermal energy dries the desiccant solutions once the water is absorbed. LDACs substitute most electricity use with thermal energy, which can be powered by many types of energy sources, including natural gas, solar thermal, biofuels, and waste heat. The benefits include generally lower source energy use, much lower peak-electricity demand, and lower carbon emissions, especially when a renewable fuel is used. The LDAC technology deployed in this demonstration was invented by AILR, and was the result of collaborative effort with NREL, and was funded by DOE.

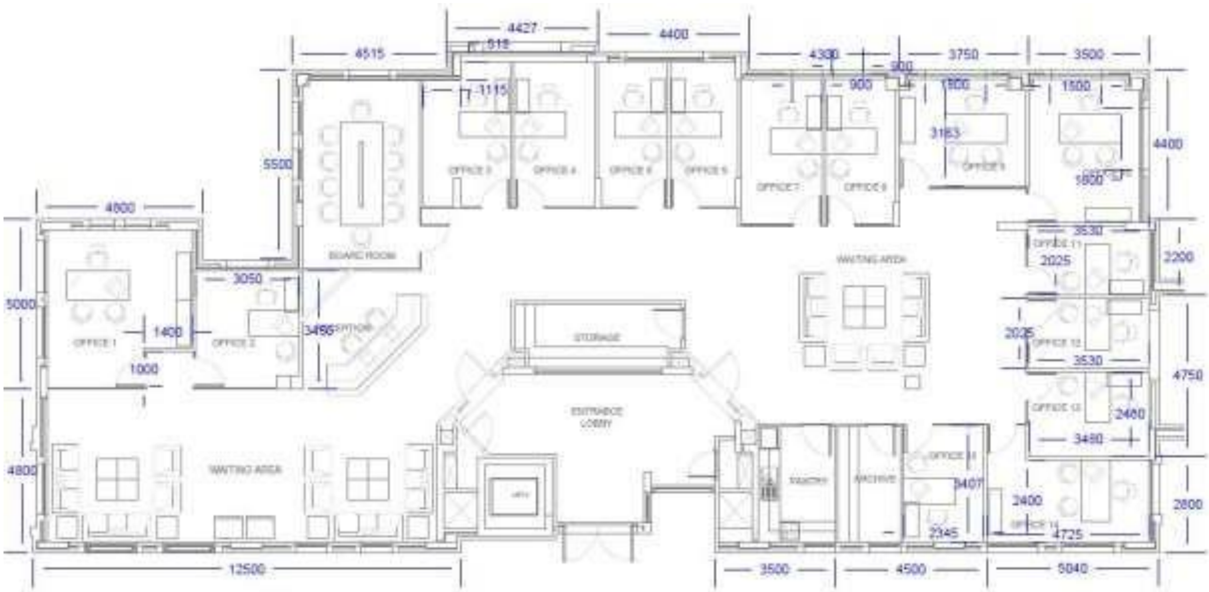
Energy is reduced by less defrosting and a lower load on the refrigeration system. Munters Corporation has taken on the task to manufacture the LDAC technology. The demonstration to date, including the Tyndall demonstration, has shown a critical level of reliability of the LDAC system and identified points of improvement. The sale of the technology shows that Munters Corporation is satisfied with the current state of reliability and willing to commercialize it.

The goal of the project was to quantify energy and water consumption, solar energy utilization, and cost savings relative to DX air conditioners. The LDAC system installed at Thiruvanathapuram was a pre-commercial technology and given that it is one of the solar-powered demonstrations, a fundamental objective of the demonstration was to evaluate the performance of the system and use the lessons learned to develop design/manufacturing guidance for future commercial LDAC systems installation to commercial building.

II. DESIGN AND EXPERIMENTAL SETUP

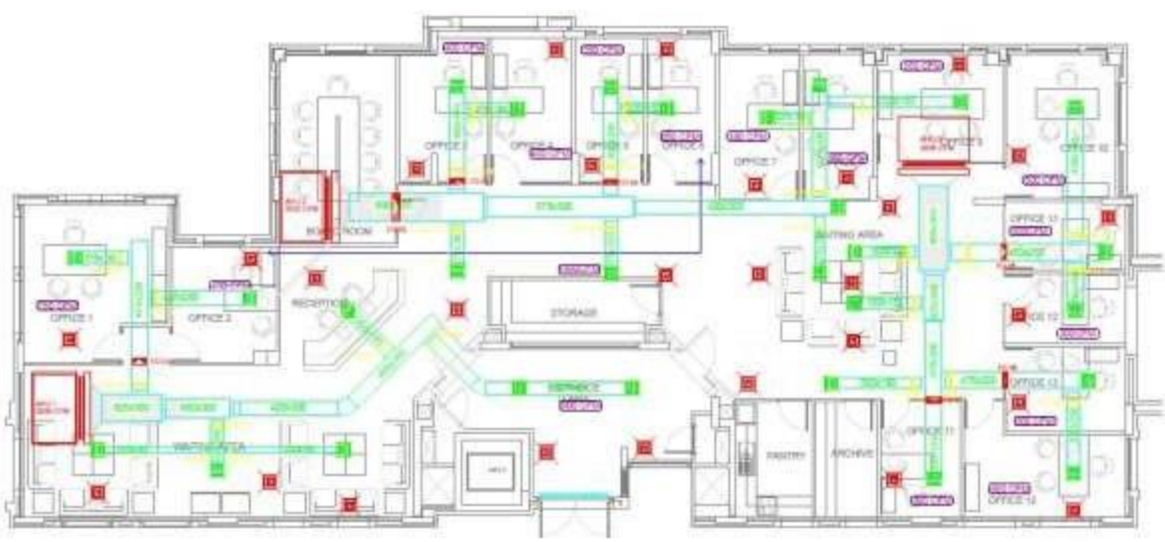
For most we obtained the architectural layout from the client Fig.1. After a detailed study next procedure is to obtain the geographical data of the building. Its collected from the ASHRAE data book. Based on geographical data and building material construction heat load is calculated on E20 excel sheet based on ASHRAE standard. The tonnage calculates is maximum for the given building and is chosen for the construction and installation. In the experimental building, it consists of seventeen number of room including office room, Reception and board room. Heat load for the building is based on occupancy, number of electric equipments, light intensity infiltration, heat gain by solar etc..,

For each room there is a corresponding heat load in tonnage or btu, which corresponds to a multiplication of cfm. Based on the cfm of each rooms size of the duct is calculated in duct sizer (Fig.3). After obtaining the size of the duct the entire plan is re-drawn for the running of the duct with its dimensions Fig.2.



ARCHITECTURE PLAN

Fig. 1: Architectural Plan



DUCT DESIGN LAYOUT

Fig. 2: Single Line Duct Design Layout.

Fig. 3: Figure showing jet numbers

Table 1: Dimensional Specifications of room with corresponding tonnage required area.

Sl No	Room/ Office	Width (m)	Length (m)	Area (m^2)	Ceiling Height (m)	Tonnage Requirement Area (m^2)
1	Office 1	4.8	5.00	24	3	24
2	Office 2	3.05	3.45	10.52	3	10.52
3	Board Room	3.45	5.00	17.25	3	17.25
4	Office 3	2.50	4.20	10.5	3	10.5
5	Office 4	2.3	4.20	9.66	3	9.66
6	Office 5	2.20	4.20	9.24	3	9.24
7	Office 6	2.20	4.20	9.24	3	9.24
8	Office 7	2.30	4.20	9.66	3	9.66
9	Office 8	2.30	4.20	9.66	3	9.66
10	Office 9	3.75	3.16	11.85	3	11.85
11	Office 10	3.50	4.40	15.40	3	15.40
12	Office 11	2.20	3.50	7.70	3	7.70
13	Office 12	2.00	3.53	7.06	3	7.06
14	Office 13	2.48	3.48	8.63	3	8.63
15	Office 14	4.70	2.40	11.28	3	11.28
16	Office 15	4.70	3.4	15.98	3	15.98
17	Office 17			68.25	3	68.25

Based on the design condition we chosen three number of VRV (Variable Refrigerant Volume) HVAC system for the three zones which serves total seventeen rooms. For the three machines the ducting is done as shown in fg:2, by using duct sizer software which is shown in fig:3. Table 1 shows the building tonnage corresponding to its tonnage. Based on the total tonnage of the each zone (Three zones and machines) the entire duct dimension is calculated and which is plotted on Fig:1. Table 2 shows the duct sizing for each machine.

Table 2: Machine 1 Duct Size calculation

	MACHINE 1				
DUCT	LENGTH	WIDTH	HEIGHT	AREA	GAUGE
A1	1742	825	300	3919500	22
A2	1861	550	300	3163700	24
A3	3062	400	300	4286800	24
A4	3456	400	300	4838400	24
A5	1819	300	150	1637100	26
A6	4275	300	150	3847500	26
A7	4499	475	250	6523550	24
A8	1441	350	200	1585100	24
A9	1794	350	150	1794000	24
A10	1640	375	150	1722000	24

A11	2976	425	200	3720000	24
A12	3214	200	150	2249800	26
A13	3414	200	150	2389800	26
PLENUM	2100	200	560	3192000	20

Table 3: Machine 2 Duct Size calculation

MACHINE 2					
DUCT	LENGTH	WIDTH	HEIGHT	AREA	GAUGE
B1	3922	800	350		22
B2	4285	575	300	9020600	24
B3	5892	400	300	7498750	24
B4	3038	450	200	8248800	24
B5	3098	400	200	3949400	24
B7	3098	400	200	3717600	24
B8	1638	375	150	3717600	24
B9	1509	375	150	1719900	24
B10	1273	375	150	1584450	24
B11	1530	375	100	1336650	24
B12	1344	325	150	1453500	24
B13	1153	325	150	1276800	24
B14	3760	325	150	1095350	24
PLENUM	2100	200	560	3572000	20
				3192000	

Table 3: Machine 3 Duct Size calculation.

	MACHINE 3				
DUCT	LENGTH	WIDTH	HEIGHT	AREA	GAUGE
C1	2488	825	300		22
C2	1327	825	300	5598000	22
C3	4602	475	300	2985750	24
C4	4492	450	250	7133100	24
C5	1797	300	150	6288800	26
C6	1797	300	150	1617300	26
C7	4174	475	200	1617300	24
C8	2673	300	150	5634900	26
C9	3903	450	150	2405700	24
C10	2388	350	200	4683600	24
PLENUM	2100	200	560	2626800	20
			total	3192000	
			total+f.s	140035900	

Table 4: Gauge selection

Gauge	sq .mm	sq.feet
20	9576000	103.0748
22	21523850	231.6799
24	90007850	968.8327
26	13514700	145.4705
TOTAL	137893000	1485

Table 4 shows the gauge selection table. Based on the calculation the gauge is fixed. This is because, for each duct depending upon the velocity of air inside the duct and quantity of air, we have to choose the corresponding duct gauge; otherwise it will make too much noise inside the conditioned space by the ramming action of air in the duct. Which make uncomfortable for the occupants? After this procedure ducting is completed by means of fabricated duct. After this the HVAC unit, three VRVs installed which supplies the cooled air to the conditioned space.

The SLDAC unit we can directly purchase from the market depending upon the load condition and cfm to be supplied to the conditioned space. Important facts that to be noted is we have to select only the unit based on the fresh air supply Because the unit is mounted on the intake of the fresh air supply duct portion of the VRV. The air which is dehumidified is being inside the room, it does not require the dehumidification of the entire air which is being inside the conditioned space. So the electric power needed to run the pump is getting reduced. Only the considerable amount of solar energy is only required for the purpose of removing the water content frm the desiccant substance. The desiccant is substance having high affinity towards water at low temperature and less affinity at elevated temperature. The solar pond will helps us to store the heat energy during the night time and also for 24 hours of operational time. The heated water is circulated by means of 0.5HP pump for maximum of half an hour time.

III. RESULTS AND DISCUSSION

Table 5: Tonnage comparison of with dehumidifier and without dehumidifier HVAC system

Area Description	Area (Sq Ft)	Without humidifier (TR)	With humidifier by HAP (TR)	Percentage Reduction in Tonnage (%)
Office 1	258	1.84	1.7	7.61
Board Room	266	1.9	1.74	8.42
Office 2	111	0.79	0.7	11.39
Office 3	112	0.8	0.69	13.75
Office 4	107	0.76	0.68	10.53
Office 5	91	0.65	0.58	10.77
Office 6	94	0.67	0.6	10.45
Office 7	104	0.74	0.65	12.16
Office 8	94	0.67	0.62	7.46
Office 9	126	0.9	0.82	8.89
Office 10	166	1.18	1.08	8.47
Office 11	77	0.55	0.51	7.27
Office 12	77	0.55	0.51	7.27
Office 13	93	0.66	0.59	10.61
Office 14	121	0.86	0.78	9.30
Office 15	86	0.61	0.56	8.20
Reception	1620	11.57	10.6	8.38
total		25.7	23.41	8.91

Dehumidification is the process of removing the water vapour from the supply air. If the water is supplied without removing the moisture content from the air the tonnage of refrigeration is needed is high as compared to removing the moisture content before supplying the conditioning equipment like AHU, VRV or CSU etc. Table 9 shows the comparison of by installing the dehumidifier and without dehumidifier. It shows that approximately 9 percentage of tonnage of refrigeration can be saved for one hours of operation. It will be a factor multiplication of the electric power. The tonnage of refrigeration calculated without the dehumidifier is by means of ASHRAE standard E20 excel heat load table and the second one by Career software called HAP (Hourly Analysis Program). Then the system is designed for the maximum heat load Because it can be adjusted to the desired level by means of VRV by means of VFD.

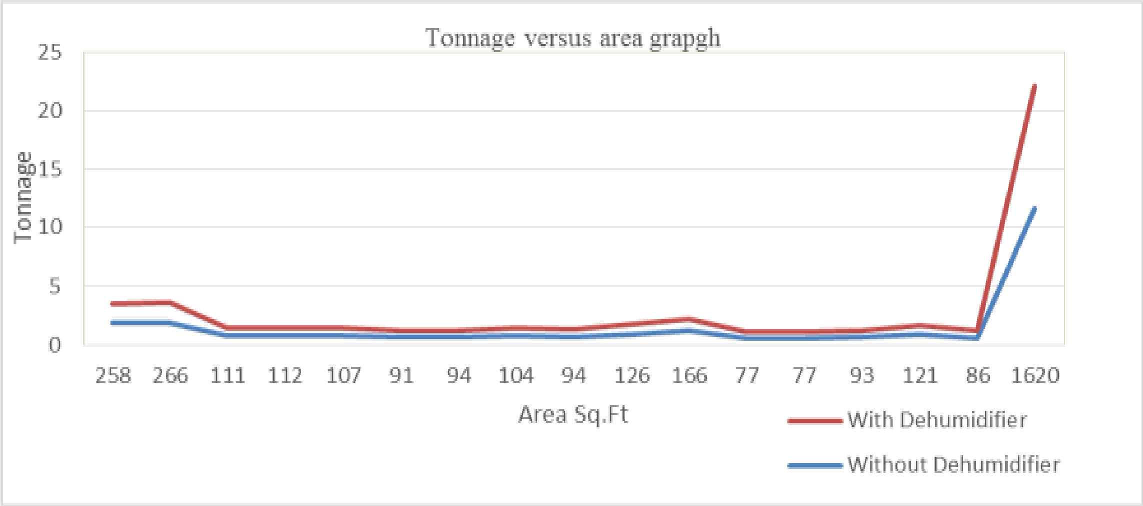


Fig. 4: Tonnage versus area Graph

IV. CONCLUSIONS

In this study, a multi-story building an integrated part of an institution located in Trivandrum was considered for calculating cooling loads. Cooling load temperature difference (CLTD) method was used to find the cooling load for summer (month of May) and monsoon (month of July).Cooling load items such as, people, light, infiltration and ventilation can easily be putted to the MS-Excel program. The program can also be used to calculate cooling load due to walls and roofs.

The results show that the total cooling load for the AC required rooms is 168.03 tons for summer (month of May) and for monsoon (month of July) total cooling load is 153.53tons. The m^2/ton for the building is about 10.9 m^2/ton for summer and 12 m^2/ton for monsoon, which is approximately same, comparing with the standard value about 10 m^2/ton.

The average sensible heat ratio of the building is 0.76 for summer and 0.637 for monsoon. It shows that the cooling load calculation is properly done with well accounted of latent heat came from the people and infiltration, especially in humid weather.

1) The total dehumidify air of building is 1467 m^3/min for summer and 946 m^3/min for winter, for any office building the dehumidify air/m^2 area should have in the range of 0.75 to 0.91 cmm for summer and 0.5 to 65 cmm for monsoon and the dehumidify air/m^2 area of the TIIR building are 0.86 cmm for summer and 0.51cmm for monsoon.
2) It is also seen that in this paper cooling requirement of summer is about 9 % more as compare to monsoon for climate condition of Trivandrum.
3) These all factors show that the cooling load calculation of building is satisfactory and the desiccant wheel can be used where solar energy is available as per the requirement and can be save lot of electrical energy.
4) The power consumption of the desiccant wheel is only small fraction of the total power consumption due the reason that once the air has been dehumidified there is only small quantity of the air is by infiltration has to be dehumidified, for that a small quantity of electricity is to be needed. This is is not significant.

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