

# Analysis and Optimization of Air Conditioning System of Computer Laboratory

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**Abstract**— In today's changing world air conditioning is the basic need of the society. The commercial areas with good environment, clean air flow and more effective air conditioning system are required, while maintaining the basic needful temperature of room with proper tonnage calculations and less energy consumption with an analyzed system at affordable cost. The aim of this paper is to study the designed tonnage capacity of refrigeration done by Design Team for computer laboratory and to analyze the design suggesting proper changes in the design. Further, old design and according to the suggestions new design will be tested on software of refrigeration cycle and the efficient system will be preferred for manufacturing by Manufacturing Team.

**Keywords**— air conditioning system, refrigeration cycle, analyze, design, efficient, tonnage.

## I. INTRODUCTION

In air conditioning system the removal of heat and moisture from an occupied space is done to improve or make occupants comfortable. The geographical factor plays an important role in an air conditioning system. In some cases, air conditioning is preferred to cool or dehumidify rooms containing devices or machines such as computer servers, power amplifiers, and many more mechanical, electronic or electrical components.

The designed team has calculated the tonnage capacity of refrigeration need for computer lab to be 3.82 tonnes. This designed is to needed to study by calculation of coefficient of performance (COP) of the designed model, its power consumptions and many more factors considerations. Thus, by assuming some factors and suggestions the new load will be calculated and further analyzed with the old model. Accordingly the best model will be considered for manufacturing by Manufacturing Department.

## II. LITERATURE REVIEW

**Vandana N. Mahajan, Shankul R. Nagdeve 2016 [1]** the paper is based on the air conditioning system installed in truck cabinet. They focus on increasing efficiency and cool the air with the help of engines exhaust gases, it means they replace the refrigerants with exhaust gases. This system is works on the reversed Brayton cycle. A refrigerant like R12,R22 are harmful for environment but here system is used air as a refrigerant so the effect on environment, ozone layer deflection is minimum as compare to the existing refrigerant. Turbocharger is used as suction device, it sucks not only the exhaust waste gases, but also air from atmosphere. The turbocharger device is also used as expander for cooling the air and it passes to engine. This paper conclude that the turbocharger device with advance system which increase COP of air cycle and because of the efficiency also increases, and this system is less harm to environment.

**XUE Xing, WEI Fenglan, LI Sheng 2016 [2]** the paper is study about air cycle refrigeration technology. For various systems or various purposes the refrigeration cycle will be change according to the condition. The paper shows the simple air refrigeration cycle and explains it, so this paper studies and analyzed the application of air conditioning system and its air cycles which is low temperature laboratory, air conditioning in train and plane, food refrigeration etc.

## III. AIR REFRIGERATION CYCLE & METHODOLOGY

Air refrigeration cycle is the part of the thermodynamic analysis. It is the study of performance of component and cooling load estimation. The refrigeration cycle explain the air in the system of air conditioner what and when we have to change at the troubleshooting if there is as much air conditioner gas. Further after evaluation of the pressure and temperature of evaporator and

condenser we can plot the p-h graph and further if the coil temperatures are subcooled or superheated observed the change in COP of the system is calculated.[5]

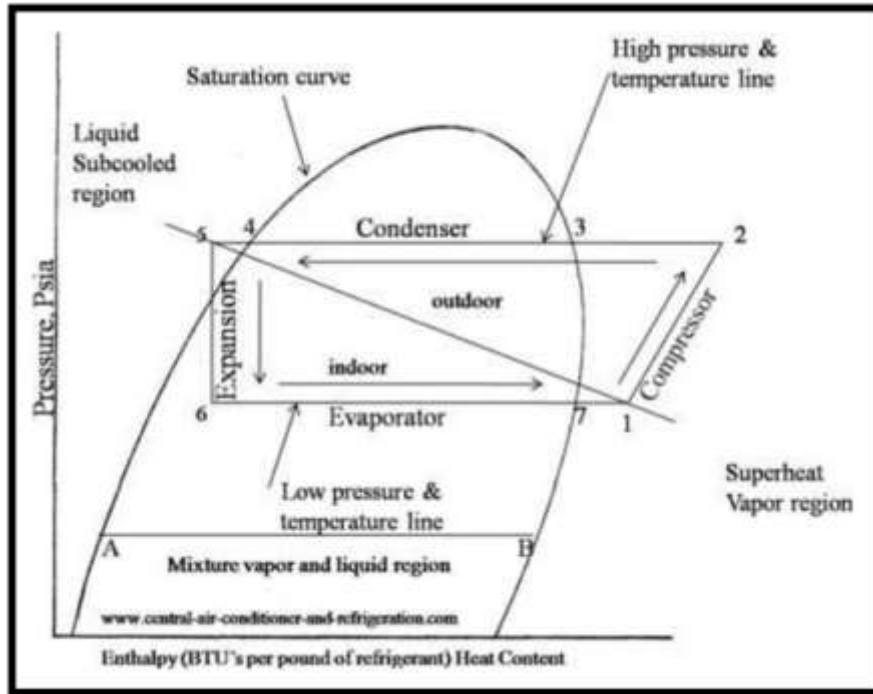


Fig 3.1

### 3.1 Methodology

The cooling load required for computer laboratory cooling is calculated by using standard method of load calculation. The various factors of heat load like solar radiation (roofs, walls, windows) normal heat gain through glass, normal heat gain through wall, air infiltration, number of persons in cabin sensible heat load, Latent heat load is calculated using ASHRAE Hand book. The design team calculations are summarized in following table 3.1 [6].

**Table 3.1**  
**System Calculations (according to the design team)**

Parameter	Values
Laboratory Dimensions	(22×40×12)ft <sup>3</sup>
Laboratory temperature without cooling	35.9°C
Sensible heat of various loads	39574.68 BTU/HR
Latent heat	6302.9 BTU/HR

The refrigeration cycle of R22 gas is prepared on the basis of the data presented by design team is shown below (fig.3.2)

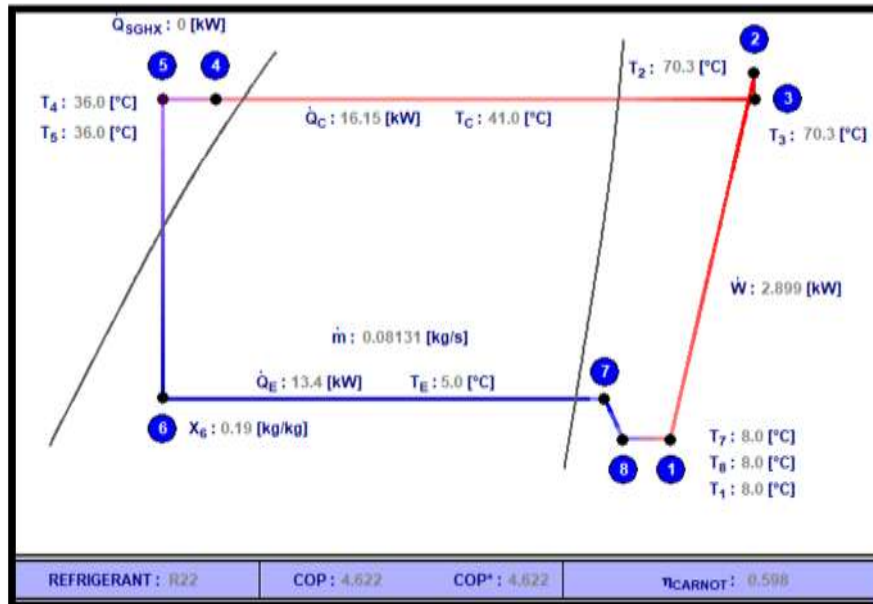


Fig.3.2 Air Refrigeration cycle R22

Further, if changes are made in the coil temperature i.e. if it is subcooled or superheated the COP of the system also changes accordingly. The following table and chart plotted gives the perfect variations in the COP of the System designed.

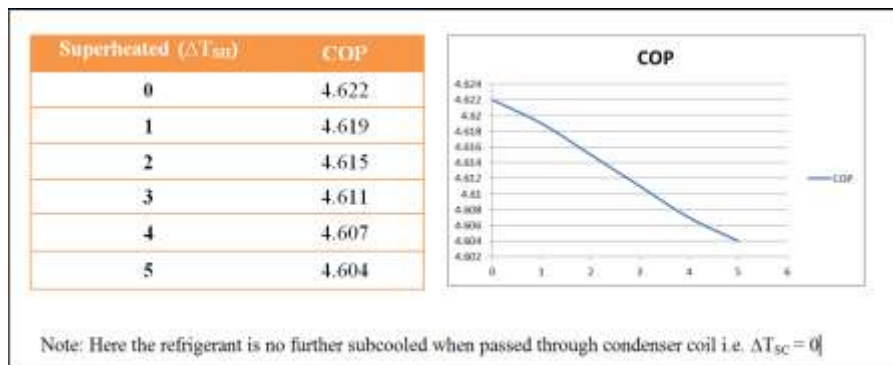


Fig 3.3

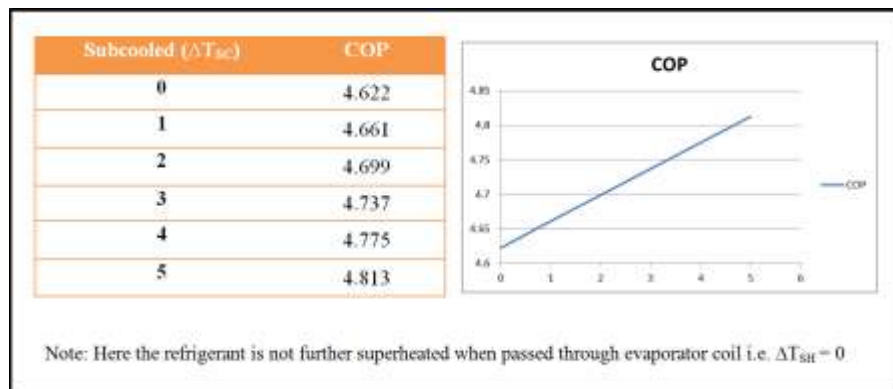


Fig 3.4

### 3.2 Construction and Calculation of New Design

We, suggest manufacturing team to provide 2 inch of insulation to all the interior wall faces. Also provide suspended ceiling and install LED tube lights of 20W in case of florescent tube lights of 40W. And also double glass heat absorbing window while sealing one of the window area completely. The following calculations are achieved assuming the factors mentioned.

Cooling Load calculation from interior		walls excluding window area 54.76 sqft							
Parameters	U	A	CLTDc	Ti	To	ΔT	Q		
NE	0.115	209.24	10.94				<b>263.2448</b>		
SW	0.115	264		76.14	75.2	0.94	<b>28.5384</b>		
SE	0.115	480		76.14	75.2	0.94	<b>51.888</b>		
NW	0.115	480		76.14	75.2	0.94	<b>51.888</b>		
ROOF	0.093	880		76.14	75.2	0.94	<b>76.9296</b>		
FLOOR	0.093	880		76.14	75.2	0.94	<b>76.9296</b>		
CLTD	LM	Tr	Ta	To	DB				
13	-1	75.2	81.14	83.84	5.4				
Occupancy	Sens./pr	Latent/pr		Lighting	Wattage(4)	B.F	CLF		
30	225	105		<b>221.1968</b>	80	0.88	1		
1	250	200							
31	<b>7000</b>	<b>3350</b>							
Equipment				GLASS					
Projector(1)	Computers(25)			Area	U	CLTDc	SHGF	SC	CLF
6912.4	200W	2000W		54.76	1.67	10.94	166	0.3	0.28
				<b>CON.</b>	<b>1000.454</b>		<b>SOLAR R.</b>	<b>763.5734</b>	
Infiltration	Sensible	Latent		Qs	Qt				
	2557.26	1452.9		<b>19004.3</b>	<b>4802.9</b>		<b>Qtotal</b>	<b>23807.2</b>	

$Q_{total} = 23807.2 \text{ BTU/HR} = 6.9\text{kW} \approx 7\text{kW}$ , Sensible Heat factor = 0.80, Conditioned Air = 700CFM.

The surface temperature of evaporator coil is  $T_s = 10.28^\circ\text{C}$ , mixing temperature  $T_m = 25.05^\circ\text{C}$ , while the Dry Bulb1 Temperature  $T_c = 3.95^\circ\text{C} \approx 4^\circ\text{C}$ , thus the evaporator refrigerant temperature is  $-1^\circ\text{C}$ .

Formulae List:-[17]

**Table 3.2**

For wall facing sunlight	$Q = U \cdot A \cdot CLTDc$
CLTDc	CLTD + Latitude & Month correction + (78-Tr)+(Ta-85)
For walls	$Q = U \cdot A \cdot (T_i - T_o)$
For Lighting Load	$Q = W_{total} \cdot \text{Ballast Factor} \cdot CLF$
Solar radiaton(Glass)	$Q = \text{Solar heat gain factor} \cdot \text{Shading coeff.} \cdot CLF \cdot \text{Area}$
Conduction (Glass)	$Q = U \cdot A \cdot CLTDc$
Equipment	$Q = W_{total} \cdot 3.142$

(Note: All formulas for calculation of cooling load are as per old design and also the data of infiltration load.)

The tonnage capacity is reduced to approximately (1.984) 2 tones. This reduces power consumptions by the refrigeration system, thus saving the energy and environment. Also the COP of the system is increased as shown in the Fig. 3.5

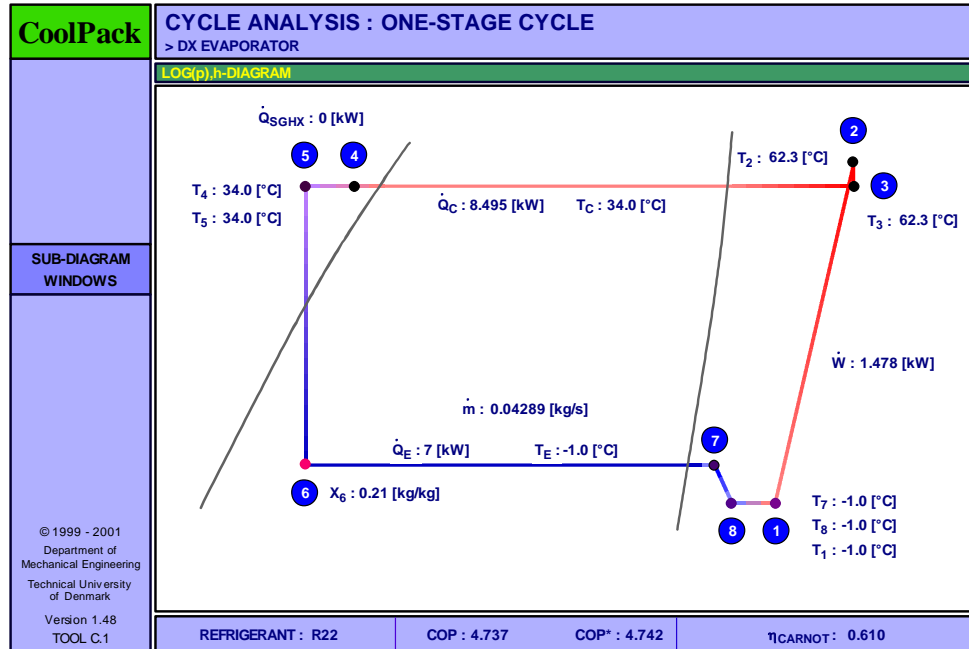


Fig 3.5

The Table 3.3 shows the comparison of both the Designs, as some factors are to be considered the initial costing for insulation purposes, is high, but overall reduced the energy consumption and bring the differences in the costing in future.

Table 3.3

Parameters	Old Design	New Design
Compressor Rating	2.9kW	1.5Kw
Power Consumption for 4 Hrs	12kWh	6kWh
COP	4.622	4.737

#### IV. CONCLUSION

The changes made in the old design such as providing insulation, installing double heat absorbing translucent glass, installation of LED tube lights has considerably saved a lot of energy consumption. Also if the refrigerant is subcooled and simultaneously superheated or only subcooled there is rise in COP of the system also the energy consumption is decreased. So, we analyzed that if one of the above suggested changes in the old design if implemented the system will be efficient.

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