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Analysis of the air system of the 2-floor electronics industry building PT. CI

Srihanto*, Moch.Sugiri, Parman Sinaga, Prio Sejati

* Faculty of Industrial Technology, Budi Utomo Institute of Technology, Jakarta, Indonesia

*✉ srihanto58@gmail.com

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Abstract: For urban areas and Jakarta's industrial sector, air freshener systems and air conditioners are becoming increasingly necessary. At the electronics-focused PT. CI Jakarta, the air conditioner cools the space. The goal of this research is to raise staff comfort levels and productivity levels in order to enhance output. Planning information and a cooling load analysis are needed in order to implement the cooling system in the industrial building. To determine how much AC (Air Conditioner) is required, it is important to analyze the calculation of the design of the AC (Air Conditioner) in the industrial room at PT. CI. The first step in the planning process is to identify the industrial building data, which includes the room's area and wall material as well as its contents. Analyze cooling load to calculate engine power. Choosing a cooling system and cooling. The cooling load analysis at the electronics industry building produced 712 kW of results, including a sensible load of 705.83 kW and a Latent load of 3.03 kW. The machine uses R134a as its refrigerant. 355.5 HP for the compressor. COP 2.77 is of a medium size. The central AC system was chosen as the cooling system.

Keywords: Industry; burden; coolers; system; power

1. INTRODUCTION

The natural climate in the Jakarta region is extremely hot, with temperatures ranging from 27 to 34 C, making it less comfortable in homes, workplaces, or businesses. As a result, the work ethic declines [1]. Due to this, it is necessary to have an air conditioner (AC), which works to lower the temperature of the air in a room, starting in homes, offices, hotels, and hospitals, as well as in enterprises [2][3]. By keeping the air cool and at the right humidity level, AC air conditioning provides comfort [4].

The issue is how big of an air conditioner is required to chill the space so that it is cool or frigid. If the space is large, has a variety of tools, and has individuals using them for various purposes [5]. The room's air conditioning system is then chosen or put into use based on the needs of the cooling device. It is required to first calculate the cooling load requirements in order to define the specifications and the cooling system [6]. The energy needed to control a room's temperature and humidity so that it corresponds to the environment in the room and the activities taking place there is known as the cooling load [7]. The building's internal layout, dimensions, location, and form all affect the cooling load [8].

This study's objective is to evaluate the cooling requirements for the electronics industry building, where the interior temperature is still too warm. So that the room temperature is as desired, it is necessary to add a cooling device. then calculate the room's or industrial building's cooling demand and the cooling device's power consumption [4].

2. METHOD

2.1. Research flowchart in design

The flowchart shows how research is carried out up till the research report is written. Diagrams of the study sequence that serve as a thinking foundation. The research process follows Figure 1 starting from the data collected for analysis that will be used or required when executing the study.

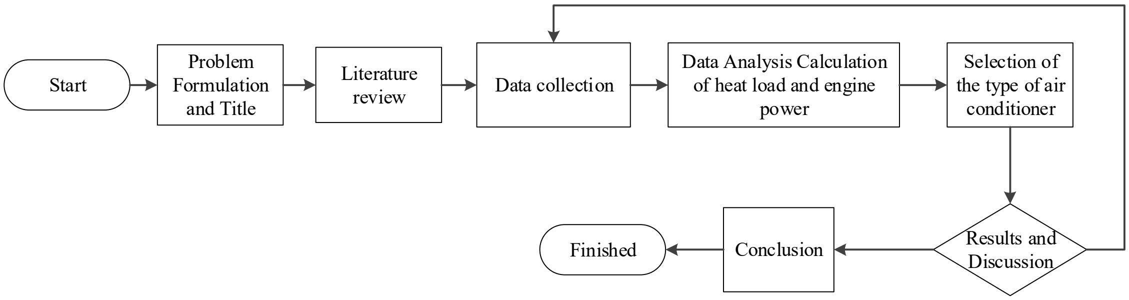

Figure 1. Research flowchart.

2.2. Research Approach

Planning is the research methodology employed in this investigation. Inductive or descriptive-deductive research methods are employed. Each stage of planning is completed in stages and has an inductive job description (an strategy that moves from micro to macro).

2.3. Literature review

References from several literature on air conditioning systems, energy conversion, thermodynamics, and heat transfer are utilized to analyze the heat load and power of the room compressor. Other resources for planning data include scientific journals, the Google Web, and field research [9].

2.4. Data collection

The next stage is to gather data after defining the issue and study goals. Data collection requires observation, specifically observation including all five senses (sight, hearing, smell, and taste). Electronic tools can be used for recording. Direct source interviews conducted face-to-face and through communication means resulted in the observations. The information gleaned from the sector is:

Building Name : PT. CI.
Activity : Electronics Industry
Building Type : Electronics Industry Building
Location : Jakarta
Size : 25 x 40 x 10 m
Number of floors: 2 floors.
Floor Data I:

- number of lights : 8 units (55 Watts/unit)
- Number of Doors : 2 units (size 1500 mm X 2000 mm)
- the number of glass windows : 8 units (size 400 mm X 500 mm)
- number of people : 15 People
- number of machines : 9 units (5.5 kW, 30 kW, 15 kW, 30 kW, 15 kW, 5.5 kW, 30 kW, 15 kW, 15 kW)

Data floor II:

- Number of lamps : 6 units (55 Watt/unit)
- Number of Doors : 2 units (size 1500 mm X 2000 mm)
- Number of glass windows : 6 units (size 400 mm X 500 mm)
- Number of people : 20 people
- Number of engines : 3 units (30 kW, 15 kW, 5.5 kW)

Room temperature planning data:

- Planned room temperature : 23°C
- Outdoor temperature : 32° C
- RH planned : 55 %
- Outdoor RH : 80 %

2.5. Heat load analysis

In the analysis of heat load in the industrial room is as described:

a. Sensible load.
   - Heat transmission through building materials, roofs, walls, glass
   - Partitions, ceilings, and floors
   - Solar radiation through glass windows
   - Heat from lights or lamps
   - Radiation of heat from the occupants of the room
   - Heat from additional equipment from the room
   - Heat from electromotor production machines
   - The addition of sensible heat due to the addition of indoor air (Ventilation) the difference in indoor and outdoor air temperatures.

b. Latent heat load
   - Heat from the occupants of the room
   - Heat from the air infiltrates the room
   - The addition of ventilation latent heat due to humidity in the air inside and outside.

2.6. Determine Compressor Power and Type of AC used

After the AC load can be determined, the next step is to determine the engine or compressor power used and determine the type of AC to be selected.

3. RESULTS AND DISCUSSION

The conditions for determining the cooling load are determined on June 25, 2021, between 12 and 14 WIB, during the hottest month and hour. The size of the cooling machine employed is determined by the cooling load calculation analysis carried out in the two-story Electronic Industry building. In order to maximize the productivity of the workers in the space and increase production, it is intended for inside to have a steady temperature and to avoid outside situations where the temperature fluctuations [10]. A temperature of 23°C is anticipated indoors. Since both internal and exterior variables can affect a room's cooling, it is necessary to have adequate design information and structures. Then, in order to get accurate results, both data from within the building and data from outside the building are thoroughly evaluated [11].

3.1. PT.CI electronic industry building planning data

3.1.1 Building Data

Building Location : North Jakarta
Building Function : Electronics Industry
Number of Floors : 2 floors
Room Dimensions : Long; 40 m, Width: 25 m, Height: 10 m
Building area : 1000 m^2 (P 40 m x L 25 m)
Building Volumes : 10000 m^3 (40 mx 25m x10 m)

1st floor:
Type : Bricks with cement plaster inside and out.
Thickness : 15 cm : 0,15 m
Plastered Outside and Inside : 1,6 cm
Number of Doors Lt 1 : 2 unit (1,5 mx 2 m)
Number of Windows Lt 1 : 8 unit (50 mx 40m)
Glass Type : Plate regulators
Number of Machines : 9 unit
Number of people : 15 Person

Floor 2:
Type : Bricks with cement plaster inside and out.
Thickness : 15 cm : 0,15 m
Plastered Outside and Inside : 1,6 cm.
Number of Doors Lt 2 : 2 unit 1,5 m x 2m)
Number of Windows Lt 2 : 4 unit (40 m x 50 m)
Glass Type : Plate regulators

Number of Machines : 3 Unit
Number of people : 20 Person

3.1.2 Outdoor air conditions.

Based on observations by the Center for Meteorology, Climatology, and Geophysics (BMKG) for the city of Jakarta, and existing data:

- Dry ball temperature : 32 ºC: 305 ºK
- Relative humidity : 77 %

From the psychrometric chart images obtained:

- Wet bulb temperature : 28,3 ºC: 301,3 ºK
- Moisture content : 0,021 kg/kg dry air.
- Daily temperature changes : 70C

3.1.3 Air condition in design

For office buildings, the room temperature will vary, but for this design, the average temperature is taken as follows:

- Dry ball temperature : 23 º C: 296 ºK
- Relative Humidity : 55 %
- From the psychrometric chart image obtained (1):
- Wet bulb temperature : ±15 ºC: 281 ºK
- Moisture content : 0,011 kg/kg dry air

3.2 Analysis of heat load from outdoors through window panes**.**

The material used for the glass is ″Flat and heat-resistant glass″ with a thickness of 12 mm.

a) Radiation load through the 1st-floor window glass.

$$Q_S = A.S_C.SHGF.CLF \quad (1)$$

Where:
Qs : Sensible Heat Window Radiation
A : Window glass area (0,40 m x 0,5 m) x 8 = 1,6 m^2
Sc : Shading coefficient = 0,59
SHGF: Solar Heat Gain Factor (Additional factor Maximum heat radiation) = 162 Btu/h ft^2 = 47,47 Watt/ft^2 = 510,98 Watt/m^2
CLF : Cooling Load Factor
CLF :0,39
Qs = 1,6 m^2 x 0,59 x 510,98 Watt/m^2 x 0,39 = 188,12 Watt (0,19 kW)

b) Conduction loads through the glass of the 1st Floor Window:

$$QJK = U.A.CLTD \quad (2)$$

Where:
U = Heat Transfer Coefficient (U) = 1,10 Btu/h ft^2 x 0,293 Watt /0,0929 = 3,47 Watt/m^2 [18].
A = Window glass area = 1,6 m^2
CLTD= Cooling Load Temperature Differential = 9ºC = (32-23) ºC = 9 ºC
QJK = 3,47 Watt/m^2 x 1,6 m^2 x 9ºC = 49,97 Watt (0,050 kW)

Table 1. The results of the calculation of the radiation and conduction sensible loads through the window glass area (Q1j).

Floor	A (m^2)	Q_{jr} (kW)	Q_{jk} (kW)
1st Floor Radiation	1,6	0,19	-
Conduction Floor 1	1,6	0,050	-
2nd Floor Radiation	0,8	-	0,094
Conduction Floor 2	0,8	-	0,025
Q $Total_j$		0,24	0,119

The calculations used to determine the heat load for the second level's glass windows are the same as those used to get the heat load for the first floor. The outcomes are displayed in **Table 1**.

3.3 Calculation of the heat load on the east wall of floor 1 (QDT)

$$QDT = U \times A \times CLTD \quad (3)$$

Where:

A = East wall area = (Wall area – windows and doors)
= [(25 x 10) – (1,5 x 2) m^2]= [(250) – (3)]
= 247 m^2.
U = 1 / Rtot = Heat transfer coefficient R. Cement plaster walls and lightweight aggregates.
Rtot = R1 + R2 + R2 = 1,39 + 1,94 + 1,39 = 4,72 m^2 K/W
U = 1/(4,72) = 0,21 W/m^2 K
CLTD = 24, east wall.
CLTD correct
CLTDcorr = {(CLTD + (25 – ti) + (t rar – 29)}

Where:

ti = indoor design temperature = 230 ºC
trar = outdoor temperature from the data = 320 ºC
CLTD Corr = {(CLTD + (25 – ti) + (t rar – 29)}
= {(24 +(25 – 23) + (32 -29)}
= 29 ºC = 302 K
Qdt = U x A x CLTD
= 0,24 W/m^2 K x 291,8 m^2 x 302 K
= 21149,7 W or 21,15 kW

3.4 Calculation of the heat load on the west wall of the 1st floor

$$QDB = U \times A \times CLTD \quad (4)$$

Where:

A = West wall area – Window area (2 units)
= Number of Windows 2 units (40 cm x 50cm)
= (25 x 10)- (0,5 x 0,4) 2 = 299,8 m^2
U = 0,24 W/m2 K
CLTD = 8 (west wall)
CLTDcorr = {(CLTD + (25 – ti) + (t rar – 29)}
= {(8 + (25 – 23) + (32-29)}
= 130C = 286 K
Q2db = 0,24 W/m^2 K x 299,8 m^2 x 286 K
= 20578,3 W or 20,58 kW

3.5 Calculation of the heat load on the north wall of the 1st floor

$$QDU = U \times A \times CLTD \quad (5)$$

Where:

A = area of the north wall. minus window area (3 units)
= [(40 x10) - 0,4x0,5) 3 = 394 m^2
U = 0,24 W/m^2 K
CLTD = 8 (north wall)
CLTDcorr = {(CLTD + (25 – ti) + (t rar – 29)}
= {(8 + (25 – 23) + (32-29)}
= 13 0C = 286 K
Qdu = 0,24 W/m^2 K x 594 m^2 x 286 K
= 40772 W or 40,77 kW

3.6 Calculation of the heat load on the south walls of the 1st floor

$$QDS = U \times A \times CLTD \quad (6)$$

Where:

A = the area of the south wall minus the area of the windows and doors
= [(40 x 10) – (0,4 x0,5) 3 – (1,5 x 2)] = 400 -0,6-3
= 396,4 m^2
U = 0,24 W/m^2 K
CLTD = 15 south wall.
CLTDcorr = {(CLTD + (25 – ti) + (t rar – 29)}
= {(15 + (25 – 23) + (32-29)}
= 20 0C = 293 K
Qds = 0,24 W/m^2 K x 396,4 m^2 x 293 K
= 27874,9 W or 27,88 kW

3.7 The total heat load on all walls is (Q2d)

$$QD = QDT + QDB + QDU + QDS \tag{7}$$

Table 2. Calculation results of the heat load of the coolant through the walls of floors 1 and floors 2 (Q2d).

Floors	Q_{dt} (kW)	Q_{db} (kW)	Q_{du} (kW)	Q_{ds} (kW)	Q_d (kW)
1st floor	21,15	20,57	40,77	27,88	110,37
2nd floor	21,15	20,58	40,77	27,9	110,4

The calculation for the heat load and cooling load on the second floor's walls is shown in Table 2, and it is the same as the calculation for the heat load on the first floor's walls. Table 4 presents the findings.

3.8 Analysis of the heat load of the coolant through the door (QP)
The door on the 1st floor is made of 10 mm steel plate, 2 units in total.

Where:
A = door area (1,5 x 2) m x 2 unit = 6 m^2
U = 1/R x R = Door heat transfer coefficient of aluminum or steel plate 10 mm R = 0,32 m^2/ KW.
CLTD = door facing east and south (24. & 15.)/2 = 19,5
CLTDcorr = {(CLTD + (25 – ti) + (t rar – 29)}
= {(19,5 + (25 – 23) + (32-29)}
= 24,5 0C = 297,5 K
Qp = 0,32 x 6 x 297,5 = 571,2 Watt
= 0,57 kW

Table 3. Coolant heat load through the doors on the 1st floor and 2nd floor.

Floor	A (m^2)	Number of doors (Units)	Qp (kW)	Qp (kW)
1st floor	(1,5x2)	2	0,57	-
2nd Floor	(1,5x2)	2		0,57

Table 3 shows the calculation for the heat of the cooling load through the second-story door, which is done after the calculation for the heat of the cooling load on the first level.

3.9 Calculation of the heat load of the coolant through the roof of the 1st floor
The roof is made of concrete cast cement and sand.

$$Q_a = U \times A \times (tr - to) \tag{8}$$

Where:
A = Refrigerated room area (m^2)
= 40 x 25 = 1000 m^2
U = The total heat transfer coefficient of corrugated roofing materials)
R = 1,94 m^2·K/W for 1st floor

U = 1/R = 1/1,94 = 0,52 (W/m^2 K)R= for the 2nd floor, Total Heat Transfer Coefficient of roofing materials concrete cement and sand 20 mm (wavy)
U = 1/R = 1/1,94 = 0,52 m^2 K/W
t_i = dry bulb temperature in the design chamber (23^{0}C = 296 K)
t_{rat} = design outdoor dry bulb temperature (32°C = 305 K)
Q_a = 0,52 W/m^2 K x 1000m^2 x (305- 196) K
= 56680 W or 56,7 kW

Table 4. Results of heat analysis of cooling loads on floors 1 and floors 2

Floor	R (m^2 K/W)	Qa (kW)	Qa (kW)
1st floor	1,94	56,7	-
2nd Floor	1,94	-	56,7

Table 4 the calculation of the heat of cooling load through the door on the 2nd floor follows the calculation of the heat of cooling load on the 1st floor.

3.10 Calculation of the heat load of the coolant through the floor Table 5

$$Q_l = U \times A(tr - o) \quad (9)$$

Where:
A = Refrigerated room area (m^2) = 40 x 25 = 1000 m^2
U = The total heat transfer coefficient of the floor of lightweight concrete R = 1,39 m^2·K/W.
U = 1/R = 1/1,39 = 0,72 (W/m^2 K)
t_i = dry bulb temperature in the design chamber (23^{0}C = 296K)
t_{rat} = design outdoor dry bulb temperature (32°C = 305K)
Q_l = 0,72 W/m^2 K x 1000 m^2 x (305- 196) K
= 78480 W or 78,5 kW.

Table 5. Results of floor heat analysis on floors 1 and floors 2.

Floor	R (m^2 K/W)	Ql	Ql
1st floor	1,39	78,5	-
2 nd floor	1,39	-	78,5

3.11 Heat analysis of cooling load on lights in buildings Table 6.

$$QLP = Input(W) \times F_b \times F_b \times CLF \quad (10)$$

Where:
Input (W): is the number of watts of light installed in the room to be cooled.
Floor 1 = 8 units, 55 Watt/unit
2nd floor = 6 units, 55 Watts/unit.
In this room the number of lamps installed.
Input Floor 1 = 8 x 55 W = 440 Watts
Input Floor 2 = 6 x 55 W = 330 Watts
CLF = Cooling load factor. Usage 10 hours = 0.85
Fb = Fluorescent lamp ballast factor 1.2.
Fu = Usage factor or usage fraction of installed lamps (0.97)
Q_{Lp} = 440 x 0,97 x 1,2 x 0,85 (Watt)
= 435,3 W or 0, 44 kW.

Table 6. Results of the analysis of the cooling load on the 1st and 2nd-floor lamps.

Floor	Number of lights	Qlp (kW)	Qlp(kW)
1st floor	8	0, 44	-
2nd floor	6	-	0,33

3.12 Heat calculation of floor office equipment 1

a) Computer = 2 units (150 Watt/unit)
b) Infocus = 1 unit (800 Watt/unit)

c) Cooler = 1 unit (300 Watt/unit)
Total Load = (2x150) Watts + 800 Watts + 300 Watts = 1400 Watts.

$$QAL = N \times HG \times CLF \qquad (11)$$

Where:
N = Number of Equipment (Watts)
a) Computers = 2 Units (150 Watt/unit), 2nd Floor = 6 units
b) Infocus = 1 Unit (800 Watt/unit), 1 Infocus
c) Cooler = 1 Unit (300 Watt/unit) 2nd floor = 1 Cooler
Total Load Floor 1 = (2x150) Watts + 800 Watts + 300 Watts = 1400 Watts = 467 Watts/unit)
Floor 2 = 6 x 150 + 800 + 300 = 2000 Watts
HG = Cooling load factor issued by the equipment: 1400 Watts
CLF = Coolant load factor that is affected by the time of use = 0.85
Chlorine load Equipment 1st floor, according to Table 7.
Qal = 1400 x 0,85
= 1191W or 1,19 kW

Table 7. Results of indoor equipment load analysis.

Floor	Total (Watts)	Qal (kW)	Qal (kW)
1st floor	1400	1,19	-
2nd Floor	2000	-	1,7

3.13 Analysis of the heat load of the production machine on the 1st floor Table 8
There are 9 units of machines on the 1st floor:
With each power on the data is:
a) Machines 1 = 5.5 kW
b) Machines 2= 30 kW
c) Machines 3= 15 kW
d) Machines 4= 30 kW
e) Machines 5= 15 kW
f) Machines 6= 5,5 kW
g) Machines 7= 30 kW
h) Machines 8= 15 kW
i) Machines 9= 15 kW +
Total = 161 kW or average = 18 kW/unit.
Number of machines on the 2nd-floor number of machines = 3 units.
Machines 1 = 30 kW
Machines 2 = 15 kW
Machines 3 = 5,5, kW +
Total = 55,5 kW or average = 18,5 kW/unit.
The heat load of the production machine**.**

$$QM = n \times HG \times CLF \qquad (12)$$

Where:
HG = Cooling load factor issued by the equipment.
Hg = 18 kW/unit (1st floor)
CLF = Cooling load factor affected by usage time (10 Hours) = 0,85
Qm = 9 x 18 x 0,85 = 137,7 kW,

Table 8. Results of engine load analysis.

Floor	Power (kW)	Qm (kW)	Qm (kW)
1st floor	161	137,7	-
2nd floor	55,5	-	47,18

3.14 Calculation of heat occupants in the room on the 1st floor.

3.14.1 Calculation of the sensible burden of people or production and administrative work.

$$QOS = n \times SHG \times CLF \quad (13)$$

Where:

n = The number of occupants in the room who are conditioned to sit down and work lightly in the office on the 1st floor: 15 people: while on the 2nd floor = 20 employees.
SHG = Sensible heat factor released by humans: workers: (0.55% of 150 Watts) = 82.5 Watts.
CLF = Cooling load factor that is affected, when occupants are in the room (10 hours): 0.89
Qos = 15 x 82,5 x 0,89
= 11013,4 W or 1,1 kW

3.14.2 Latent caloric calculation Table 9

$$QOL = n \times LHG \times CLF \quad (14)$$

Where:

LHG = Latent heat factor emitted by humans.
= 150-82,5 = 67,5 Watt
CLF = Latent calorie for person = 1
Qol = 15 x 67,5 x 1 = 10125 W or 1,01 kW

Table 9. Heat gain from residents.

Activity	Heat Gain, (W)	Heat Gain, (W)
Sleep	70	75
Sit down, calm down	100	60
Stand	150	50
Walk	305	35
Occupation (office)	150	55
Discussion	175	50

Table 10. Results of employee load analysis in the room.

Floor	Number of people	Sensible Heat (Qos) (kW)		Latent heat (Qol) (kW)	
1st floor	15	1,1	-	1,01	
2nd Floor	20	-	1,65	-	1,35

3.15 Heat load of ventilation and infiltration air

The amount of air infiltration is determined based on the outside air that enters through the window slits and open doors [12]. Infiltration load is divided into sensible heat load and latent heat load which is explained in **Table 9**. While the ventilation load depends on the number of people in the room, the air requirement for 1 person is 2.5 ltr/s which is explained in **Table 10** [13].

A. Sensible ventilation heat calculations (QVS)

$$QVS = (1{,}23).(Q").(t_0 - t_i) \quad (15)$$

Where:

Q” = Outside air volumetric flow rate L/dt
The need for every 1 office worker is = 2,5 l/dt
Q” = 15 x 2,5 l/dt = 37,5 l/dt
Q“ = floor 2 = 20 x 2,5 l/dt = 50 l/dt
t_0 = Outdoor air temperature, (32°C).
t_i = Indoor air temperature, (23°C).
Qvs = 1,23 (37,5) (32-23) = 415,13Watt (0,15 kW).

B. Latent permeability and ventilation loads (QVL) at Table 11.

$$QVL = 30Q'(w_0 - w_i) \quad (16)$$

Where:

W_0 = Outside air humidity 32 °C, Relative Humidity (RH) = 77 %
W_i = Room humidity. On 23 °C, RH = 55 %
QVL = 30 Q' ($w_0 - w_i$)
= 30 (37,5 lt/dt) (0,77-0,55)
= 247,5W or 0, 25 kW.

Table 11. Results of ventilation cooling load heat analysis.

Floor	Sensible Load (kW)	Latent load (kW)
1st floor	0,15	0,25
2nd Floor	0,55	0,33

3.16 The results of the heat load analysis of the building on the 1st and 2nd floors of the building.

Table 12 results of the heat load analysis of the building on the 1st and 2nd floors of the building

Table 12. Results of the heat load analysis of the building on the 1st and 2nd floors of the building.

No.	Component	Sensible Load (kW)		Latent Load (kW)	
		1st floor	2nd Floor	1st floor	1st floor
	External heat load:				
1	Window heat load (Ql)	0,24	0,119	-	-
2	Wall heat load (Qd)	110,37	110,4	-	-
3	Door heat load (Qp)	0,57	0,57	-	-
4	Roof heat load (Qa)	56,7	56,7	-	-
5	Floor heat load (Qla)	78,5	78,5	-	-
	Internal heat load:			-	-
6	Lamp Heat Load (Qlp)	0,44	0,33	-	-
7	Equipment Heat Load (Q al)	1,19	1,7	-	-
8	Machine Load (Qm)	137,7	47,8	-	-
9	Occupant Heat Load (Qol)	1,1	1,65	1,01	1,35
10	Ventilation Load	0,15	0,55	0,25	0,33
	Amount	386,96	298,32	1,26	1,68
11	Safety Factor 3 %	11,61	8,94	0,03	0,06
	Amount	398,57	307,26	1,29	1,74
	Total Latent and sensible load of floor 1	399,86 kW			
	Total Sensible and Latent Load Lt 2	309 kW			

The total load:
Total Sensible load of Floors 1 and 2 = $Q_{sl1} + Q_{sl2}$ = 398,57 + 307,26

$Q_{s1} + Q_{s2}$ = 705,83 kW

The sum of the latent loads on floors 1 and floors 2 = Ql1 + Ql2 = 1,29 + 1,74

Ql1 + Ql2 = 3,03 kW

Total sensible latent load and floors 1 and 2 (Qt) = 708,8 + 3,03 = 711,9 kW or Qt = 712 kW.

3.17 Analysis of the selection of the type of cooling system

To give workers a comfortable work environment, office or industrial facilities need to have fresh air. It is frequently utilized in situations involving air fresheners to safeguard office supplies [14]. Due to this, while selecting a cooling system, installation, operational, and economic variables, namely upfront expenses, ongoing costs, and maintenance costs, must be taken into account.

3.17.1 The operational and maintenance factors include:

a) Simple construction, and easy to install.
b) Long lasting.

c) Easily repaired when there is damage.
d) Easily available in the market.
e) Can serve to changing operating conditions.
f) High efficiency.

3.17.2 There are several types of air fresheners according to cooling load
a) Cooling Load 1-4 TR Type of room air freshener, i.e. Split or Cassette type.
b) The load is a 2-10 TR Type of Air Conditioning (AC) Package. 10 - 30 TR Split Duct AC Type.
c) Moderate 50 - 1000 TR AC Central.

3.17.3 Determine the cooling machine to be used

Based on the conversion of the cooling load of the air freshener system to TR, or tons of refrigeration, building cooling loads are frequently estimated. One TR equals 12000 BTU/hour or 3517 Watts [15]. The overall cooling load in the electronics industry building (Qt) was calculated to be 712 kW. In order to determine the cooling load or capacity from the cooling load calculation results, namely: Capacity for Cooling (Qe) = $\frac{Gt}{3517\,W} \times 1\,TR.\,Qt = \frac{712000}{3517} \times 1\,TR = 202{,}45\,TR$

3.17.4 Determine the compressor power on the refrigeration machine.

While the outside temperature is 32 °C, the design temperature for the indoor air conditioning in this industrial facility for electronics is 23 °C. such that 23 °C - 8 = 15°C is the engine temperature on the evaporator. and the condenser's temperature is 32 + 8 = 40 °C [16]. It is obtained by using a sub-cooler and a 5 °C sub heater, which are typically seen in cooling machines: Temperature of the refrigerant leaving the evaporator T1 = 15 + 5 = 20 °C Figure 2.
a) Compressor exit temperature T2 = 40 +22 = 62°C
b) Condenser exit temperature 40 - 5 = 35°C.
c) From the price table the refrigerant enthalpy:

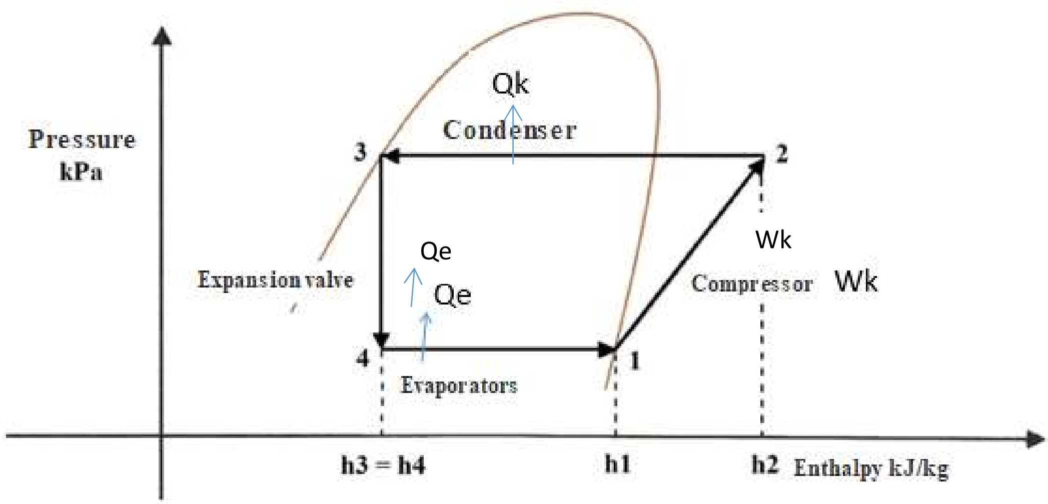

Figure 2. Diagram of the refrigeration cycle.

1) From the refrigerant 134a table, the enthalpy value is obtained.
   a) From the refrigerant 134a table, the enthalpy value is obtained.
      - Enthalpy (h1) Refrigerant enters the compressor at 20 °C, hg = 390 kJ/kg
      - Enthalpy (h2) Refrigerant leaving the compressor at 62 °C, hg = 445 kJ/kg
   b) Process 2-3 condensation
      - Enthalpy (h3) exit condenser temperature 35 °C, hf = 240 kJ/kg
      - Enthalpy h3 = h4 refrigerant enters and exits the expansion
2) Determining refrigerant flow (m)

$$Qe = m(hl - h44)$$

Where:

m = Refrigerant flow rate (kg/dt).
Qt = Cooling capacity = 712000 Watt
712 kW = m (490 kJ/kg – 240 kJ/kg).

$$m = \frac{712\ kW}{150\ kJ/kg} = 4{,}75\ kg/dt.$$

3) Large compressor power (W).

W = m (h2-h1)
= 4,75 kg/dt (445 – 390) kJ/kg
W = 261,25 kJ/dt = 261,25 kW

Internal compressor power HP = 261,25 x 1000/735 = 355,44 HP.
Rounded up to compressor power (Wk) = 355,5 HP.

Determining COP (Coefficient of Performance) Prices

For AC engine work planned as follows:

$$COP = \frac{Refrigeration\ effect}{compressor\ work} = \frac{m(h1-h4)}{m(h2-h1)} = \frac{Q}{W}$$

$$COPac = \frac{712\ kJ/dt}{261{,}25\ kJ/dt} = 2{,}7$$

In order to calculate the efficiency of the refrigeration circuit, the real COP value (Coefficient of Performance) is employed to express the performance of the refrigeration circuit [17].

3.18 Discussion.

The investigation of the cooling load's thermal calculation yields its results. Layers 1 and 2's reasonable cooling heat load is given as = 705.83 kW. The latent heat load for floors 1 and 2 is 3.03 kW, in comparison. To put it another way, the cooling load for the electronics industry building's second level is 712 kW, or 202.45 TR. The central air conditioner is used. The device operates between 200 °C and 400 °C and uses the refrigerant R 134 A. This results in cold COP = 2.7 and compressor power (Wk) = 355.45 hp.

3 CONCLUSION

The following inferences can be made from all the descriptions and calculations made when constructing air conditioners for a two-story electronics industrial building with dimensions of 40 m x 25 m x 10 m: 1) The combined logical cooling demand for floors 1 and 2 is 705.83 kW. La3.03 kWatt is the cooling load. After incorporating the adjustment factor, the total cooling load is 712 kW. 202 TR corresponds to this. 2) Total cooling load or room area is the cooling load per square meter. The ratio's magnitude is 712 kWatt/2000 m^2 or 356 W/m^2. 3) The chosen compressor and COP chiller have a combined horsepower of 355.45, up from 256. The COP of a central AC motor is 2.7 horsepower.

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