Cooling and Air Conditioning System Design in Offset Engine Room at Company X to Maintain Performance and Durability of Engine Components

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Abstract. In order to maintain the performance and durability of engine components against damage, several influencing factors are temperature, air cleanliness, and humidity levels in the room. The temperature, air cleanliness and humidity of the room are not within the standard conditions of the machine, resulting in many mechanical and electrical components in the machine being damaged and those problems occurred at Company X. If there is no improvement in the air conditioning in the engine room, the more severe damage to the engine will occur. The engine room area is 104 m^2. The design of the cooling and air conditioning system is carried out by several methods, including the calculation of the required capacity, analysis, and design drawings in the engine area. Based on the calculation, the required cooling capacity unit in the engine room is 9.36 Kw with 1640 l/s. This capacity already includes the need for Fresh Air which is needed at 245 l/s. With this capacity, the temperature and air quality suitable for the engine can be achieved.

Keywords: Cooling System, Air Conditioning, Design, Air Handling Unit, Engine

1 Introduction

Air conditioning system in building is important as it can control the air in working area, and it can produce quality, clean, comfortable and healthy air for humans and the durability of machine components. Air conditioning systems can support human and machine activities and productivity. There are several types of air conditioning systems that can be used for various conditions and special needs according to certain design conditions, other than for human habitation. To achieve this goal, what needs to be known is the cooling load and the characteristics of the room and air conditioning system required [3].

When choosing an air conditioning system and equipment, it is necessary to take into account the working cooling capacity to calculate the heat that must be handled by the air conditioning equipment and to maintain comfortable conditions in a particular room. This cooling capacity calculation is based on the Cooling Load Calculation Manual published by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). Calculation of cooling capacity compared to environmental conditions close to the usual extreme values is based on peak conditions [8].

The design of cooling and air conditioning systems in buildings and office spaces is very important to maintain the comfort and health of the occupants, including in the industrial

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machine room. Maintenance of temperature and air quality in industrial engine rooms is often neglected, resulting in decreased engine performance and service life of engine components. If left with the temperature and air quality conditions, it can result in more severe damage to the machines. The condition that occurs in the offset 1 engine room is that many machine components are damaged, so machine experiences problems in operating and producing [15].

The damage to engine components is caused air cleanliness, air circulation, and room temperature that does not match engine standards. Heat arising from a moving machine and also supporting electronic components that experience excessive and continuous heat causes the system to malfunction and damage to the engine components, so the damage to other engine components can continue.

The air in the engine room reaches 30^0 C to 32^0 C, while the ideal temperature for the engine in the room is 19^0 C to 23^0 C.

Fig 1. Offset Engine Room 1

Fig 2. Hamada B452 A engine

Fig 3. Hamada 500 CDA engine

Fig 4. Ryobi 500N engine

In Figure 2, Figure 3, and Figure 4 are machines that suffered damage to several mechanical and electronic components. This results in huge losses for repair and replacement of components. Moreover, the machines cannot be used for production activities and of course will result in huge losses because the production target is not achieved.

Seeing the importance of that problem, the authors are interested to research on "Designing Air Conditioning Systems in Offset Engine Room 1 to Maintain Component Durability and Engine Performance". Through this research, it is expected to be a solution to problems in machines that are very important to support the achievement of production targets.

2 Research Methods

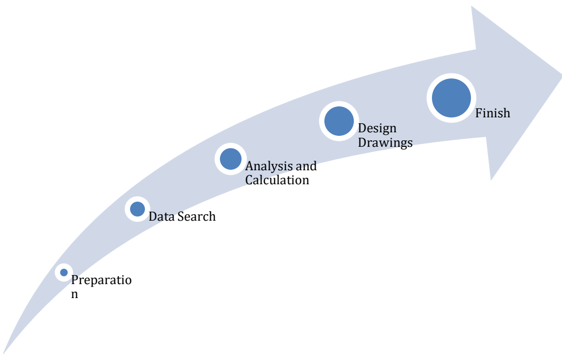

Fig 5. Research Flow

The following is an explanation of the implementation stages in the image above:

a. Preparation Stage – In this stage which is the stage of the research team determining the theme and looking for references regarding the design of cooling and air conditioning systems

b. Data Search Stage - This stage is the stage of searching for data related to the design, related to the temperature, humidity of the cooling system and the required air conditioning from journals, books and articles
c. Analysis and Calculation Phase – Analyzing the data and calculating the required capacity of Air Handling Unit, duct sizes, number and size of grille, and amount of fresh air required to maintain engine room quality and freshness
d. Design drawing stage – at this design stage, the research team makes design drawings according to the capacity and dimension calculations
e. Completion Stage – The final stage or completion stage, the research team makes a research article

3. Result and Discussion

3.1. Calculation of supply air pressure loss and return air duct

From the calculation of the total heat obtained flow rate of 1640 L/s. This flow rate will be used to calculate the airway pressure drop. determine the number of diffusers that will be the air outlet for each unit. For the return airflow value ($Vreturn$), the power airflow is reduced by the fresh air flow. The fresh air flow is 15% of the supply air flow. In determining the dimensions of the air duct, the Equal Friction method is used. The recommended value is 0.8 to 1 Pa/m [18].

Grille return and exhaust can be placed on the ceiling. However, for laying the grille below, it can make the air flow rate laminar. The requirement for laminar air is to have a Reynolds number 2100. Determination of the size of the grille return and exhaust can be based on a core velocity of 1.5 to 2.5 m/s to control noise and reduce pressure drop [12].

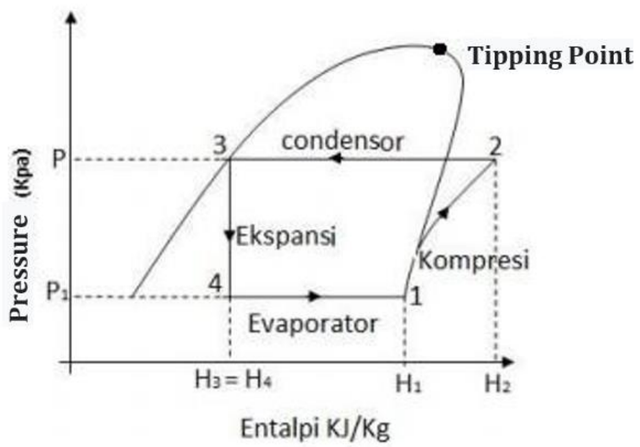

Fig 6. P-h Diagram

Table 1 Building Geography Data

Parameter	Remark
Latitude	6º LS
Peak Load	October
Maximum outside air temperature	34,5º C
Minimum outside air temperature	24,5º C
Rh	67%
Soil temperature	32,6º C

3.2. Machine room area drawing

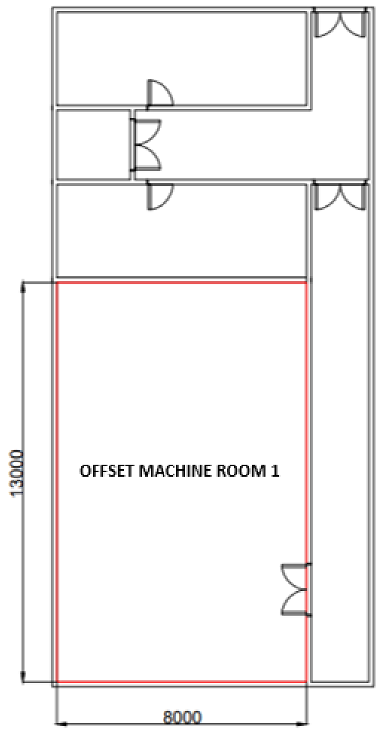

Fig 7. engine room layout

From the drawing of the structure, the dimensions of the room to be conditioned are obtained:

Room Length : 13 m
Room Width : 8 m
Ceiling Height : 3 m

3.3. Air Conditioning System Design Parameters

Based on the function of the room, the air conditioning system design parameters for the engine room are the required temperature is 19^0 C to 23^0 C with the recommended humidity for the room is 50% [8]

3.4. Calculation of Pressure Loss Supply and Return Air Duct

Based on the calculation, the cooling capacity unit needed in the engine room is 9.36 Kw cooling with a total Air flow of 1640 l/s. For the return air flow rate (V_{return}), then the supply air flow rate is reduced by the fresh air flow rate. Fresh Air air discharge is 15% of the supply air.

Based on the calculations, the capacity data and the number of griles are obtained as shown in the table below.

Table 1. Supply Debit Value and Amount of Diffuser

V_{supply} (L/s)	Total Diffuser	**V_{supply} per Diffuser (L/s)**	Diffuser Dimensions
1640	8	205	345 x 345

Table 2. Debit Return Value and Amount of Grille

V_{supply} (L/s)	Total Return Grille	**V_{supply} per Grille (L/s)**	Grille Dimensions
1292	4	323	480 x 480

Table 3. Debit Value and Amount of Grille Fresh Air

V_{supply} (L/s)	Total Return Grille	Diffuser Dimensions
246	1	205

After obtaining the number of diffusers and their respective discharges, the next step is to make a schematic image of the air conditioning and cooling system

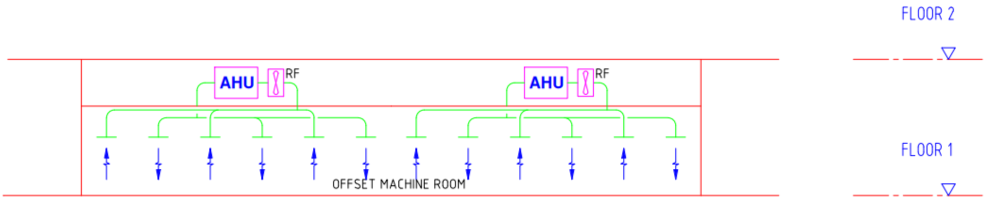

Fig. 8. Air Conditioning System Schematic

The unit used in this engine room uses 2 Air Handling Units with the aim of making it easier for machine maintenance and repairs when there is damage to the Air Handling Units.

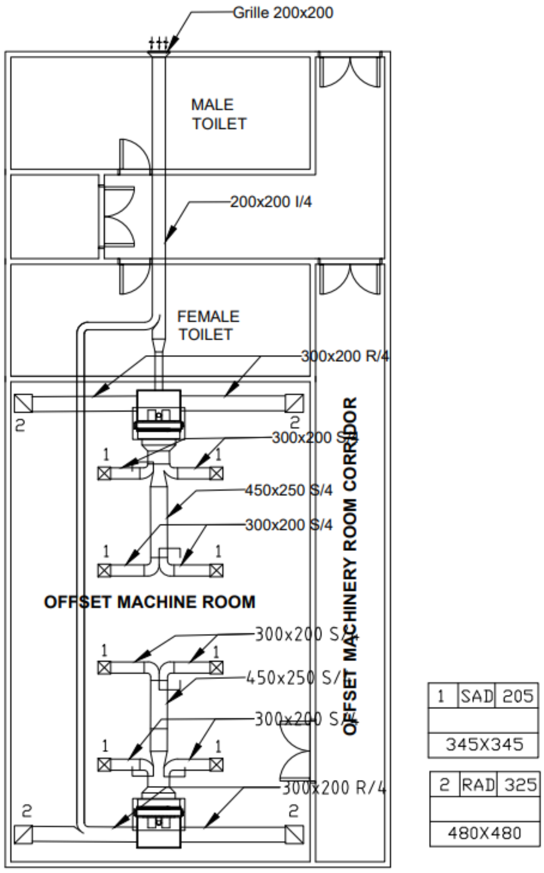

Fig. 9. Drawing of Cooling and Air Conditioning System Design in Engine Room

Based on the calculation, the required cooling capacity unit in the engine room is 9.36 Kw with 1640 l/s. This capacity already includes the need for fresh air or fresh air sucked by the unit from the outside air which is needed at 245 l/s. The capacity that has been obtained is divided into 2 AHU units, each unit using 4 supply air diffusers (SAD) with an air flow of 205 l/s and 2 return air diffusers (RAD) with an air flow of 325 l/s. temperature and air quality suitable for the engine can be achieved.

4. Conclusion

The performance and durability of components in the engine are strongly influenced by several factors are temperature, air cleanliness, and humidity levels in the room . The room temperature air cleanliness, and humidity levels are not in accordance with the standard conditions of the machine, resulting in damage to many mechanical and electrical components in the machine. Damage to several machines that occurred at PT X until now, was also caused by this. The room air temperature when measuring is 30^0 C-32^0 C. If there is no improvement in the air conditioning in the engine room, then more severe damage to the engine will occur. The engine room area is 104 m2. The design of the cooling and air conditioning system is carried out by several methods, including the calculation of the required capacity, analysis and design drawings in the engine area. Based on the calculation, the required cooling capacity unit in the engine room is 9.36 Kw with 1640 l/s. This capacity already includes the need for Fresh Air which is needed at 245 l/s. With this capacity, the temperature and air quality suitable for the engine can be achieved.

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