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Commisioning And FAT HVAC For Offshore On The KLA Flow Station

Yusup Firdaus[1], Engkos Koswara [2]
[1] Mechanical Engineering Universitas Majalengka
[1]yusuffirdaus707@yahoo.com

Abstract
HVAC stands for Heating Ventilation Air Conditioning, in the industrial world it is very necessary to condition a room according to its needs, it can be used to regulate a room or freeze a product, the selection of HVAC materials for Offshore is very important so that the unit lasts a long time and does not rust easily.
The importance of selecting materials that are in accordance with the provisions in terms of safety, function and quality, materials that are easy to obtain, sizes according to calculations, aesthetics, and materials that are not easy to rust.
commissioning is done because to determine the quality and function of the HVAC unit whether it is in accordance with the design, function or calculation.

Keywords: *HVAC, Commisioning, Offshore*

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Introduction

HVAC basically functions to maintain the condition of the surrounding air to protect equipment, and personal comfort by regulating ventilation and air conditioning. HVAC stands for Heating, Ventilation, and Air Conditioning. Which air conditioning system is an application of several branches of Mechanical Engineering, namely thermodynamics, fluid mechanics, and heat transfer.

HVAC is vital for its use in several industries, especially in buildings, offices filled with computer equipment that need to be kept moist, as well as large industries that require a good ventilation system.

The functions of the main components are as follows:

- Compressor, functions as a pressurizer for fluid flow in the HVAC system
- The condenser functions as a heat exchanger because it is convectional assisted by the surrounding air and a fan that blows it out, so that by exchanging heat the fluid can change, which was originally gas to become a mixture of liquid and vapor
- Expansion, functions as a regulator of the fluid flow rate because the pipe model shrinks so that the temperature and pressure drop, in this case the fluid can change which initially is a mixture that can become dominant steam
- Evaporator, functions as a heat exchanger but also receives heat from the surrounding air to change the fuila phase into perfect steam.

Offshore is a building designed for the middle of the sea as accommodation needs and special rooms, this building requires a cooling system called HVAC.
FAT stands for Factory Acceptance Test, meaning unit testing at the place that sells the unit, the goal is to ensure the unit to be purchased is in good condition, functioning properly, all controls can work properly, testing and measuring according to the SOP the results are also well, make sure the ESD system is functioning properly, the safety device can function properly, this is one of the reasons why FAT is done.
Commissioning, namely ensuring the reliability of the HVAC unit can run normally, the measurements are according to the design, and there are no problematic parameters, both in terms of the main components and supporting components.

Research Method

FAT must be prepared as a condition for fulfilling the tender obligations that have been planned, in this case several that must be prepared include material documents, installation documents, P&ID documents and their layouts, electrical installation wiring diagram documents, instruments, and processes, documents standard operating procedures for running the unit, component certificate or calibration documents, unit specification documents, wiring diagram control documents, FAT list Inspection material documents, Bill of Material documents, HVAC system parameter measurement or taking documents, punch list/defect finding documents, repair document from the punch list, then the minutes.

All of this must be done on the FAT agenda, usually starting from checking the documents first, checking the bill of materials in the field whether they are in accordance with what has been recorded in the document, checking the electrical wiring diagrams as well as the instruments and components that have been installed, checking all name tags and matching them. according to what has been designed, if everything is in accordance with the documents then carry out commissioning starting from measuring the power supply, testing the unit without loading first, testing all controls, such as testing the delta temperature or delta pressure, making sure it is in accordance with the controls, testing the process of opening the damper lid , and testing the damper when there are dangerous conditions, for example there is a gas leak that will enter the room, then the Gas detector sensor will function, so the shut off damper will work immediately to close and the system will shutdown, then if all the controls can function properly, then the HVAC system is run in pseudo-normal only, after that do the measurements starting from taking the amperage data, the pressure from the high and low pressure gauge or the suction and discharge, whether it is in accordance with the specifications of the unit or not, the percent opening of the damper must be considered, as well as the starting temperature from the compressor suction and discharge, evaporator coil temperature, condenser coil temperature, water supply temperature, and the temperature difference from the surrounding air, then measure the vibration of the compressor motor, condenser motor, blower motor (AHU), pressurize fan motor, pay attention also the temperature of the drive end and non-drive end too.

Results and Discussion

4. AIR COOLED CONDENSER UNIT (ACCU)

		GENERAL		
1	Location	KLA F/S	Manufacturer/Brand	Safesphere
2	Area Classification	Hazardous Area Zone 2	Mode Operation	Redundant (1 Running, 1 Stand by)
3	Equipment Name	Air Cooled Condenser Unit (ACCU)	HVAC Type	Split Unit
		GENERAL EQUIPMENT DATA		
4	Unit Dimension (LxWxH mm)	2,000 x 1,200 x 2,500	Unit Weight (kg)	1,300 Kg
5	Unit Model Number	ECU400A3GH0EX	Total Cooling Load (kWR)	117
6	Electric Supply (V/Ph/Hz)	480 / 3 / 60	Refrigerant	R-417 A
7	Total Power (kW)	117	System Installation	Knock Down System
8	S/N	1019ECU616	Refi. Charge	20,5 kg
		1019ECU617	Cooling (Btu/h)	400,000
9	Compressor	Semi Hermetic Reciprocating		
		COIL CONDENSER		
10	Number of Rows	3	Fins Material	Copper
11	Type	Air Cooled	Fin Thickness (mm)	0.15
12	Quantity	2 Coil for each ACCU	Minimum Fin Spacing (mm)	1.5
13	Tube Material	Copper	Overall Dimension (HxLxW)	(1,200 x 1,600 x 136)
14	Header Material	Copper	Condensing Temperature (°C)	50
15	Tube Diameter (inch)	3/8	Air Inlet Temperature (°C)	35
16	Tube Thickness (mm)	0.40	No. of fins per Inch	12
17	Frame & Casing Material	Copper	Coil & Fin Corrosion Protection	Black Electro Tin Coating
18	Weight (Kg)	87	Total Cooling Load (kW)	60.80 x 2 pcs
		REFRIGERATION CIRCUIT & COMPRESSOR DATA		
19	Rated Power (kW)	29.8	Manufacture/Brand	Carlyle
20	Compressor Type	Reciprocating	Liquid Line Solenoid Valve	Available
21	Service Type	Semi Hermetic	Compressor Isolating Valve	Available
22	No. Of Compressor	1 ea / CDU		
		REFRIGERATION CIRCUIT & COMPRESSOR DATA		
23	Saturated Suction Temperature (°C)	7.25	Expansion Valve	Available
24	Saturated Discharge Temperature (°C)	53.4	High Pressure Gauge	Available
25	Net Refrigerant Capacity	20,5 kg	Low Pressure Gauge	Available
26	Compressor Motor Rating (kW)	29.8	Loading / Unloading method	Available
27	High-Low Pressure Control	Available	Compressor Cooling	NA
28	Sight Glass	Available	Oil Type	POE 46
29	Compressor Speed (rpm)	1,750	Oil Charge	9 lb
30	Drive Type	Reciprocating	Crankcase Heater with terminal Box	Available
31	Sight glass	Available	Weight (kg)	320
32	Oil Flow Controller	Available	Temperature Sensor for Motor	NA
33	Compressor Capacity Control	Available (2 stage)	Power	480 V – 3Ph – 60 Hz

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Figure 1. ACCU HVAC system data sheet

5. PRESSURIZING FAN UNIT (PFU)

		GENERAL		
1	location	KLA F/S	Manufacture/Brand	Safesphere
2	Area Classification	Hazardous Area Zone 2	Mode Operation	Redundant (1 Running,1 Stand by)
3	Equipment Name	Pressurizing fan		
		GENERAL EQUIPMENT DATA		
4	Fan Type	Forward Curved	Fan Motor	Hazardous Area (Ex d IIB/IIC T4 Gb)
5	Supply Power (V/Ph/Hz)	480/3/60	Motor Rating	480 / 3 / 60
6	System Installation	Knock Down System	Power Motor	1.1 kW
7	Unit model	EPFU3000/EEX	Total Static Pressure (Pa)	250
8	Unit Dimension (LxWxH mm)	1.200 x 950 x 1.050	Unit Weight (kg)	400
9	Location Installation	Outdoor	Air Volume (cfm)	4.000
10	S/N	1019EPFU618	Rated Current (Amp)	2,69
		1019EPFU619	Type Fan	Centrifugal Fan
		SUPPLY FAN DATA		
11	Motor Enclosure Type	TEFC (Totally Enclosed Fan Cooled)	Motor Insulation Class	Class F (IP55)
12	Fan Blade Type	Forward Curved	Temperature Rise	Class B
13	Driver Type	Belt Drive	Fan Speed (rpm)	800
14	Manufacture	Nicotra	Total Static Pressure (Pa)	250
15	Total Supply (L/s)	1651	Anti Vibration Mounting Type	Spring Mounting
16	Fan Model/Serial	ADH 315 K	Belt Type	V- Belt
17	Fan Motor manufacture	ABB Motor	Belt Model	SPB
18	Motor Model / Serial	3GJA092101-ASC	Belt Manufacture	Optibelt
19	Motor Classification	Hazardous Area (Ex d IIB/IIC T4 Gb)	Bearing Type	6205DDU/C3 – 6205DDU/C3

Figure 2. HVAC system data sheet PFU

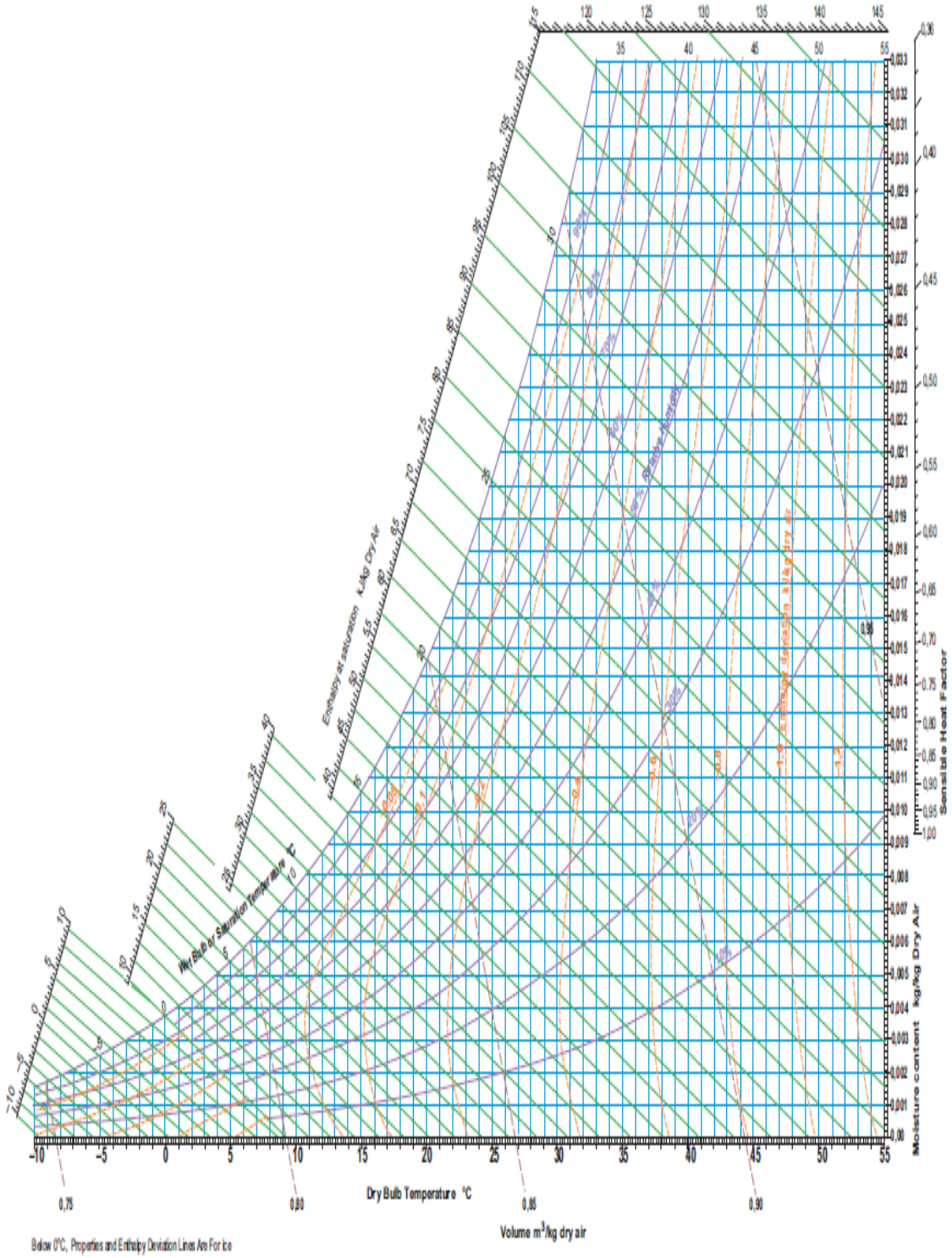

Figure 3. HVAC Psychometric Chart

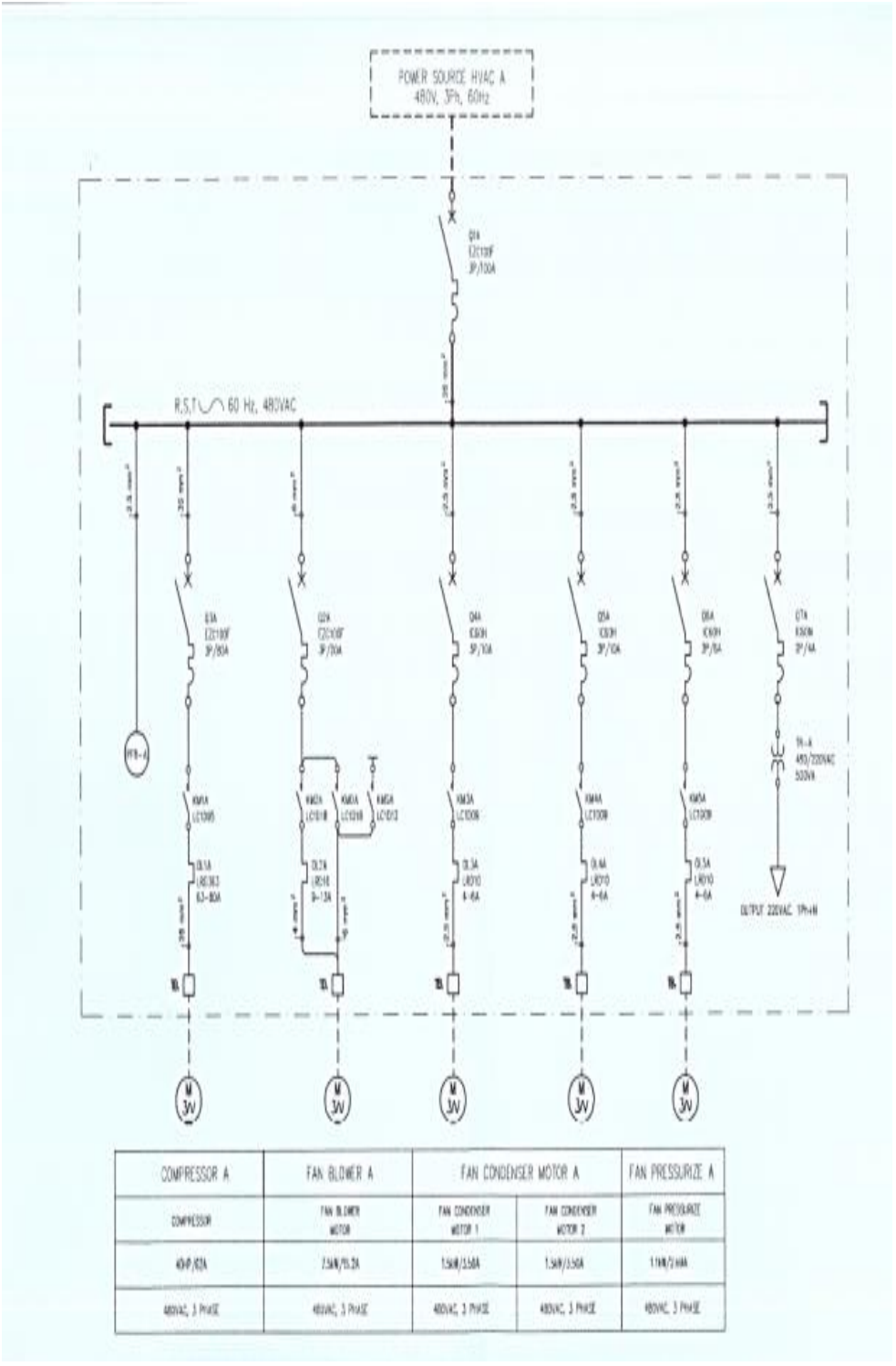

Figure 4. Single line diagram of the HVAC system

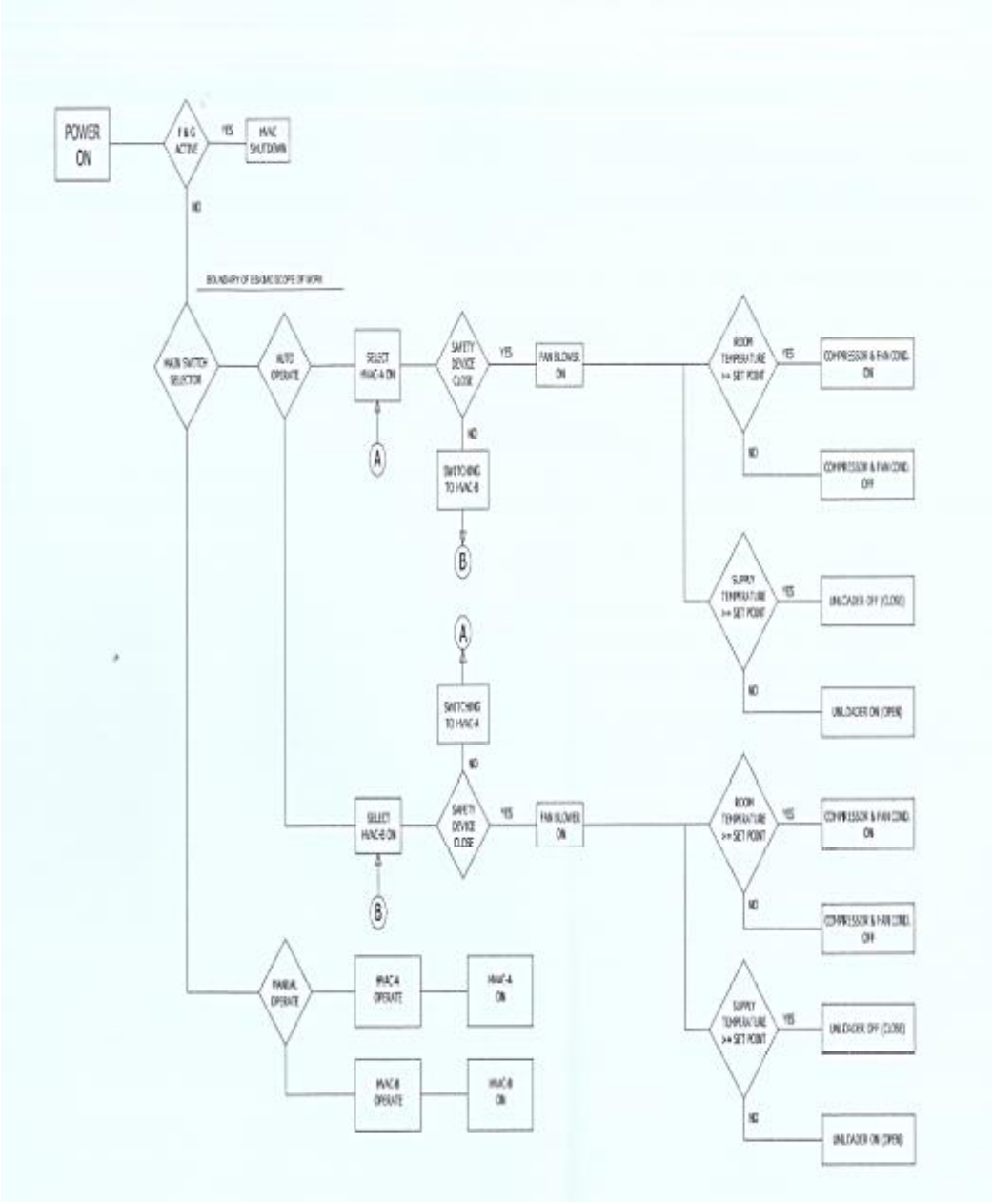

Figure 5. HVAC System Flow Chart

REFRIGERANT SIDE LOAD CALCULATION

	Inlet Compressor	Outlet Compressor	Outlet condensor	Inlet TXV	Inlet TXV	Outlet Evaporator	Air exits the Evaporator	Air exits the condenser
	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
ºC	15,72	80,47	53,35	52,36	8,94	19,10	21,33	47,88
ºF	60,29	176,85	128,02	126,25	48,09	66,38	70,39	118,18

Point ENTHALPHI FROM PH CHART

A = 56 (In Evaporator / Out TXV)
B = 56 (In TXV / Out Cond)
C = 103 (In Compressor)
D = 117 (Out Compressor)

PRESSURE DATA

HP	295	Psig	309,7	Psia
LP	56	Psig	70,7	Psia
OIL	85	Psig	99,7	Psia

Actual Compressor Diplasement	82,5	cfm	Note :
Mass Flow Rate	144,7368421	lb/min	1.82,5 CFM pada 50 Hz
Absolute Discharge Pressure	309,7	Psia	2.66 CFM pada 60 Hz
Absolute Suction Pressure	70,7	Psia	
Spesific entering volume compressor	0,57	Ft^3/lb	
Compressor volumetric Effisiency	75	%	

FROM MOLLER CHART R-417 A :

1. **Refrigernt Effect**
   RE = C - A
   = 47 Btu / lb
2. **Heat Off Compressor**
   HC = D – C
   = 14 Btu/lb
3. **Heat Rejection**
   HR = D – A
   = 61 Btu/lb
4. **Mass flow Rate**
   Spessification volume enter compressor from table (Superheated vapor & absolute pressure)
   Mass flow rate = $\frac{\text{Actual comp display x comp Vol Efficiency}}{\text{Spessific volume entering compressor}}$
   = 144,7368421 lb/min
5. **Coefficience of Preformance**
   CoP = RE / HC
   = 3,357142857
6. **Compression ratio**
   = Discharge Pressure / Suction Pressure
   = 4,380480905

7. Refrigerant capacity

Capasity = Mass Flow rate x RE
= 418157,8947 Btu/h

AIR SIDE LOAD CALCULATION
Description Condensor

Diameter area condensor	0,7	m
Jumlah fan condensor	2	Unit
FV (Kecepatan) Max	12,5	m/s
FV (Kecepatan) Min	10,8	m/s
Temperatur Ambient	33,9	°C
Temperatur Output Air	47,88	°C

Perhitungan Q Rejection

Face area orifice condensor	=	0,38465	m^2
Total face area condensor	=	0,7693	m^2
Face velocity rata rata	=	11,65	m/s
Total AVF Condensor	=	8,962345	m^3/s
	=		
Q Rejection	=	M x CP x ΔT	
	=	129864,2046	kcal/h
	=	515560,8925	Btu/h

Conclusion

In carrying out the test, you can adjust the specifications of the unit starting from its working current, the refrigerant used in the HVAC unit, motor power, cooling capacity and voltage which is 380 VAC to become 480 VAC, so the results are multiplied by 1.2.

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