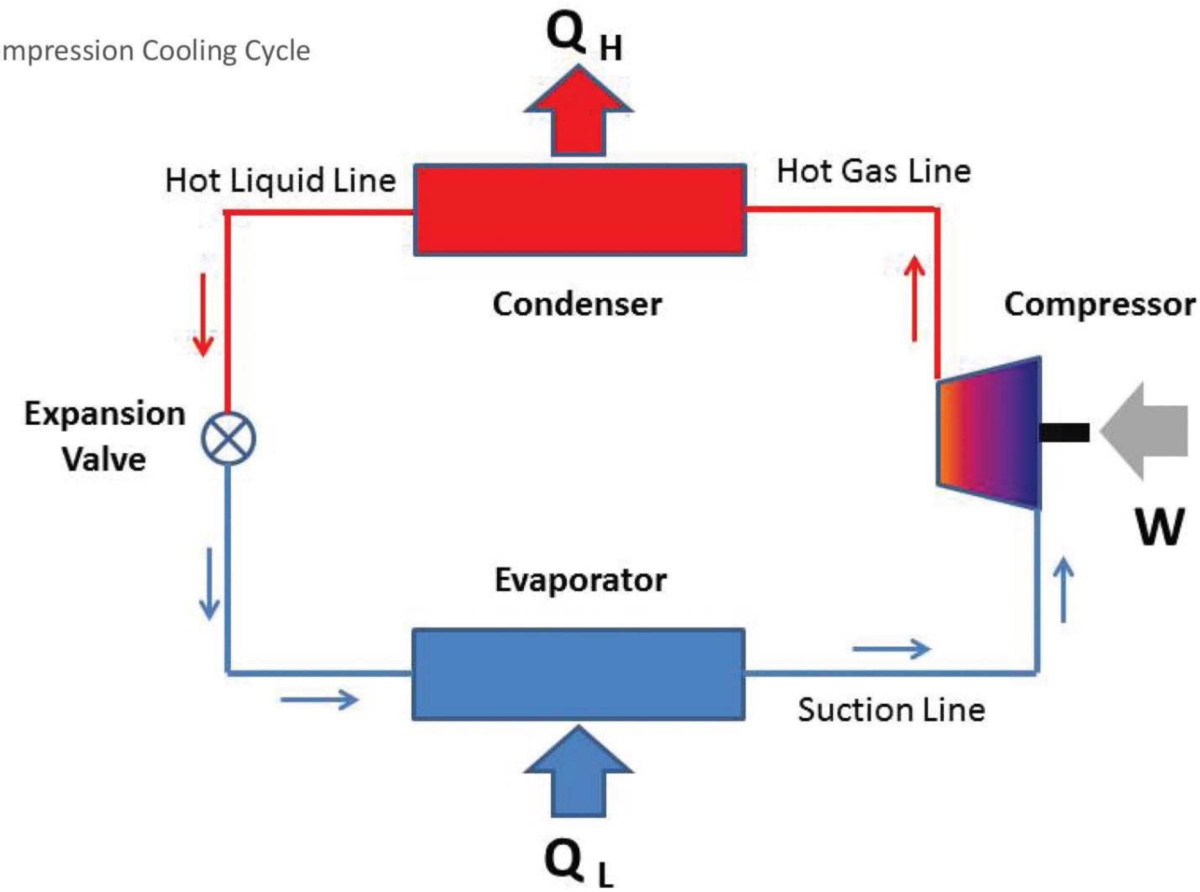
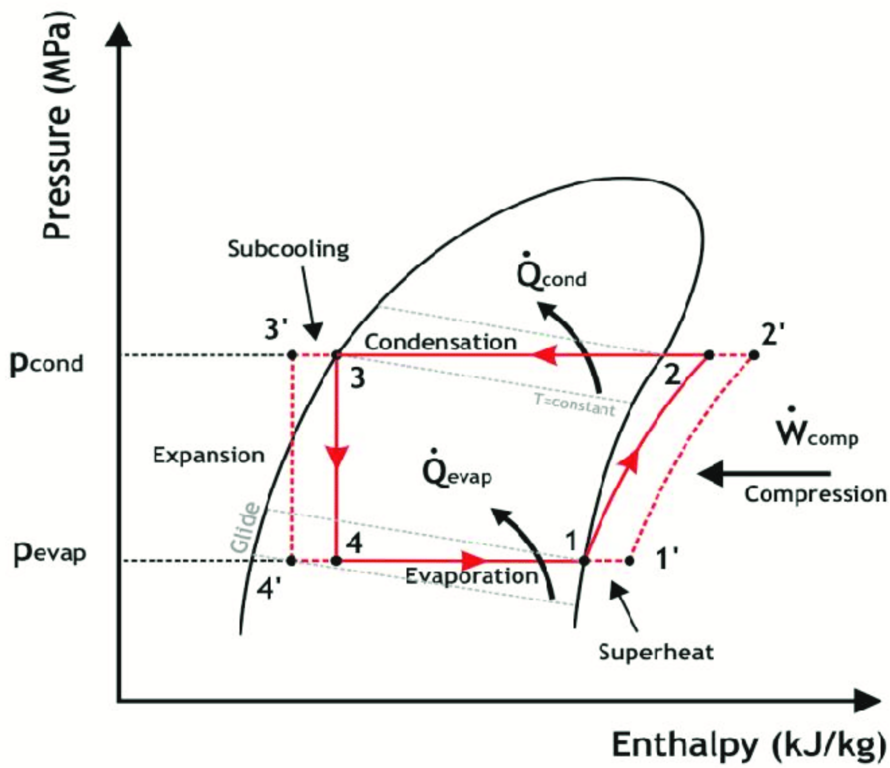
Vapor Compression system analysis

Figure 1
Basic Vapor-Compression Cooling Cycle





Q1) Define balance point and system simulation for vapor compression system.

Ans:-

1- Balance point:- Is the point of operation of two components of vapor compression system where plotted the performance characteristic of two components on the graph.
2- System simulation:- Is the mathematical procedure for simultaneous solution of two equations representing the performance of all components of system

Q2) Explain with Drawing the expected trends of refrigeration capacity and power requirements as a function of the evaporating and condensing temperatures.

Ans:-
An increases in evaporating temperature or a decreases in condensing temperature results in increases refrigerating capacity. The power increased with increasing in condensing temperature.

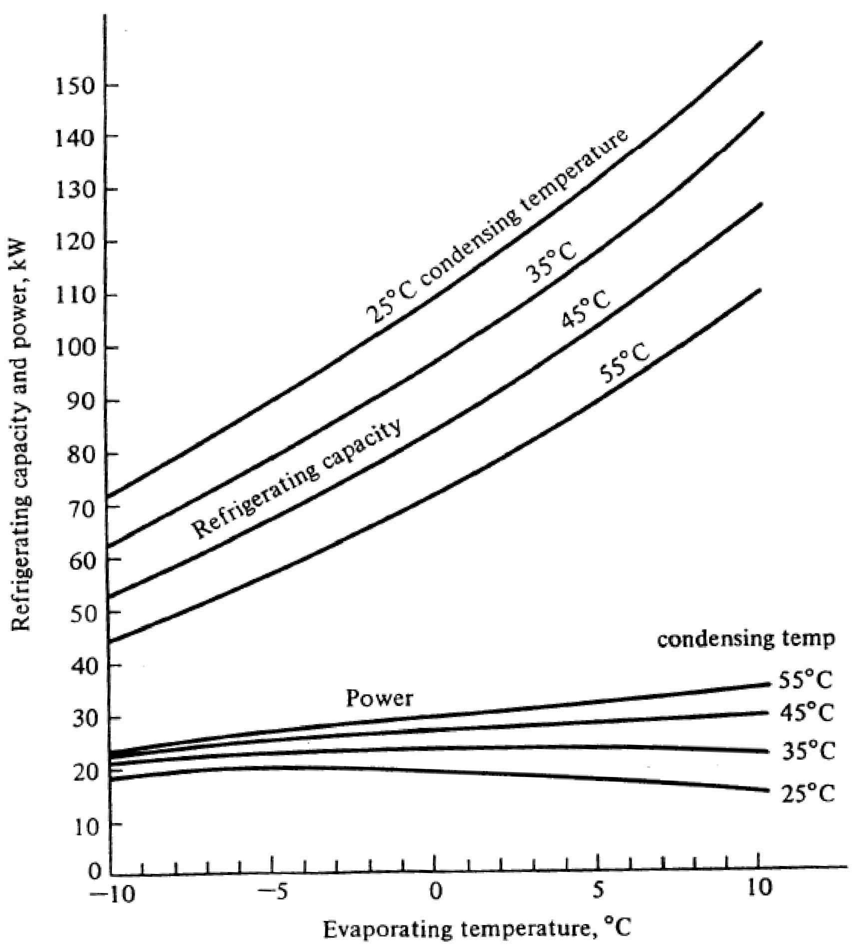


Figure 14-1 Refrigerating capacity and power requirement of a York (Division of Borg-Warner) hermetic reciprocating H62SP-22E, refrigerant 22, 1750 r/min compressor.

Q3) Explain with drawing the performance of air- cooled condenser for a given ambient temperature.

Ans:-

The heat rejection from condenser will be increased with increasing in condensing temperature or decreasing in ambient temperature.

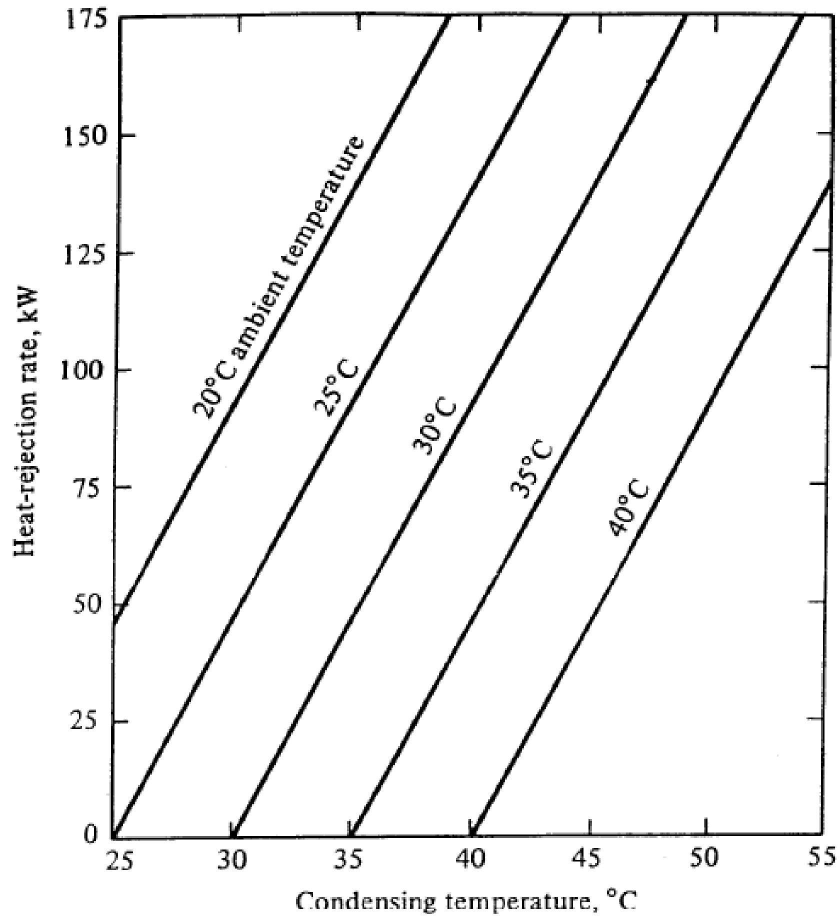


Figure 14-3 Performance of Bohn Heat Transfer Division air-cooled condenser, refrigerant 22, model no. 36.

Q4) Explain with drawing the performance of condensing unit

Ans:- The refrigeration capacity increases as evaporating temperature increases.

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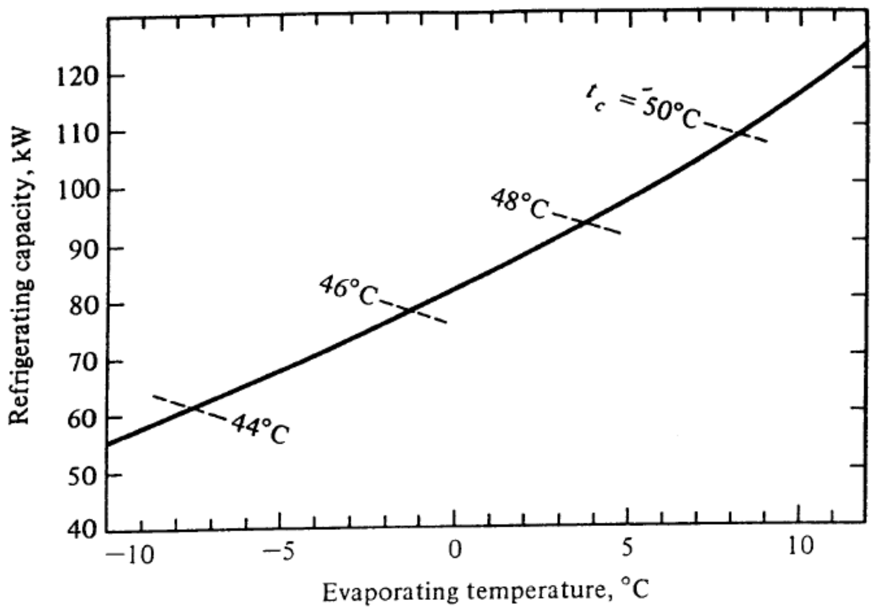


Figure 14-6 Performance of condensing unit consisting of the compressor of Fig. 14-1 and the condenser of Fig. 14-3. The temperature of ambient air for the condenser is 35°C.

Q5) Explain with drawing the performance of direct expansion inner fin liquid chiller (Evaporator)for a given entering water temperature.

Ans:- 1-The refrigerating capacity increases with a reduction in evaporating temperature or an increase in the temperature of entering water.

2- The refrigerating capacity is reduced when the rate of water flow is decreased at given inlet temperature.

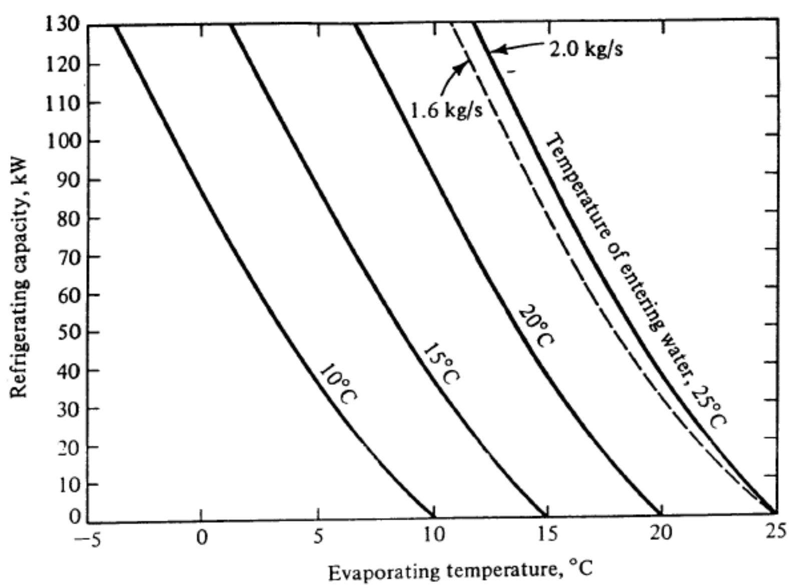


Figure 14-8 Refrigerating capacity of a Dunham-Bush, refrigerant 22, direct-expansion, inner-fin liquid chiller CH660B. The solid lines show performance with 2 kg/s water flow and the dashed line with 1.6 kg/s.

Q6) Explain with drawing the system performance when the expansion valve starving the evaporator.

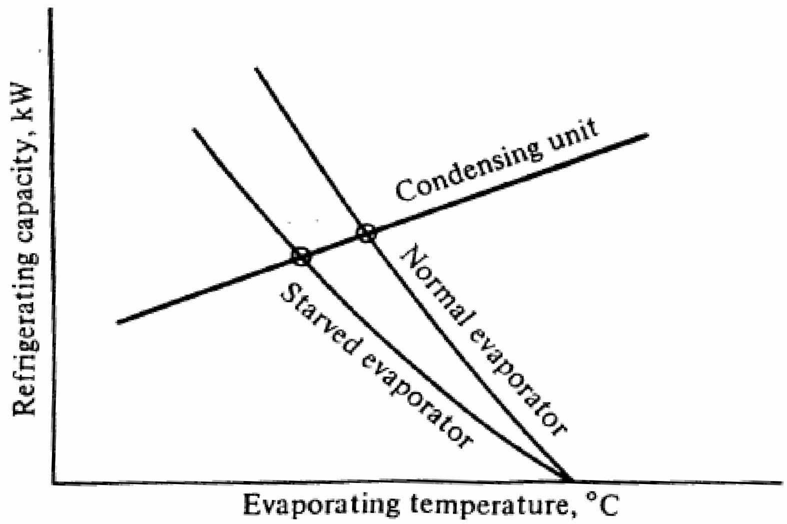


Figure 14-11 Reduction in capacity and evaporating temperature due to feeding insufficient refrigerant to the evaporator.

The figure showing the balance points between the condensing unit and evaporator. When the evaporator is starved the overall heat transfer coefficient drops the balance point shifts to a lower evaporating temperature and refrigerating capacity. The reasons for starving the evaporator are.

1- The expansion valve is too small.
2- Some vapor entering the expansion valve.
3- Low pressure difference across the expansion valve.

Q7) Use the figures. (14-1), (14-2), (14-3) for refrigeration system R-22 as a refrigerant. Tabulate and draw the balance points for condensing unit (air cooled condenser and compressor) an ambient temperature (outdoor temp.) T_{amb} = 35 °C.

خطوات الحل:-

1- نستخدم المخطط (14-3) حيث يتم اسقاط خطوط عمودية من محور x ($T_{condensing}$) الى خط درجة حرارة الهواء الخارجي ($T_{ambient}$ = 35 °C) ومن ثم نتجه يساراً لإيجاد قيم الحرارة المطروحة (Heat rejection) وترتب النتائج فى جدول.

(1)

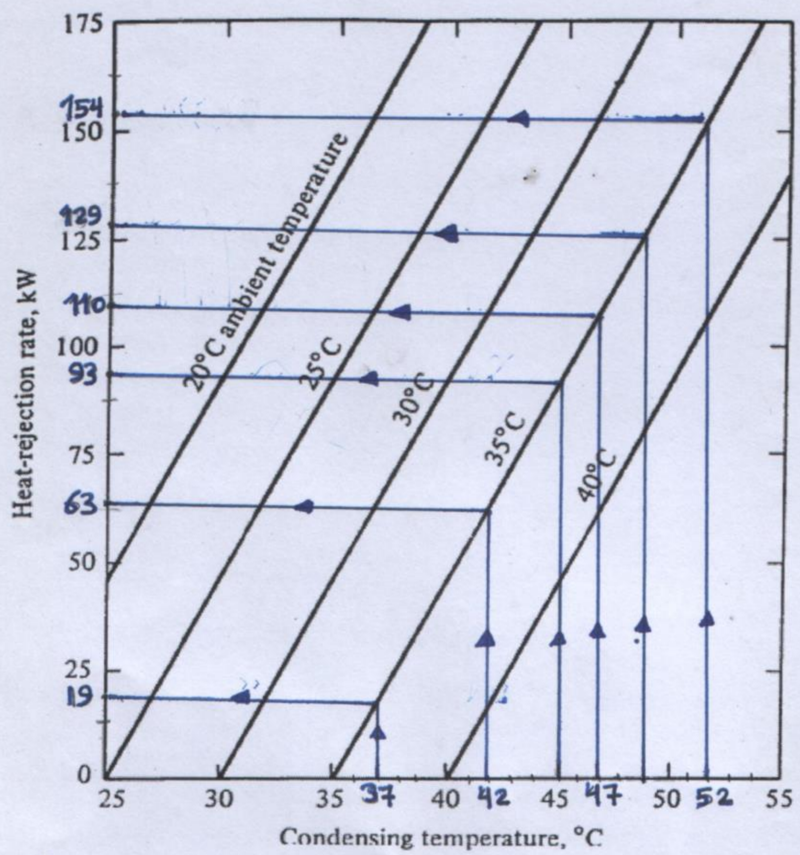


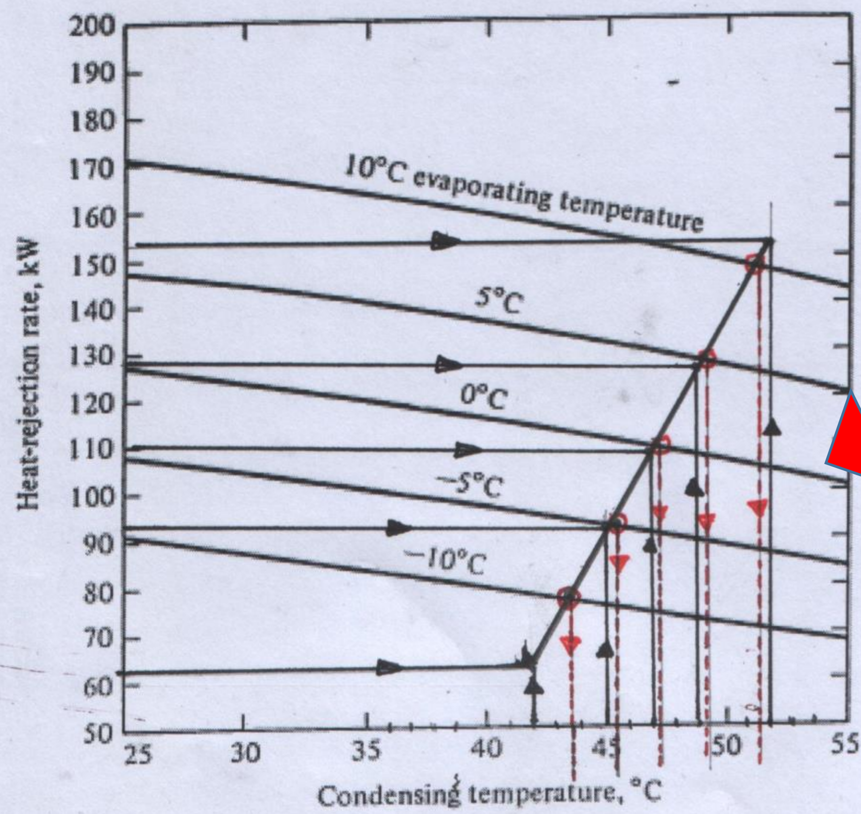
Figure 14-3 Performance of Bohn Heat Transfer Division air-cooled condenser, refrigerant 22, model no. 36.

جدول (1)

$T_{cond.}$ °C	Heat rejection KW
37	19
42	63
45	93
47	110
49	129
52	154

2− نستخدم المخطط (2-14) يتم تثبيت نقاط ($T_{condensing}$ and Heat rejection) من الجدول في أولاً على المخطط واستخراج قيم $T_{evaporator}$ و $T_{condensing}$ وترتب النتائج في جدول.

(2)



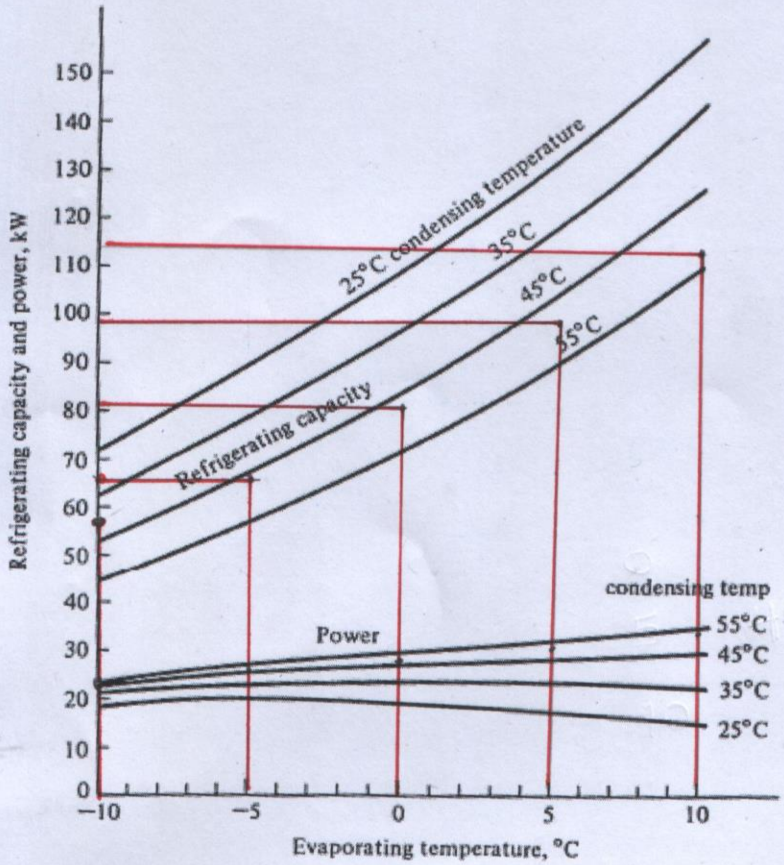
$T_{cond.}$ °C	Heat rejection KW
37	19
42	63
45	93
47	110
49	129
52	154

Figure 14-2 Heat-rejection rate of a York (Division of Borg-Warner) hermetic reciprocating compressor, H62SP-22E, refrigerant 22, 1750 r/min.

$T_{Evap.}$ °C	T_{cond} °C
−10	43.7
−5	45.5
0	47
5	49
10	51.5

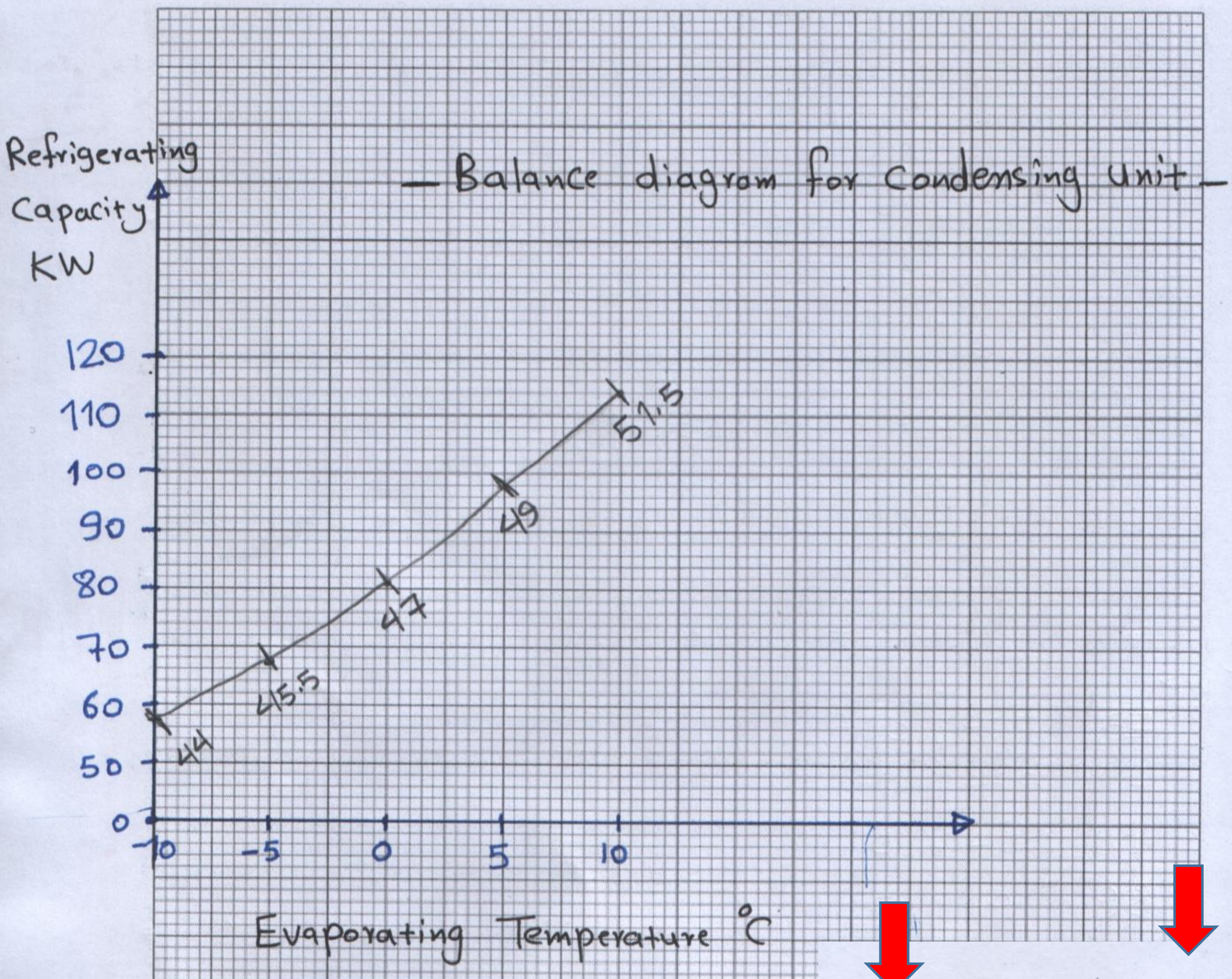
3– يتم اسقاط نقاط ($T_{condensing}$ and $T_{evapoarting}$) من الجدول في ثانياً على المخطط (14-1) لايجاد (Capacity and Power) وهي نقاط التوازن ويتم أدراجها في جدول وتثبيتها (رسمها) على ورقة بيانية لايجاد مخطط توازن وحدة التكثيف Condensing unit .

(3)



Tevap.	Tcond.	Capacity kW
-10	43.7	57
-5	45.5	67
0	47	81
5	49	98
10	51.5	114

Figure 14-1 Refrigerating capacity and power requirement of a York (Division of Borg-Warner) hermetic reciprocating H62SP-22E, refrigerant 22, 1750 r/min compressor.



$T_{evap.}$	$T_{cond.}$	Capacity kW
-10	43.7	57
-5	45.5	67
0	47	81
5	49	98
10	51.5	114

Q8)

Q2) Use the figures. (14-1), (14-2), (14-3) and (14-8) for refrigeration system R-22 as a refrigerant. Find the balance points for a complete system (condensing unit and evaporator) for an ambient temperature T_{amb} = 35 °C. and a chilled water temperature 15 °C. Tabulate the results.

الحل:- يتم استخدام الخطوات السابقة نفسها (1و2و3) وبعد ذلك يتم تثبيت قيم Refrigerating Capacity و $T_{evaprator}$ على المخطط (14-8) وايجاد القيم عند تقاطع الخط المرسوم مع T_{water}= 15 °C وكما موضح في الشكل التالي.

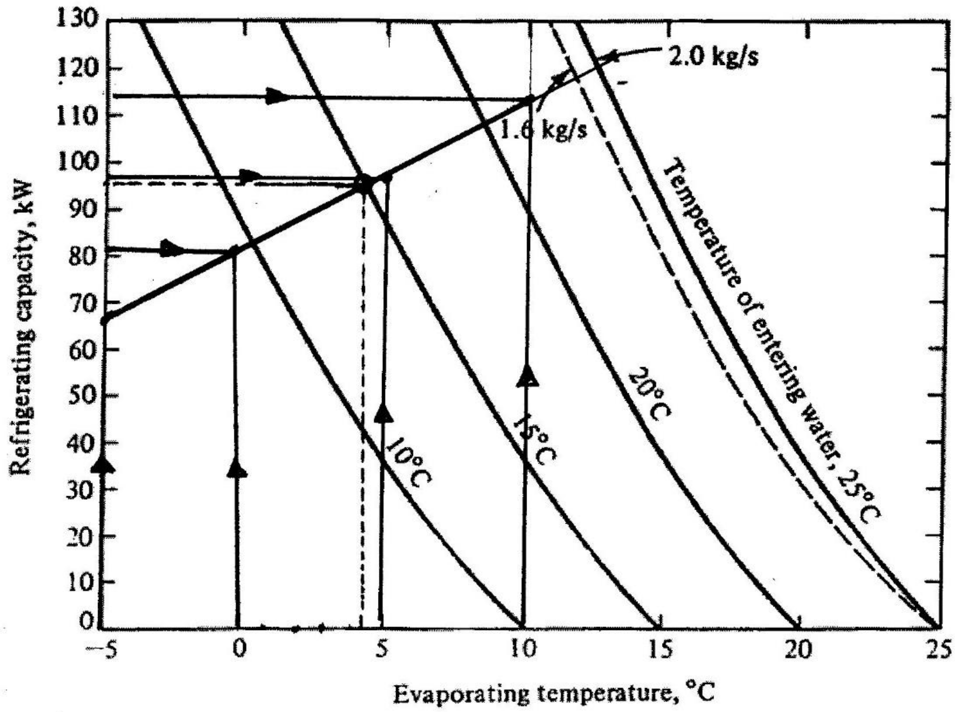


Figure 14-8 Refrigerating capacity of a Dunham-Bush, refrigerant 22, direct-expansion, inner-fin liquid chiller CH660B. The solid lines show performance with 2 kg/s water flow and the dashed line with 1.6 kg/s.

∴ At T_{Water} = 15 °C , $T_{evap.}$ = 4.3 °C Capacity = 97 KW

$T_{Evap.}$ °C	Capacity kW
-5	67
0	81
5	98
10	114