Model : KTE-6000BR

BRINE REFRIGERATION EXP. EQUIPMENT

USAGE MANUAL

KTENG CORPORATION

Korea Technology Institute of Energy Convergence

Korea Technology Engineering Co.,Ltd.

CONTENT

Chapter 1. Description of an Air conditioner,a Refrigeration, or a Freezer system

1. Brine (Ice Maker) Refrigeration Experiment Equipment

1-1. System Description of Brine (Ice Maker) Refrigeration

(1) CONTROL PANEL : Comosition with N.F.B, Toggle Switch, Am · Vm meter, Buzzer, Lamps(Red, Green, Orange), High · Low Pressure Switch, Magnetic Contactor, Relays, Thermal Switch, Push Buttons, Power Input, these devices make the refrigeration system run by several electric circuit.

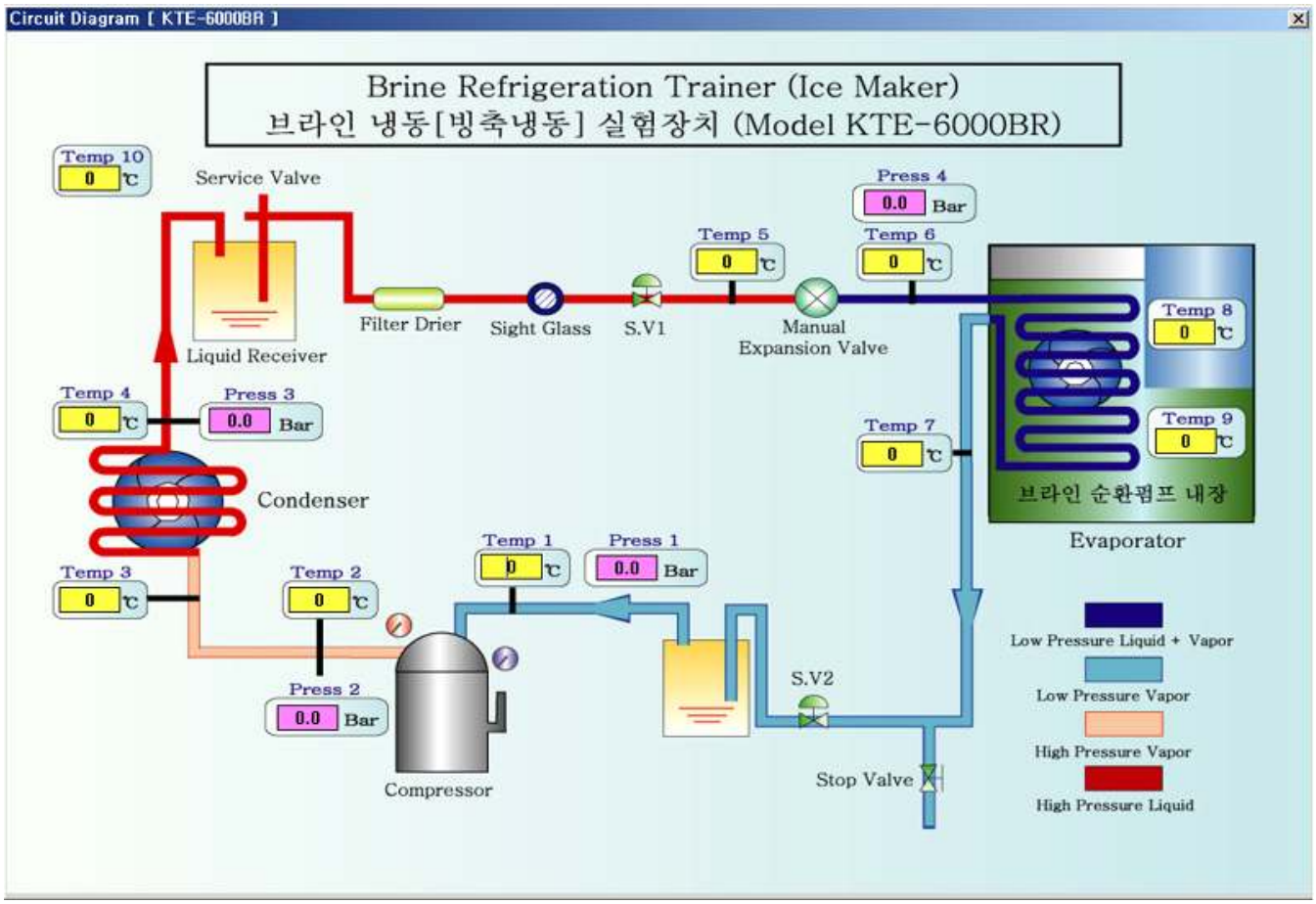
(2). MECHANICAL REFRIGERATION : Composition with Compressor, Condenser(with fan motor), Receiver, Filter-dryer, Sight glass, Solenoid Valve, Manual expansion Valve, Evaporator, Brine Tank, ICE can, Accumulator, High-Low pressure gauge, etc, these devices run as set up circuit in Control panel.

(3) SOFTWARE P/G : KTE-DA100(Software) supply tools with that temperature, pressure, enthalpy, amount of the exchanged heat in each position can be measured in real time, and then saved by Microsoft excel, so that the saved data can be show and analysis by graph.

(4) HARDWARE PCB : Composition with KTE-DA100(Hardware), PC(over than Pentium4, Window OS 98, Memory 256M , Hard space 100MB),S.M.P.S, 9 of T-Type Thermo couple , and 4 of Pressure sensor, these devices let all of data from system as like temperature, pressure, enthalpy, amount exchanged heat in each position, and COP acquisited to software at PC.

1-2. Brine (Ice Maker) Ref. System cycle and Measuring device for temp.& pressure

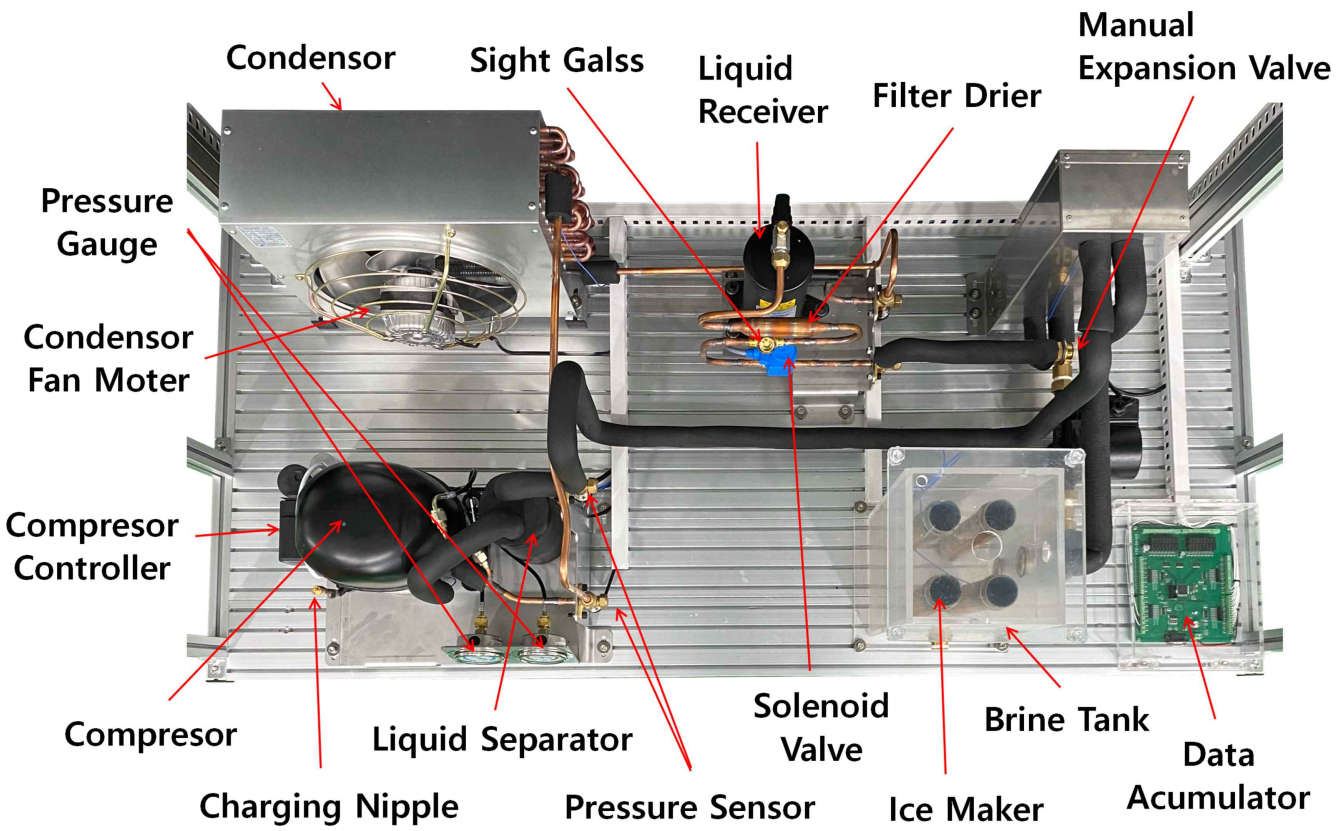
(1) Cycle diagram of Brine (Ice Maker) Ref. System



(2) Temperature, Pressure position for measurement in Brine (Ice Maker) Ref. System

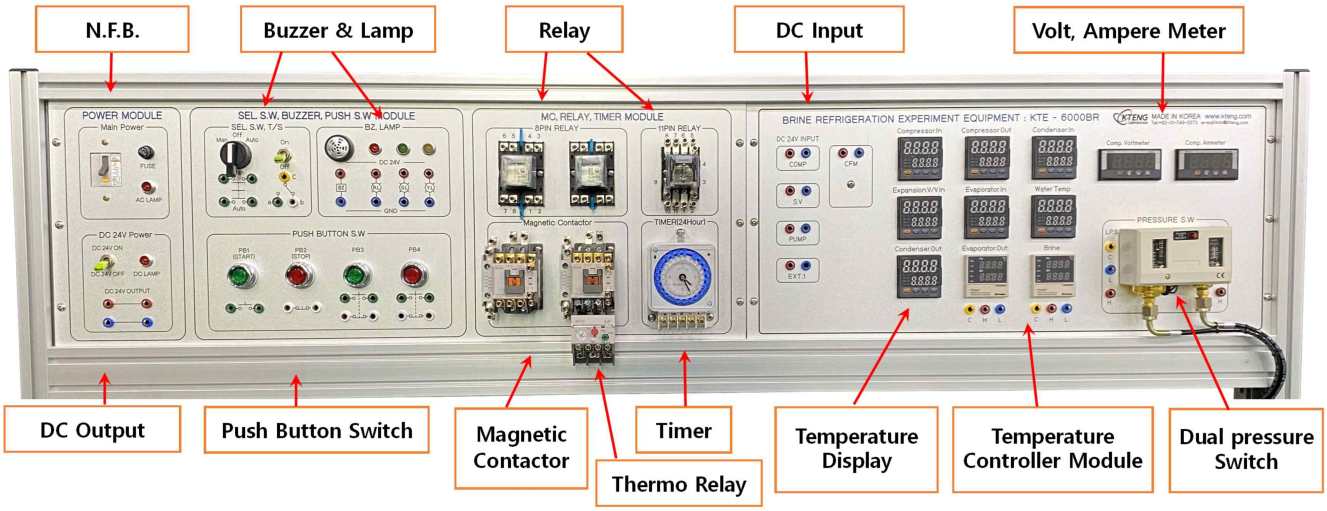
Measuring point	Remark
Temp 1, Press 1	COMP in
Temp 2, Press 2	COMP out
Temp 3	CFM in
Temp 4, Press 3	CFM out
Temp 5	Exp.v in
Temp 6, Press 4	Eva in
Temp 7	Eva out
Temp 8	Ice Maker Temp.
Temp 9	Brine Temp.

1-3. Mechanical refrigeration device component



① Condenser
② Data performance automatic measuring equipment
③ Pressure Sensor
④ Liquid receiver
⑤ Filter drier
⑥ Solenoid valve
⑦ Manual expansion valve
⑧ Ball Valve
⑨ Ice maker
⑩ Sight glass
⑪ Liquid Separator
⑫ Compressor
⑬ Compressor controller
⑭ High pressure gauge
⑮ Low pressure gauge
⑯ Charging Nipple
⑰ Condenser Fan Motor

1-4. Control panel device component for Binary Ref. System



① DC Volt Meter
② DC Ampere
③ Buzzer
④ Lamp
⑤ Magnetic Contactor
⑥ T.H.R
⑦ On/Off Switch
⑧ Toggle Switch
⑨ Temperature Display
⑩ Temperature Controller
⑪ DC Input
⑫ Relay
⑬ Pressure Switch
⑭ DC Output
⑮ N.F.B

Chapter 2. Component of Air Con. Refrigerator, and Freezing machine

1. Mechanical device component

(1) Compressor

※ Specification
- Model : CAJ246Z
- 1HP
- Range : Medium, High temperature
- Eva Temp. : -25℃~10℃
- Motor Type : PISTON Type
- Refrigerant : R-404A
- Single phase 220V, 110V
- Controller

The motor compressor absorbs heat from an object in the evaporator of the standard refrigeration test equipment, increases the pressure by compressing the vaporized gas refrigerant at low-temperature and low-pressure and reduces the distance between molecules. Then, it increases the temperature and thus makes the gas easily in the condenser at the room temperature. That is, it sends the heat from the evaporation of refrigerant at the low heat source(evaporator) to the superheat source(condenser) at the high temperature and pressure.

(2) Condenser

1HP

※ Specification
- Size : 400(W) × 300(H) × 330(D)mm
- Motor : AC220V 5-60Hz 4P 16W
- Capacity : 1HP

The condenser emits and condenses the refrigerant gas heat at the high temperature and pressure from the compressor to the air at the room temperature. It condenses and liquidizes the heat of gaseous refrigerant through the heat exchange between the gaseous refrigerant at the high temperature and pressure from the compressor and the surrounding air or cooling water. The condenser emits the hot blow as the external device. The refrigerant gas from the compressor is liquidized to the refrigerant liquid.
The condenses the refrigerant gas from the compressor at the high temperature and pressure

to the liquid refrigerant at the high temperature and pressure through the heat exchange between the refrigerant gas and water or air at the room temperature. The reason to change the refrigerant gas to the liquid state is to use the latent heat during the change of state. The highest volume of heat can be taken from the evaporator when using the latent heat, that is, when the liquid state is changed to the gaseous state. If the condenser is installed in the place with too higher external temperature or lower ventilation because of foreign substances, the condensing temperature and pressure become increased so that the evaporator will not work properly. Thus, the refrigeration effect can be improved when the condenser is installed near the compressor and on the place that is well ventilated without direct sunlight. The condenser requires the special attention for more effective heat exchange with the external air through the regular fan cleaning. The condenser receives, condenses and liquidizes the refrigerant gas from the compressor. Higher refrigeration effect(that is, if the heat exchange between the coolant and refrigerant gas is well processes) of the condenser reduces the temperature and condensing pressure inside the condenser. The condenser works at the constant condensing temperature as the volume of refrigerant gas from the compressor keeps the balance with the cooling operation of condenser.

(3) Nipple

The charging nipple is the requisite to use the manifold gauge for the airtight and vacuum tests and refrigerant filling and transferts anof the standard refrigeration tnsfeequipment. It is attached to the low and high pressure ducts on the mechanical compressor output and s put sides. Before soldets and refrirging nipple to the high and low pressure ducts on the compressor output and s put sides, the internal r sber(for keeps and reairtight tput) rs anis removed and set again after refrigeration.

(4) Receiver Tank and Service Valve

Refrigerant that flows from condenser stays at a receiver before it goes expansion valve. The amount of staying refrigerant at a receiver must be constant for control refrigerant amount emitting into an evaporator. And also it need for recharging (pump down operation) when its repair.

(5) Filter Drier

Any moisture or impurities that exist in the refrigerants have a variety of negative impacts on the refrigerators. Then, the filter drier removes moisture or impurities. It is installed between the expansion valve and the receiver.

(6) Solenoid Valve

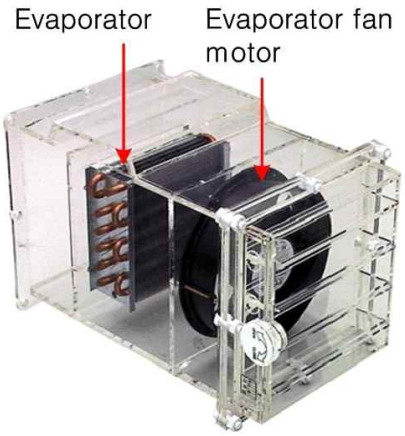
The electronic valve for main duct controls the refrigerant flow as it is opened or closed depending on the power input. It is connected to the temperature switch in series during the pump-down operation. In this case, the pump-down operation is processed by the opening or closing of the electronic valve for the main duct according to the closing or opening of temperature switch contact.

(7) Expansion Valve

Manual Expansion Valve

The manual expansion valve insulates and expands the high temperature and pressure liquid refrigerant to the low temperature and pressure liquid refrigerant for easy expansion in the expander. The condensed and liquidized refrigerant is rapidly discharged from the narrow side to the wide side(crossing action) and starts the evaporation because the pressure is removed. Moreover, the volume of refrigerant is properly adjusted for the absorption of sufficient heat in the evaporator.

(8) Evaporator



The evaporator performs the heat exchange activity to directly achieve the refrigeration goals as the low temperature and pressure liquid refrigerant from the expansion valve absorbs the latent heat of evaporation. The evaporator absorbs the latent heat of evaporation from the low temperature and pressure liquid refrigerant from the expansion valve to directly refrigerate an object(copper duct aluminumpinair).

(9) High Pressure Gauge

This device is for measurement of refrigerant pressure behind of compressor, liquid type high pressure gauge. Range is -1 ~ 35kgf/cm2.

(10) Low Pressure Gauge

This device is for measurement of refrigerant pressure front of compressor, liquid type low pressure gauge. Range is -1 ~ 20kgf/cm2.

(11) Sight Glass

A sight grass that is for indication of refrigerant charging level and status with direct and simple way is available to HFC, HCFC, CFC family with no matter within －50℃ ~＋80℃.
Overcharging of refrigerant makes lubricating oil happening bubble, compression liquid, so that it makes an accident sometimes. For protecting this, through an installed sight grass refrigerant should be charged suitable.

(12) Accmulator

Accumulators have been used for years on original equipment. More recently they have been field installed. The significance with respect to accumulator and system performance has never been clarified. Engineers have been foreced to evaluate each model in terms of the system on which it is to be applied. Application in the field has been primarily based on choosing a model with fittings that will accommodate the suction line and be large enough to hold about half of the refrigerant charge.

There is no standard rating system for accumulators. The accuracy of rating data becomes a function of the type of equipment used to determine the ratings. Some data is now available to serve as a guide to those checking the use of an accumulator.

(13) Brine Tank

Refrigerant (1st refrigerant) at given evaporator gets heat from brine liquid in brine tank
The brine liquid (2nd refrigerant) lost heat already roles to make water freeze to become ice inside copper cylinders.

(14) Data Performance Automatic Measurement Equipment

This device roles to be acquisitive temperature and pressure data at all of position in a refrigeration system.
Temperature point : 20ea
Pressure point : 8ea
Input Power : DC 5V
Ref.) See its software program for each detail position.

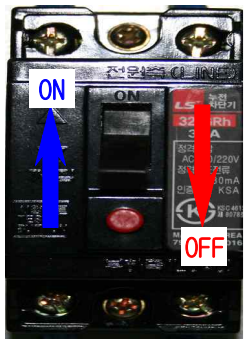
(15) Pressure Sensor

This sensor measures high pressure, low pressure, condensing pressure, and evaporating pressure in a refrigeration system.
Input power : DC 5V
Output : 0~3.3V

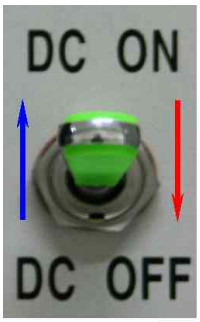
2. Automatic control device component

(1) Main Power (N.F.B)

Main Power



N.F.B



Toggle Switch

The over current breaker(N.F.B) protects the compressor motor, fan motor of condenser or evaporator or wires of the refrigeration training equipment from the over current due to overloads or short circuit. The circuits are automatically cut out so that the equipment stops operation. It is not required to replace like a fuse if any cutout is occurred. The power can be immediately and easily reentered just using a handle.
After connection between equipment and power line, for flowing of current a NFB is used, and then a AC LAMP will be on. And also if a Toggle switch is on, a DATA LOG device is on.

(2) DC Volt Meter

Volt meter (Analog type)

Volt meter (Digital type)

This device installed in equipment measures Voltage by DC.

(3) DC Ampere

Ampere(Analog type)

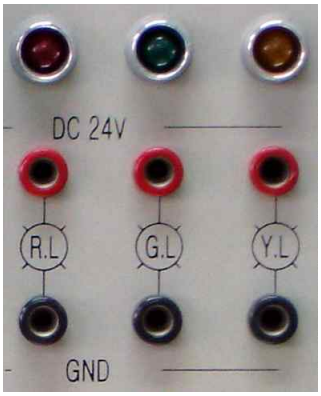
Ampere(Digital type)

This device installed in equipment measures current by DC.

(4) Buzzer

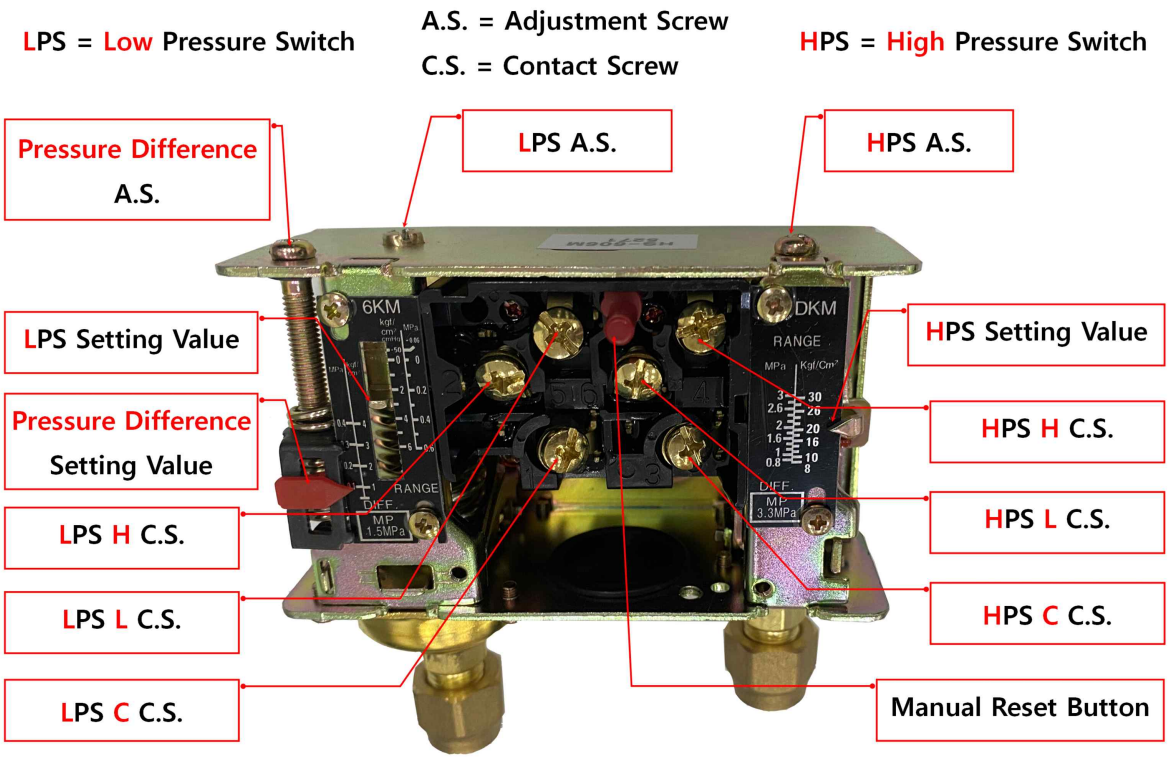
The buzzer and alarm lamp display the abnormal status when a thermal relay and safety devices(H.P.S) are working. That is, the alarm lamp is more effective than the buzzer in the noisy places and the buzzer is more effective than the alarm lamp for the color blind operators in the quiet working places. Using both the buzzer and alarm lamp will be ideal.

(5) Lamp



The power lamp(P.L) is on when the power is connected and the operating lamp (G.L) is on during the operation. the stop lamp(R.L) is on when the operation stops and the emergency lamp or alarm lamp(Y.L) displays the abnormal status during the operation such as operation of thermal relay. The reserve lamp(Y.L) circuit can be configured to be turned on when the automatic control devices such as low temperature switch, temperature control switch and condensation and pressure control switch are operating.

(6) Pressure Switch



The Dual Pressure Switch(DPS) is the set of HPB and LPS. If the high pressure is over a certain level or the low pressure is below a certain level, it stops the motor for compressor. The excessively low differential pressure of LPS induces frequent setout of compressor and this is called Hunting.

On the contrary, the excessively high differential pressure of LPS extends the down time too much. So the temperature in the refrigeration room is increased. This is called Off Set.

A. L.P.S Low pressure control

In Fig. 1-22, the right part of dotted line shows setting value (RANGE) of low pressure, the other part difference (DIFF).

Ⓐ Set your desirable low pressure value by screw pin using screw driver.

Ⓑ Set your desirable difference value by screw pin using screw driver.

Ⓒ Connect between 'H' or 'L' and 'com' as your desirable control.

Ⓓ LPS-L Line OUT(When the desire value is lower than your setting value, connect 'com' and 'L')

Ⓔ LPS-H Line OUT(When the desire value is upper than your setting value, connect 'com' and 'H'.)

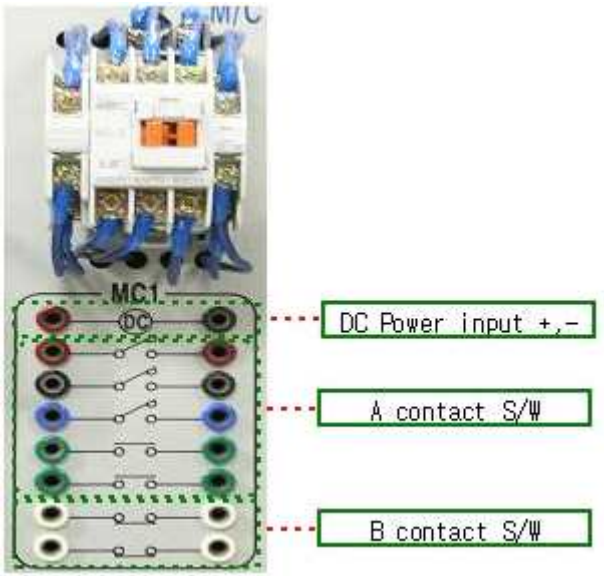
B. H.P.S High pressure control

Ⓐ Set your desirable high pressure value by screw pin using screw driver.

Ⓑ LPS-L Line OUT(When the desire value is lower than your setting value, connect 'com' and 'L')

Ⓒ LPS-H Line OUT(When the desire value is upper than your setting value, connect 'com' and 'H', RESET : return.)

(7) Magnetic Contactor

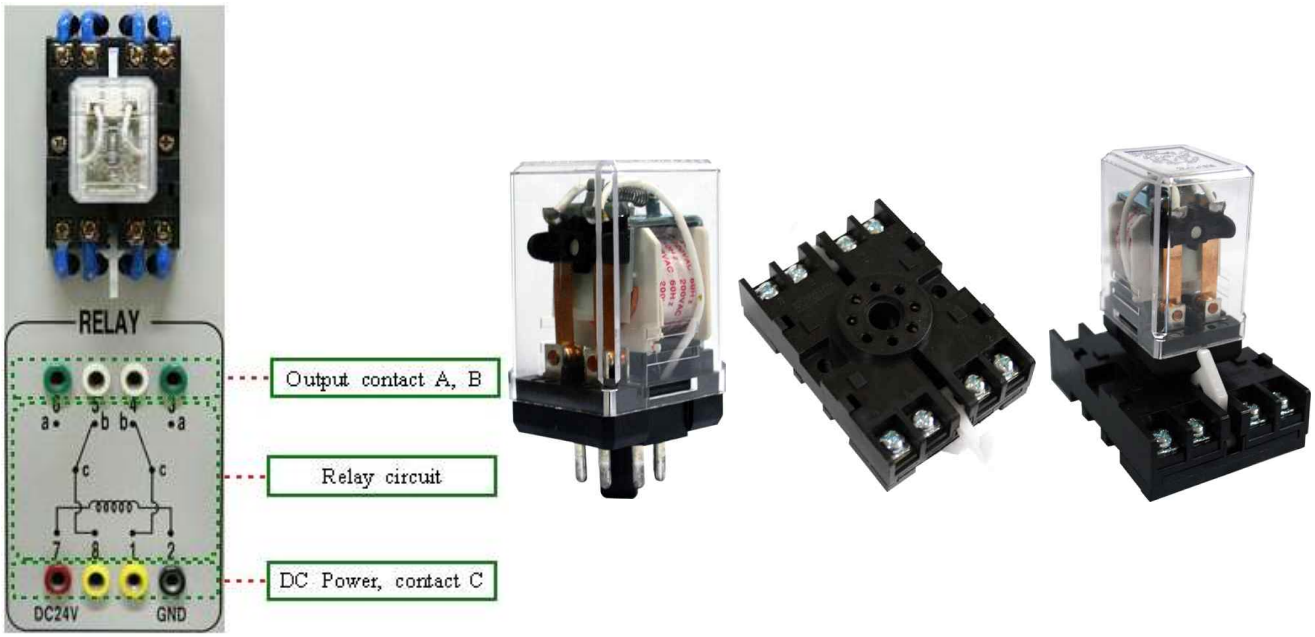


Magnetic contactor (MC) controls compressor motor, condenser motor, solenoid valve and evaporator motor through sequence circuit.

① DC Power red is +, black -.

② When DC power is on, A contact sticks to each other, so current can flow, and B contact separated, so current cut.

(8) Relay



Relay controls compressor motor, condenser motor, solenoid valve and evaporator motor through sequence circuit.

① DC Power red is +, black -.

② When DC power is on, each contactor 1-3, 8-6 are connected each other(Flow current), at same time separated contactor 1-4, 8-5 each other(Close current).

(9) Thermal Relay

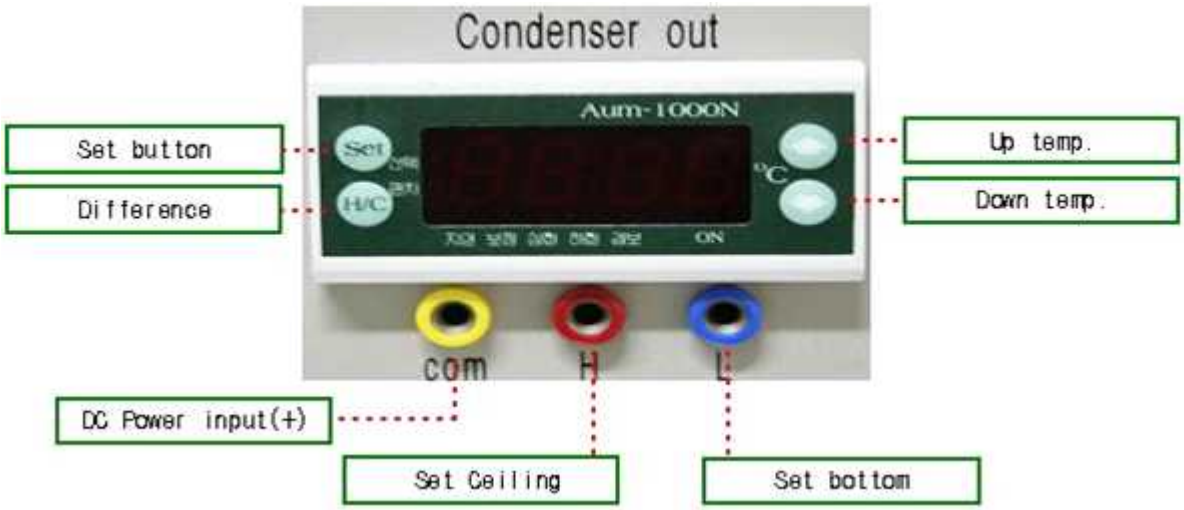
This device is called by thermostat overload relay makes the contact work under abnormal current than setting valve, so this device is needed for protecting from overflow current aborutly. The bimetallic thermostat operates as a function of expansion or contraction of metals due to temperature changes. Bimetallic thermostats are designed for the control of heating and cooling in air-conditioning units, refrigeration storage rooms, greenhouses, fan coils, blast coils, and similar units.

The working principle of such a thermostat is two metals, each having a different coefficient of expansion, are welded together to form a bimetallic unit or blade. With the blade securely anchored at one end, a circuit is formed and the two contact points are closed to the passage

of an electric current. Because an electric current provides heat in its passage through the bimetallic blade, the metals in the blade begin to expand, but at a different rate. The metals coefficient of expansion is placed at the bottom of the unit. After a certain time, the operating temperature is reached and the contact points become separated, thus disconnecting the appliance from its power source.

After a short period, the contact blade will again become sufficiently cooled to cause the contact point to join, thus reestablishing the circuit and permitting the current again to actuate the circuit leading to the appliance. The foregoing cycle is repeated over and over again. In this way, the bimetallic thermostat prevents the temperature from rising too high or dropping too low.

(10) Temperature Switch



The digital temperature meter(Temp Meter) for measuring temperature measures on a defined areas for the performance test when the refrigeration training equipment is running. Then, it draws the pressure-enthalpy diagram with the measured temperature for the performance test of refrigeration training equipment. At this moment, the digital temperature meter is required to measure the temperature on each area. The performance test of refrigerator will be separately described.

① Setting temperature value by push set button.
② Choose temperature value by push up or down button.
③ Setting deviation value.
④ Connect contactor 'com' and '+ '.
⑤ Connect contactor 'H' or 'L' and '+'.

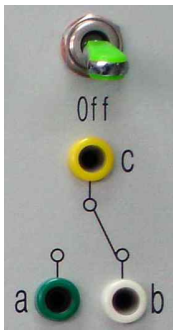
(11) On/Off Switch

This device is for start, stop, or ON/OFF.

① PB1 is for Running (A contact)

② PB2 is for Stop (B contact)

(12) Toggle Switch



This device is for start, stop, or ON/OFF.

① Connect 'C' and '+' power, operate by selection of 'a' or 'b'

(13) Temperature Display

Comp in : Display temp. at compressor inlet

Comp out : Display temp. at compressor outlet

Exp. v. in : Display temp. at expansion valve inlet

Exp. v. out : Display temp. at expansion valve outlet

Condenser in : Display temp. at condenser inlet

Condenser out : Display temp. at condenser outlet

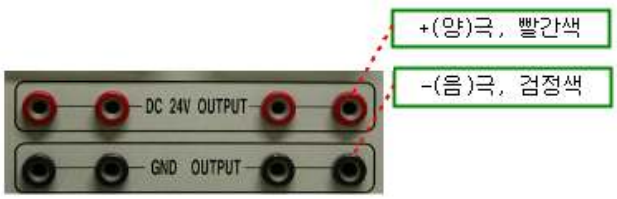
Eva. v. out : Display temp. at evaporator outlet

Water(Ice) Temp : Display temp. of water

(14) DC Power input

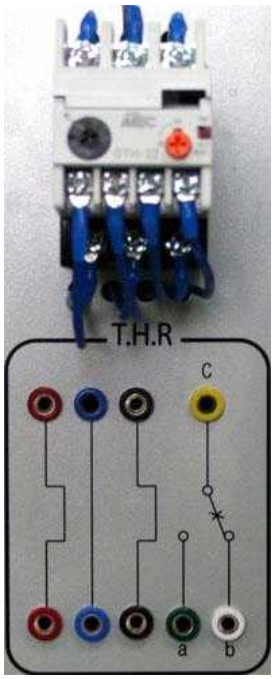
COMP : Compressor Motor
CFM : Condenser Fan Motor
EFM : Evaporator Fan Motor
SV : Solenoid Valve
EXT1 : Extra
Pump : Pump Motor
Plug for electric circuit among each devices(Red plug +, Black - .)

(15) DC Power Output



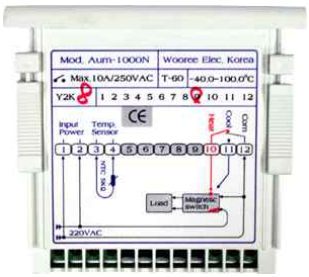
Plug for electric circuit among each devices(Red plug +, Black - .)

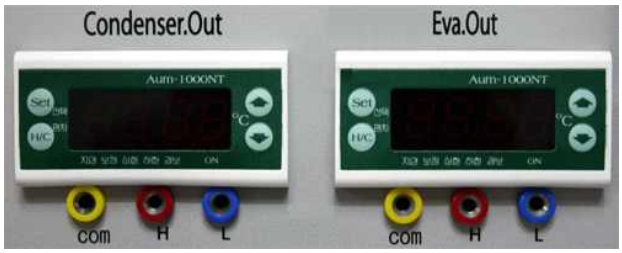
(16) Thermo relay (T.H.R)



The working principle of such a thermostat is two metals, each having a different coefficient of expansion, are welded together to form a bimetallic unit or blade. With the blade securely anchored at one end, a circuit is formed and the two contact points are closed to the passage of an electric current. Because an electric current provides heat in its passage through the bimetallic blade, the metals in the blade begin to expand, but at a different rate. The metals coefficient of expansion is placed at the bottom of the unit. After a certain time, the operating temperature is reached and the contact points become separated, thus disconnecting the appliance from its power source.

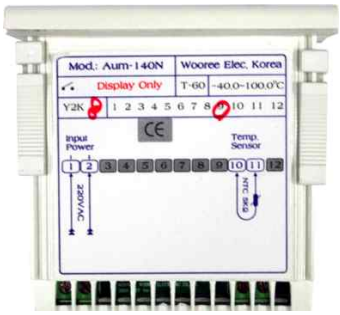
(17) Digital Temperature Switch





The given temperature value is over the critical point, then the contactor is closed, and then the temperature turns down, then the contactor open, so that equipment can be on, off.

(18) Digital Temperature Display



Digital thermometer displays temperature value by digital figure that is voltage or current value that is converted from resistance element under changing temperature, so that user can recognize easier.

(19) Dual Pressure Switch

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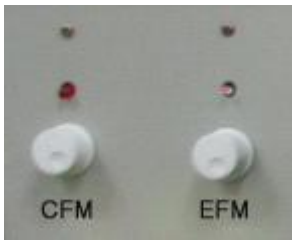
Dual Pressure Switch (DPS) consists of HIGH PRESSURE SWITCH AND LOW PRESSURE SWITCH in a case. On contacts part like as Bellows, lever and contact setting screw, these contacts is a fair of 2. High pressure control is return type HPS (HIGH PRESSURE SWITCH), this switch is used when abnormal raising of compressor outlet (ex. clogging of tube, freezing of expansion valve), and LPS (LOW PRESSURE SWITCH) is used when abnormal down of intaking pressure.

When all pressure of intake and emit are not normal, the system can not work. In other words, on piping and tubing part in refrigeration system this device is used in control of compressor working/stop. it is just for safety device.

(20) Condenser, Evaporator Temperature Control section

After setting temperature, when it is over the critical point, contactor in temperature switch is open, so that the connection will be shut up, and then when the temperature returns, the switch is on as the temperature at outlet of condenser or evaporator.

(21) Condenser Fan, Evaporator Fan Motor Speed Control section



This volume controller is for control of condenser fan motor or evaporator fan motor. Turning to right is for going up RPM, and left down. As motor speed the efficient of condensing or evaporating can be controled.

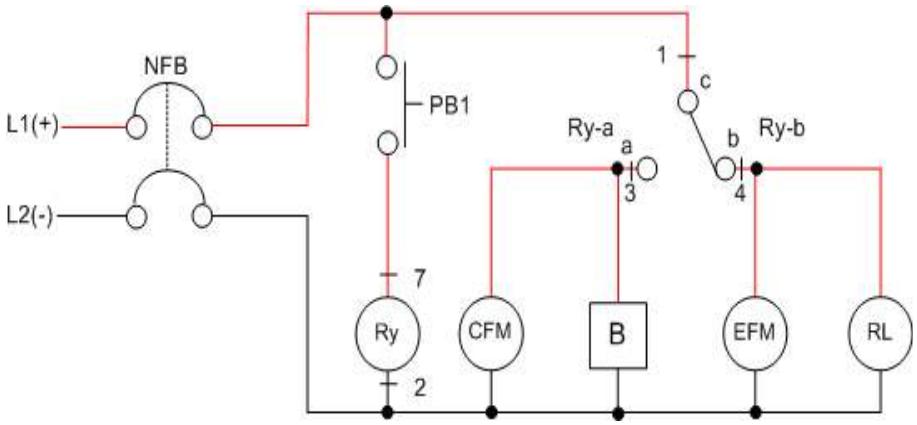
Chapter 3. Construction and Operation as circuit

1. Construction and operation of Temp. Pressure, & Defrost control refrigeration system

Experiment name	1. Practicing to configurate circuit using contact point "c" of Ry device.	Class time(hr)
		8
The object of experiment	① To understand construct and principal of relay(Ry) ② To configurate circuit using contact point "c" of Ry ③ To descript about configuration circuit using contact point "c" of Ry	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit



L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
B : Buzzer
EFM : Evaporator Fan Motor
RL : Red Lamp
CFM : Condenser Fan Motor
PB : Push button
MC : Magnet contactor coil

A. When N.F.B is on, EFM and R.L are ON because contactor RY-b is closed, and for contactor RY-a is open, CFM and Buzzer are OFF. (Under PB1 is open)
B. When PB1 is pushed, current flows on Relay coil at the same time contactor RY-a is closed, so CFM and Buzzer are ON.
C. Contactor "a" means working contact, initial a from arbeit contact
D. Contactor "b" means breaking contact, initial b from breaking contact.

Brine refrigeration trainer
(KTE-6000BR)

Refrigeration real wiring training kit
(KTE-4000SQ)

· Check point

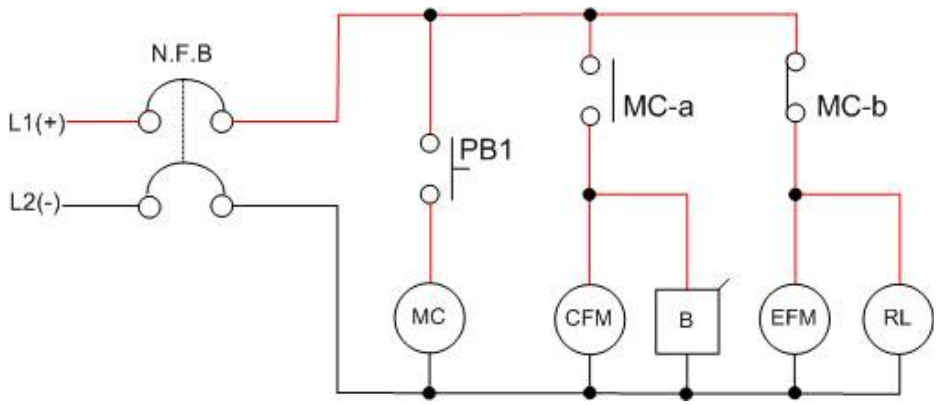
1. Checking tools and materials.
2 Practicing more 2 times through banana jacks using equipment(KTE-1000TP or KTE-1000BA), tools and materials.
3. Understanding construct and principal of MC.
4. Understanding the function of operating circuit.
   ① Explaining the running process when PB is pushed.
   ② Explaining the running process when PB is released.
5. Describing contact "c" of refrigeration circuit.
6 Practicing to configurate circuit with electric wire using refrigeration real wiring trainer.(KTE-4000SQ).

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	2. Practicing to configurate circuit using contact point "a","b" of magnet contactor(MC).	Class time(hr)
		8
The object of experiment	① To understand construct and principal of magnet contactor(MC) ② To configurate circuit using contact point "a", "b" of MC ③ To descript about configuration circuit using contact point "a", "b" of MC	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

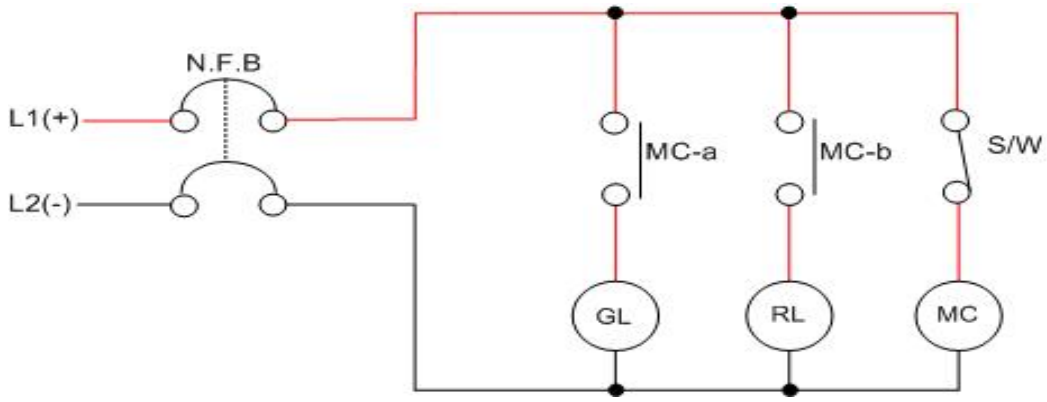
Control Circuit



L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
CFM : Condenser Fan Motor
EFM : Evaporator Fan Motor
MC-a : MC "a" contact
MC-b : MC "b" contact
B : Buzzer
PB : Push button
RL : Red Lamp
MC : Magnet contactor coil

A. When N.F.B is on, EFM and R.L are ON because contactor MC-b is closed, and for contactor MC-a is open, CFM and Buzzer are OFF. (Under PB1 is open)
B. When PB1 is pushed, current flows on magnetic coil at the same time contactor MC-a is closed.
C. Contactor "a" means working contact, initial a from arbeit contact
D. Contactor "b" means breaking contact, initial b from breaking contact.

1. circuit of contact "a", circuit of contact "b"



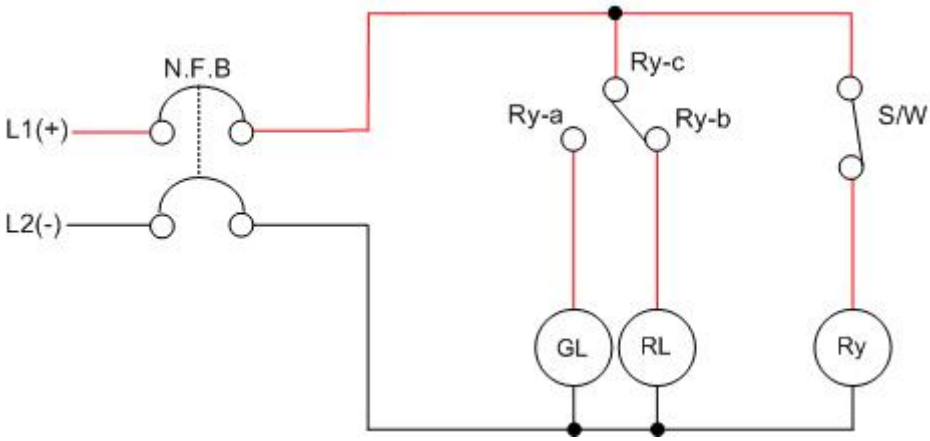
A. If NFB switch is on, MC-b contact is closed and RL is on , MC-a contact is opened and GL is off. (S/W opening state)

B. If S/W is closed, MC-a contact is closed and GL is on, MC-b is opened and RL is off.

C. Arbeit contact means 『working contact』, so it`a initial is "a".

D. Break contact means 『Opening contact』, so it`s initial is "b".

2. contact "c" (change circuit)



A. If N.F.B S/W is closed, RL is on and GL is off.

B. If S/W is closed, contact "b" is opened and RL is on, contact "a" is closed and GL is off. As like this, when there is current at electric coil Ry, one side is "a" contact circuit that is closed, the other side is "b" contact that is opened.

C. Change over contact means 『transferring contact』, so it`s initial "c".

Brine refrigeration trainer
(KTE-6000BR)

Refrigeration real wiring training kit
(KTE-4000SQ)

・Check point

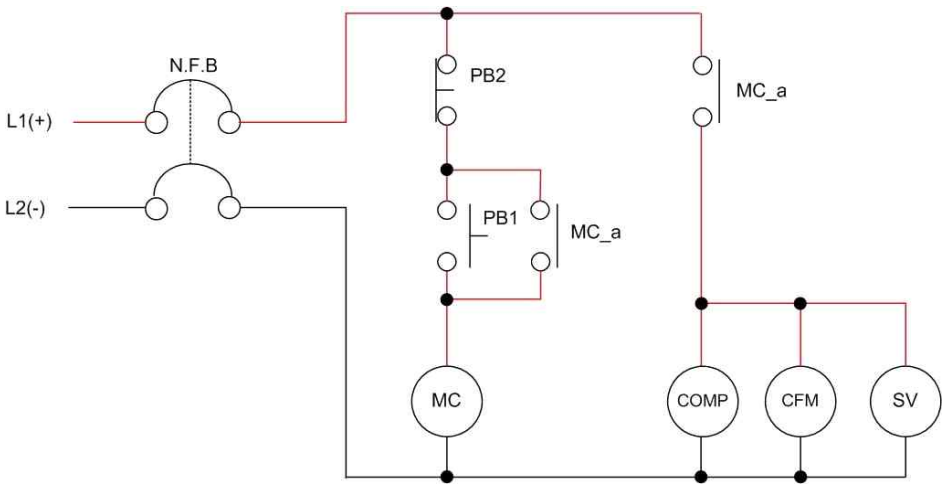
1. Checking tools and materials.
2 Practicing more 2 times through banana jacks using equipment(KTE-1000TP or KTE-1000BA), tools and materials.
3. Understanding construct and principal of MC.
4. Understanding the function of operating circuit.
   ① Explaining the running process when PB is pushed.
   ② Explaining the running process when PB is released.
5. Describing contact "a" and contact "b" of refrigeration circuit.
6 Practicing to configurate circuit with electric wire using refrigeration real wiring trainer.(KTE-4000SQ).

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	・Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	3. Practicing to configurate self-holding circuit for priority STOP of standard refrigeration system.	Class time(hr)
		8
The object of experiment	① To understand self-holding circuit for priority STOP, and to operate standard refrigeration system as the circuit. ② To describe self-holding circuit configuration for priority STOP of standard refrigerator.	

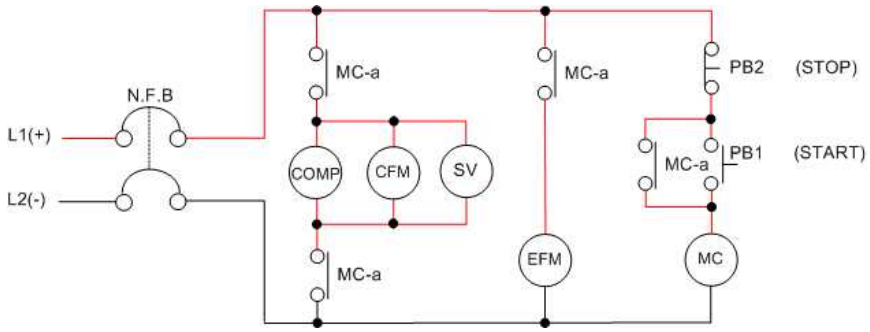
Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit



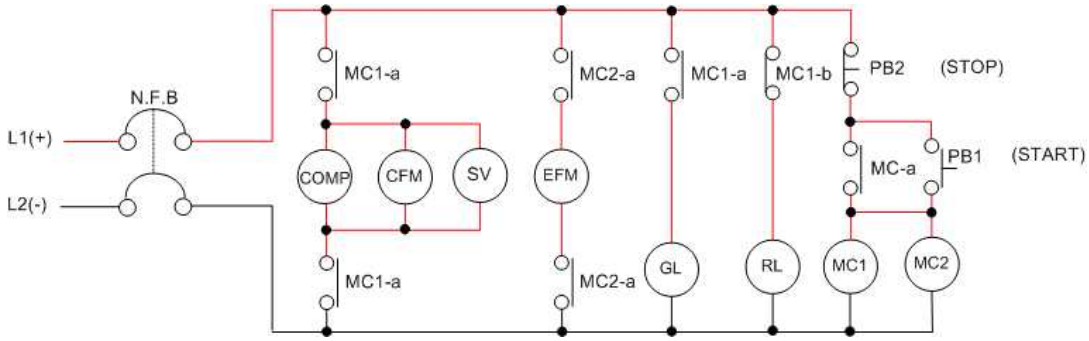
L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
MC : Magnet contactor coil
MC-a : MC "a" contact
CFM : Condenser Fan Motor
SV : Solenoid V/V
PB : Push button
COMP : Compressor motor

1. Manual Operating Circuit(Self-Holding Circuit) Design and Configuration in Refrigerator



The manual operating circuits are configured, tested and experimented using the banana jacks in accordance with the refrigeration cycle drawings and operating circuits. The circuit designs and configuration principles are described below. Turn the Start button on, and the MC coil(MC Electric Coil) is excited. So the relay circuit “a”, the main contact, is closed and the Motor Compressor and Condenser Fan Motor run. Then, the normal operation is started. Press the Stop button to turn the circuit off, and the MC coil(MC Electric Coil) is demagnetized. Then, the main contact is opened and so the Motor Compressor, Condenser Fan Motor and Evaporator Fan stop.

For the manual operation of refrigerator, the self-holding circuit is configured and operated using the relay circuit "a" of the magnetic switch(MC Electric Coil). Press the Start button, and the refrigerator runs. Press the Stop button, and the refrigerator stops. This is the basic application control circuit in the refrigeration devices.



When the N.F.B is opened, the break light(RL) of the relay circuit ‘b' is on as the magnetic switch (MC Electric Coil) is demagnetized. Press the Start button, and the magnetic switch (MC Electric Coil) is excited. Then, the relay contact "a", the main contact, is closed and so the Motor Compressor, Condenser Fan and Evaporator Fan run. Accordingly, the normal operation is started. At this point, the operation light(GL) is on to indicate the refrigerator runs as the relay circuit ‘a' is closed.

The relay circuit ’b' is opened and so the break light(RL) is off. Press the Stop button, and the magnetic switch(MC Electric Coil) is demagnetized. Then, the main contact is opened and so the Motor Compressor, Condenser Fan Motor and Evaporator Fan stop. Accordingly, the operation light(GL) is off and the relay circuit "b" is closed. Then, the break light(RL) is on to indicate that the operation stops.

As described above, the manual operation to start and stop the refrigerator is carried out by configuring the self-holding circuits using the relay circuit "a" of the magnetic switch (MC Electric Coil). The refrigerators run by pressing the Start button and stop by pressing the Stop button. This method can be applied for the tests, practices and circuit designing in the actual fields.

Brine refrigeration trainer
(KTE-6000BR)

Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

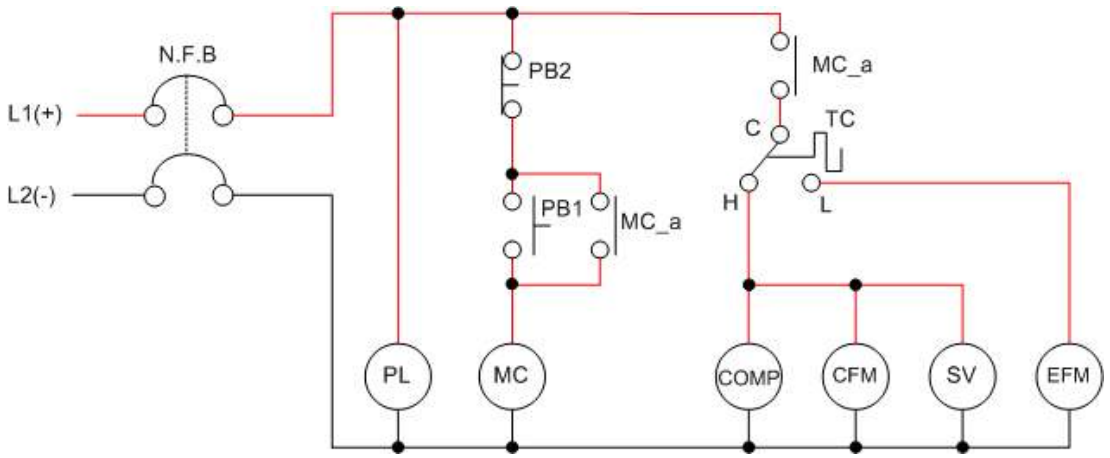
1. Checking tools and materials.
2. Configurating circuit of operation with banana jacks using tools and material.
3. Understanding the function of operating circuit.
   ① Explaining the process when NFB S/W is on.
   ② Explaining the process when PB1 is pushed.
   ③ Explaining the process when PB2 is pushed.
   ④ Explaining the principal of the self-holding circuit for priority STOP.
4. Configurating circuit with electric wires and operating using tools and materials.

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	4.Practicing to configurate circuit for low temperature control using a temperature switch.	Class time(hr)
		8
The object of experiment	① To understand the principal of low temperature control using temperature S/W, and adjust it. ② To configurate and operate circuit for low temperature control . ③ To understand the feature after note and define distribution and variation of low temperature points.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
‥ Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175㎜ · 150㎜ · 0.5~6㎟ · 300A 600V	1 1 1 1/Group

Control Circuit



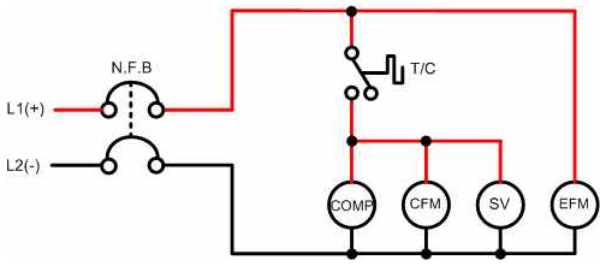
L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
PB : Push button
COMP : Compressor motor
MC-a : MC "a" contact
TC : Temperature control S/W
CFM : Condenser Fan Motor
SV : Solenoid V/V
MC : Magnet contactor coil
EFM : Evaporator Fan Motor
PL : Power Lamp

distribution and variation of low temperature

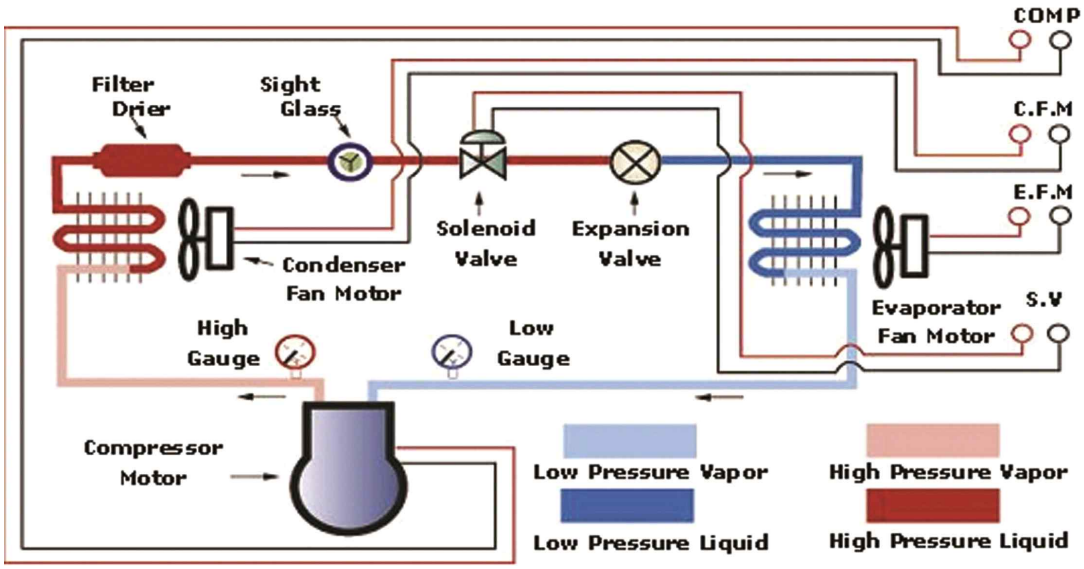
Test Steps	Temperature Setting	Temperature Deviation	In T	Out T	Actual Temperature	Adjustment
1	10	2				
2	9	2				
3	8	2				
4	7	3				
5	5	3				

[Related Theory]

1. Understanding Automatic Temperature Control and Pump-down Operating Circuit



A. Automatic Refrigerator Temperature Control Overview Set the temperature → Cut-out point of the preset temperature → Condensing Unit (Compressor motor, Condenser Fan motor) stops → Cut-in point of the preset temperature→ Condensing Unit restarts



Automatic Temperature Control and Operating Circuit in Refrigeration Cycle

Brine refrigeration trainer
(KTE-6000BR)

Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

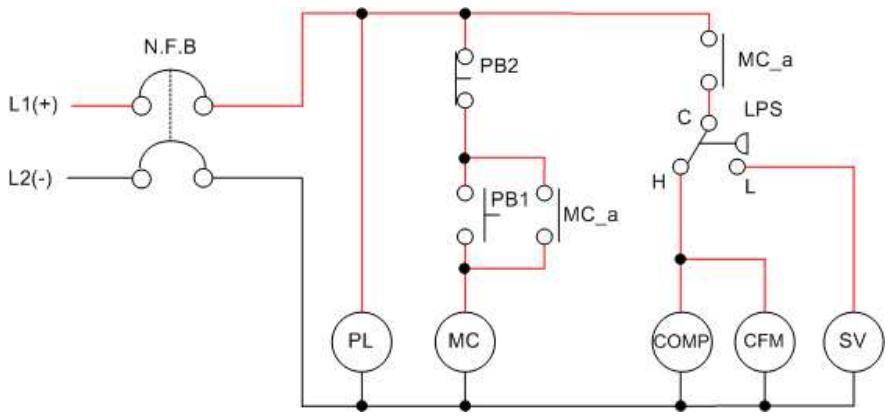
1. Checking tools and materials.
2. Configurating circuit of operation with banana jacks using tools and material.
3. Understanding the principal of temperature S/W as kinds of it, and setting the low temperature control value and explaining it.
4. Understanding the function of operating circuit.
   ① Explaining the progress when PB1 is pushed.
   ② Explaining the progress that refrigerator stops when temperature S/W is opened.
   ③ Explaining the progress that refrigerator restarts when temperature S/W is closed.
   ④ Explaining the progress that refrigerator starts when PB_2 is pushed.
5. noting and defining distribution and variation of low temperature points
6. Configurating circuit with electric wires and operating using tools and materials.

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	5. Practicing to configurate circuit for low pressure control(LPS) using a pressure switch.	Class time(hr)
		8
The object of experiment	① To understand the principal of low pressure control(LPS), and adjust it. ② To configurate and operate circuit for low pressure control and understand. ③ To understand the feature after note and define distribution and variation of low pressure.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175㎜ · 150㎜ · 0.5~6㎟ · 300A 600V	1 1 1 1/Group

Control Circuit

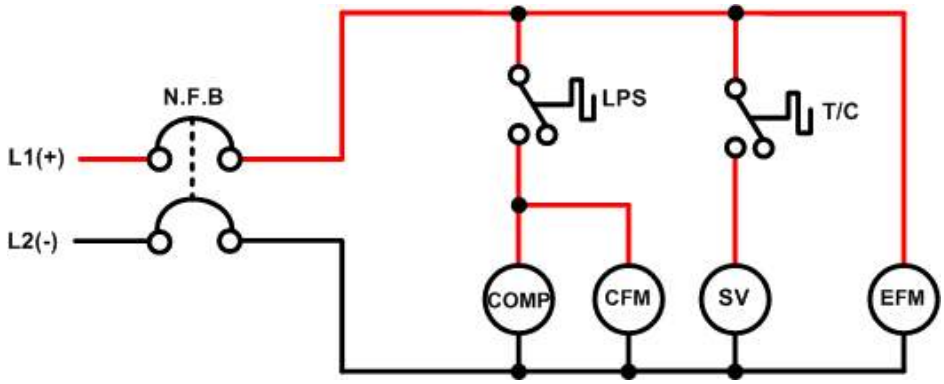


L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
PB : Push button
COMP : Compressor motor
MC-a : MC "a" contact
CFM : Condenser Fan Motor
SV : Solenoid V/V
MC : Magnet contactor coil
LPS : Low pressure S/W
PL : Power Lamp

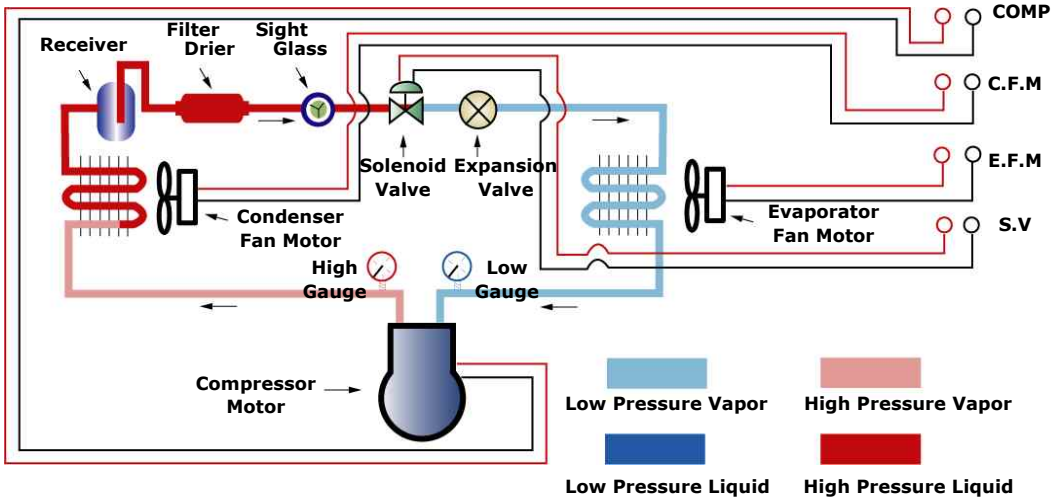
Test Steps	Cut in P	D.P	Cut out P	Pressure Gauge Scale	Adjustment
1	3	2	1		
2	3	3	0		
3	3	1	2		

[Related Theory]

1. Automatic Refrigerator Pump-down Overview



Set the appropriate temperature and LPS pressure→ Cut-out point of the temperature switch → Shut the electric valve of the high pressure liquid tube in the refrigeration system → High pressure increased and low pressure dropped in the refrigeration system → The refrigerant on the low-pressure side moves to the high pressure side → Cut-out point of LPS → Condensing Unit stops (Refrigeration stops) → In-point of temperature switch due to the increase of load in the refrigeration room → The electric valve of the high pressure liquid tube in the refrigeration system opens → High pressure dropped and lower pressure increased in the refrigeration system→ The refrigerant on the high pressure side moves to the low pressure side (refrigeration is activated) → Cut-in point of LPS→ Condensing Unit runs(normal operation)



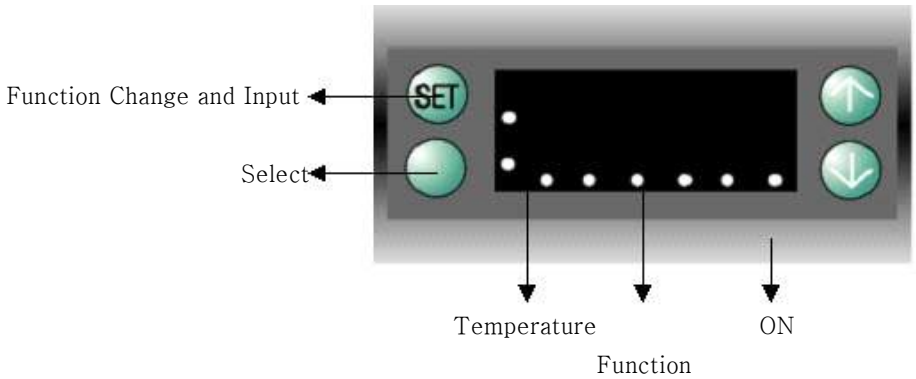
Automatic Pump-down Operation in Refrigeration Cycle

2. Operation Characteristics Comparison

Division	Automatic Temperature Control Operation	Automatic Pump-down Operation
Run→Stop	Temperature control switch opened → Condenser, compressor and stop and electric valve closed.	Temperature control switch opened → Electric valve closed → LPS contact opened→Condenser and compressor stopped
Stop→Run	Temperature control switch closed→ Compressor and condenser run and operation and electric valve opened (Normal Operation)	Temperature control switch closed → Electric valve opened → LPS contact closed →Condenser and compressor run(Normal Operation)
Refrigerant Flow Features	Stop under the normal operation of the refrigeration system	Refrigerant moves to the high pressure side in the refrigeration system and stop

3. Adjustment of Temperature/Pressure Switch

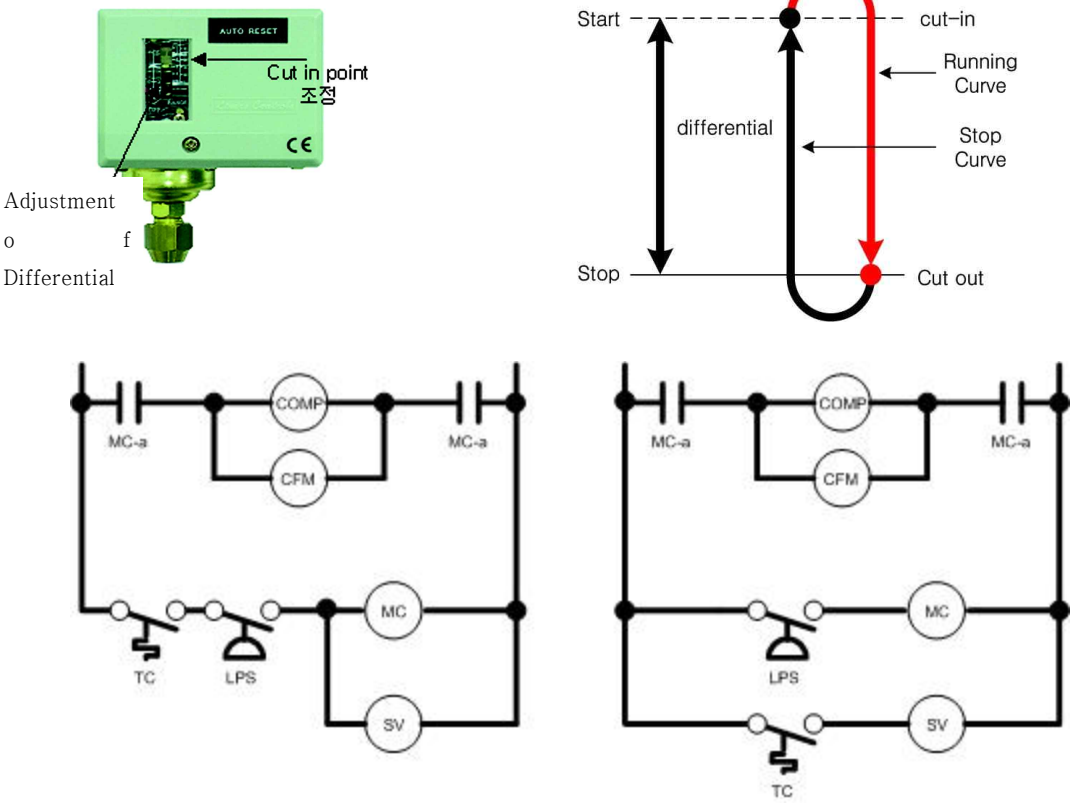
1) Adjustment of Temperature Switch



For keeping the temperature of evaporator to −15℃, the temperature deviation of the digital thermostatic control switch is kept to 1℃. Then, the temperature switch contact is closed at −14℃ and so the electric valve of the high pressure liquid tube is opened. Next, the temperature switch contact is opened at −16℃ and the electric valve of the high pressure liquid tube is closed. The low pressure switch(LPS) contact is opened at the cut-out point during the operation in the refrigeration training center as shown in the control circuit and control in the figure. And the operation is stopped. When the temperature comes to the cut in point, the refrigeration device restarts its operation. For the operation principle, if the temperature of evaporator is on the cut out point, the contact of the thermostatic control switch is opened and the electric value of the liquid tube is closed. When the operation is continued with the electric valve closed, the high pressure goes up and the low pressure drops.

After all, the low pressure drops to the cut out point pressure of LPS. Then, the LPS contact is opened and the compressor and condenser stop. Accordingly, the refrigeration system stops. When the evaporation load is increased and so the temperature of evaporator goes up, the contact of thermostatic control switch is closed and the electric valve is opened. Next, the low pressure is balanced(high pressure down and low pressure up) and reaches to the LPS Cut out point(Cut in point). Then, the LPS contact is closed and the compressor and condenser restarts. Finally, the normal operation is started.

2) Adjustment of Pressure Switch



LPS Adjustment and Control Circuit

For LPS pressure setting and adjustment, the LPS adjustment circuit is designed and configured. Then, the values are accurately adjusted to the actual values through the stepwise tests. Next, the refrigerator is operated.

-. Test Procedure

a. Configure the circuit using the banana jacks.

b. Set and adjust the cut in and cut out points of L.P.S.

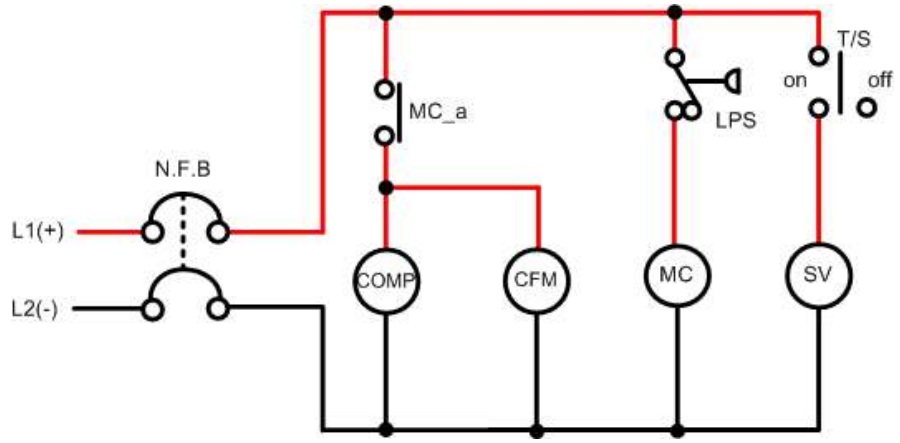
c. Connect the low pressure inlet of L.P.S to the low pressure charging ripple

d. Turn the N.F.B on.

e. Turn the T/SW off, and the electric valve is closed. Under this condition, the refrigerator

runs. Then, the low pressure drops to the cut out point.

f. The LPS contact is opened and so the COMP and CFM stop. At this point, check the pressure gauge on the low pressure side to identify whether the pressure matches up to the preset pressure on the cut out point.



g. To close the LPS contact, turn T/SW on and then SV on. And the low pressure goes up.

h. The low pressure gradually goes up to the cut in point and so the LPS contact is closed. Next, the COMP and CFM run. At this point, check whether the low pressure gauge matches up to the cut in point (keep the record)

i. Check whether the recorded data matches up to the pressure switch adjustment. If not matched, repeat the adjustment to accurately set the cut in and cut out points of LPS.

Brine refrigeration trainer
(KTE-6000BR)

Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

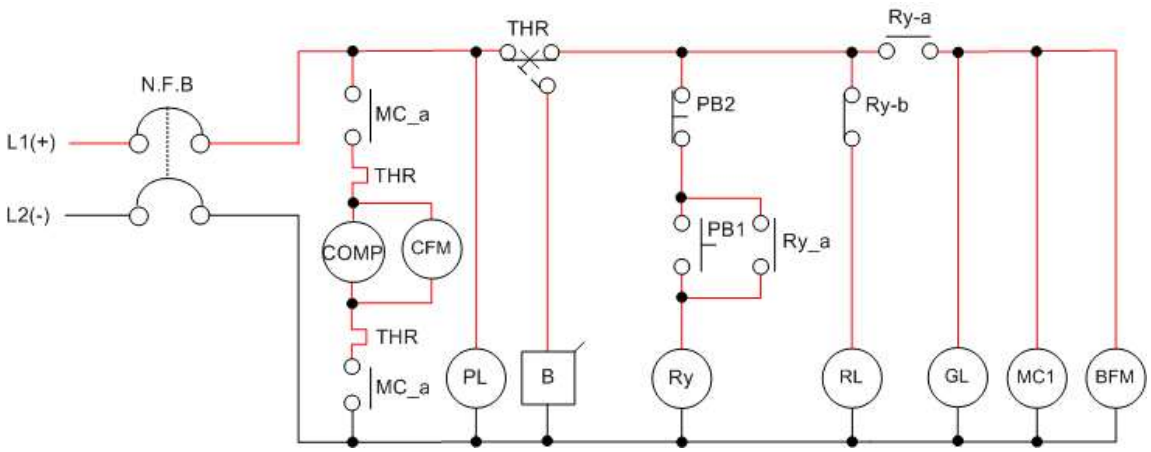
1. Checking tools and materials.
2. Setting the difference as the valves of LPS and explaining the operation principal of it .
3. Configurating circuit of operation with banana jacks using tools and material.
4. Understanding the function of operating circuit.
   ① Explaining the progress when PB1 is pushed.
   ② Explaining the progress that the refrigerator is stoped when pressure at low pressure part goes down on running of compressor motor.
   ③ Explaining the progress that the refrigerator is restarted when pressure at low pressure part goes up on stop of compressor motor
   ④ Explaining the progress that refrigerator starts when PB_2 is pushed.
5. noting and defining distribution and variation of high temperature points
6. Configurating circuit with electric wires and operating using tools and materials.

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	6. Configuration manual control circuit for "brine refrigeration system" and operation	Class time(hr)
		8
The object of experiment	① To understand the principal of brine refrigeration system. ② To configurate manual control circuit of brine refrigeration system, and explain. ③ To make wiring manual control circuit of brine refrigeration system, and explain.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175㎜ · 150㎜ · 0.5~6㎟ · 300A 600V	1 1 1 1/Group

Control Circuit

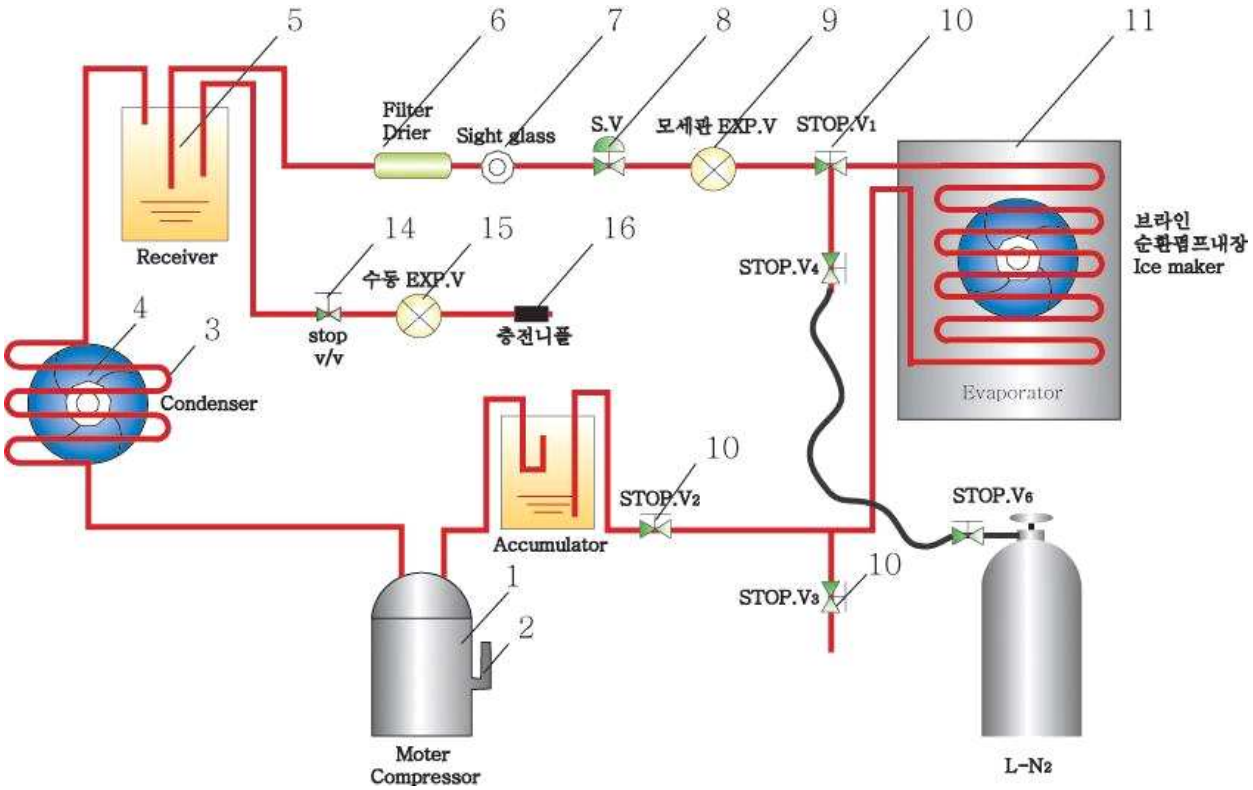


L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
MC-a : MC "a" contact
THR : Thermal Relay
COMP : Compressor Motor

PB : Push Button S/W
B : Buzzer
Ry-a : Relay"a"contact
Ry-b : Relay"b"contact
Ry : Relay Coil

CFM : Condenser Fan Motor
GL : Green Lamp
RL : Red Lamp
PL : Power Lamp
MC : Magnetic Contactor Coil

[Related Theory]



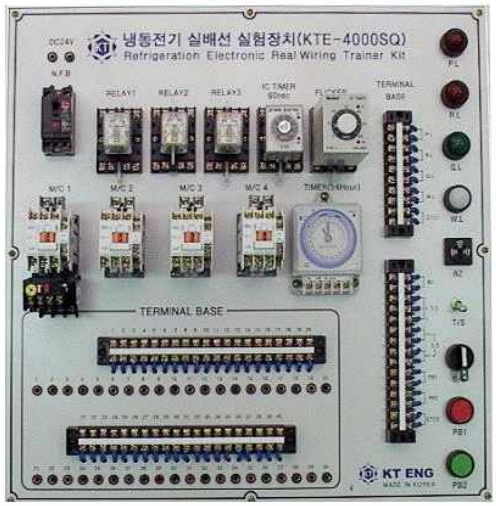
COMP : Compressor Motor

CFM : Condenser Fan Motor

S.V : Solenoid V/V

PUMP : Brine PUMP

Brine refrigeration trainer
(KTE-6000BR)



Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

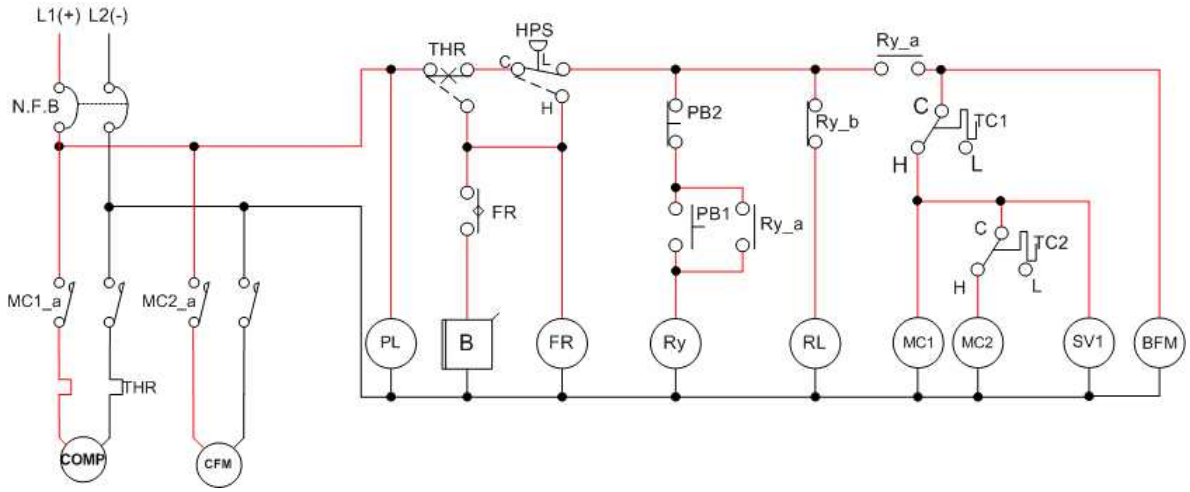
1. Set a brine refrigeration system(KTE-6000BR) and check electric and refrigerant charging states.
2. Understand the principal of brine refrigeration system.
3. Understand the function of operating circuit.
   ① Explain the progress that refrigerator starts when NFB is on.
   ② Explain the progress that refrigerator starts when PB_1 is pushed.
   ③ Explain the progress that refrigerator starts when PB_2 is pushed.
4. Adjust and explain the refrigerant charging state during maunal operation of brine refrigeration system.
5. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
6. Configurate circuit using real wires and operate using banana jacks with experiment equipments, tools and materials.

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	7. Configuration temperature automatic control circuit for "brine refrigeration system" and operation	Class time(hr)
		8
The object of experiment	① To understand the principal of brine temperature, evaporating temperature and ice temperature control of brine refrigeration system. ② To configurate for low temperature control of brine refrigeration system. ③ To note and understand distribution and variation between temperature that was set and one that was displayed.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit

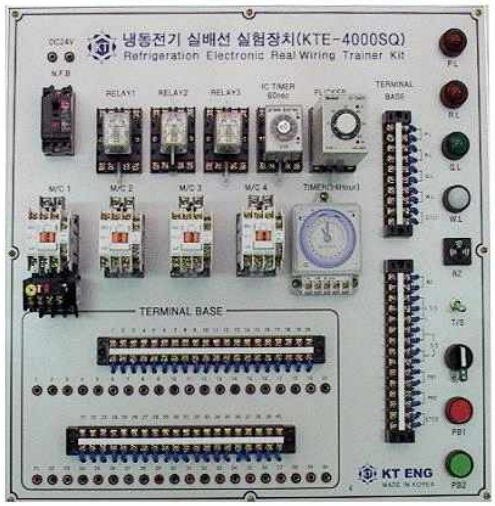


L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
MC-a : MC "a" contact
THR : Thermal Relay
COMP : Compressor Motor
HPS : High Pressure S/W

PB : Push Button S/W
SV : Solenoid V/V
Ry-a : Relay"a"contact
Ry-b : Relay"b"contact
TC : Temperature control S/W
MC : Magnetic Contactor Coil

B : Buzzer
FR : Flicker Relay
RL : Red Lamp
PL : Power Lamp
Ry : Relay Coil
CFM : Condenser Fan Motor

Brine refrigeration trainer
(KTE-6000BR)



Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

1. Check tools and materials.
2. Understand the function of operating circuit.
   ① Explain the progress when PB_1 is pushed.
   ② Explain the electric effect of temperature S/W(TC1) and temperature auto expansion V/V(Brine temperature or evaporator for brine refrigeration system.
   ③ Research how to exhaust least residence during steady state operation.
   ④ Explain the progress that refrigerator starts when PB_2 is pushed.
3. Explain the feature of Brine refrigeration system and note the data about distribution and deviation of temperature.
4. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
5. Configurate circuit using real wires and operate using banana jacks with experiment equipments, tools and materials.

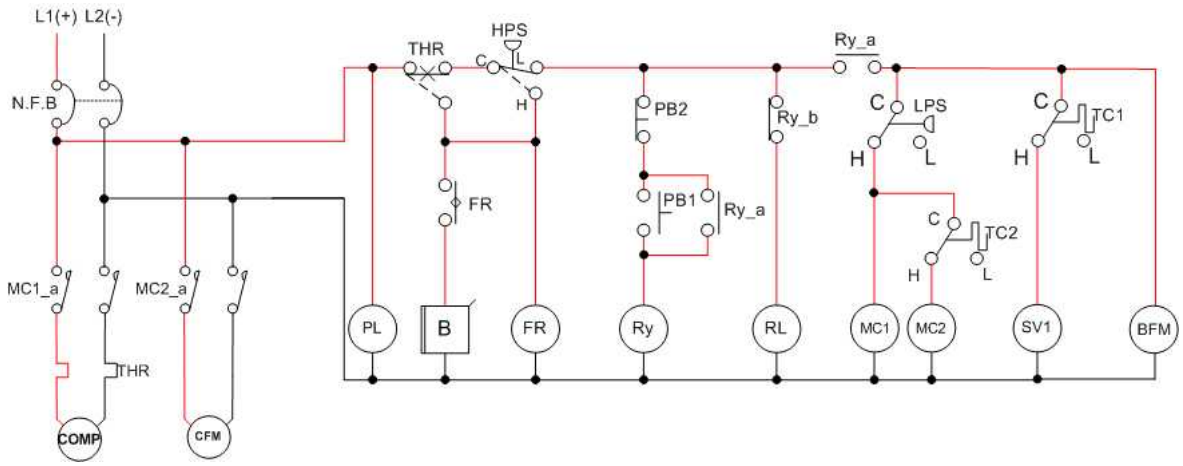
Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Experiment name	8. Configuration pump down control circuit for "brine refrigeration system" and operation	Class time(hr)
		8

The object of experiment	① To understand the principal of pump down operation) of "brine refrigeration system". ② To configurate circuit of pump down operation of "brine refrigeration system". ③ To wire circuit of pump down operation of "brine refrigeration system". ④ To set temperature S/W and pressure S/W for pump down operation of "brine refrigeration system". ⑤ To operate the system after Adjusting temperature S/W and setting pressure S/W during running "brine refrigeration system" , to understand the feature of this system.

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit

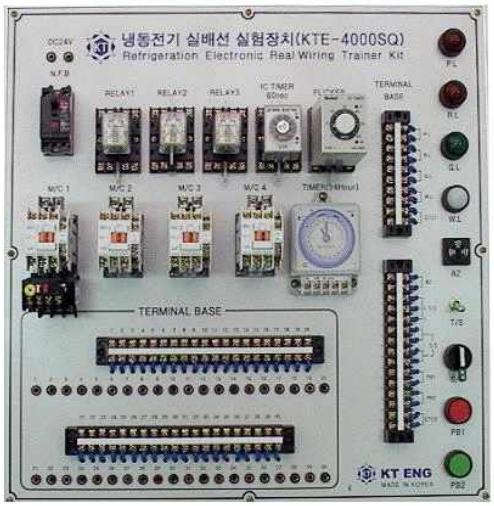


L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
MC-a : MC "a" contact
THR : Thermal Relay
COMP : Compressor Motor
LPS : Low Pressure S/W
HPS : High Pressure S/W

PB : Push Botton S/W
SV : Solenoid V/V
Ry-a : Relay"a"contact
Ry-b : Relay"b"contact
Ry : Relay Coil
MC : Magnetic Contactor Coil

B : Buzzer
FR : Flicker Relay
TC : Temperature control S/W
CFM : Condenser Fan Motor
RL : Red Lamp
PL : Power Lamp

Brine refrigeration trainer
(KTE-6000BR)



Refrigeration real wiring training kit
(KTE-4000SQ)

· Check Point

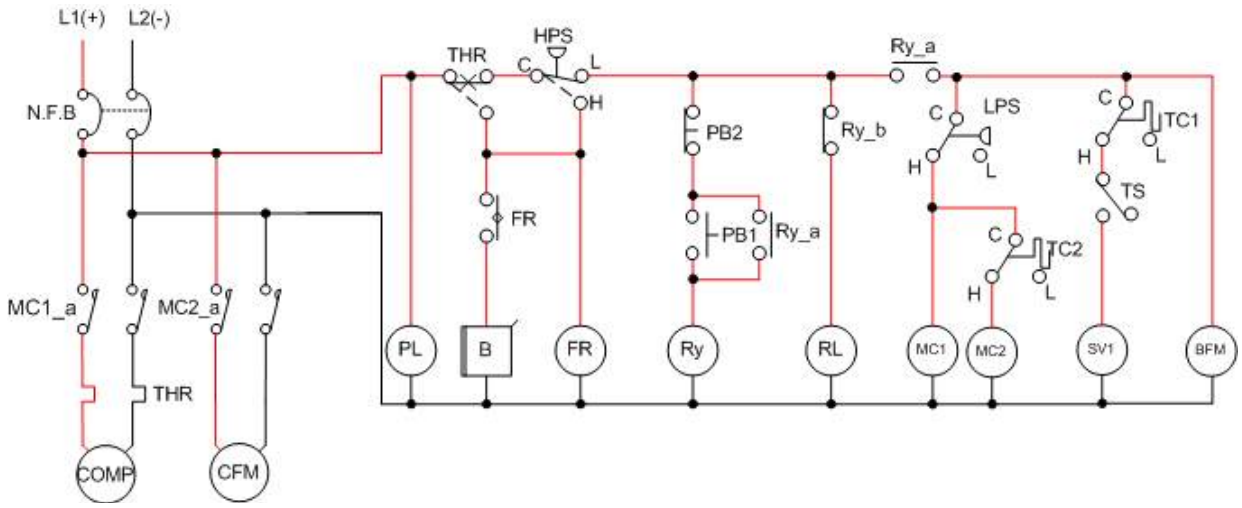
1. Check tools and materials.
2. Understand the function of operating circuit.
   ① Explain the progress when PB_1 is pushed.
   ② Explain the operation progress that temperature S/W is opened during the system running.(For control temperature at outlet of evaporator)
   ③ Explain the condition that pressure S/W can be opened during the system running.
   ④ Explain the progress that the system stops when pressure S/W is opened.
   ⑤ Explain the progress that refrigerator starts when PB_2 is pushed.
3. Explain the feature of brine and note the data about distribution and deviation of temperature.
4. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
5. Configurate circuit using real wires and operate using banana jacks with experiment equipments, tools and materials.

<table>
<tr><td rowspan="8">Relationship between technical description rating items and task</td><td colspan="2">Appraisal</td><td>Allot</td><td>Point</td><td colspan="5">Remark</td></tr>
<tr><td rowspan="4">Work (Point 70))</td><td>Circuit configuration using banana jack</td><td>20</td><td></td><td colspan="5" rowspan="6"></td></tr>
<tr><td>Circuit configuration using real wire</td><td>20</td><td></td></tr>
<tr><td>Configuration state</td><td>10</td><td></td></tr>
<tr><td>Understand and description for circuit</td><td>20</td><td></td></tr>
<tr><td rowspan="2">Task (Point 10)</td><td>Task attitude and safety</td><td>5</td><td></td></tr>
<tr><td>Application and standstill of tools</td><td>5</td><td></td></tr>
<tr><td>Time (Point 20)</td><td colspan="3">· Demerit mark Point ( )
in every ( ) minute after finish</td><td>Work</td><td>Task</td><td>Time</td><td>Total</td></tr>
<tr><td colspan="3"></td><td></td><td></td><td></td><td></td></tr>
</table>

Experiment name	9. Configuration compulsory pump down control circuit for "brine refrigeration system" and operation	Class time(hr)
		8
The object of experiment	① To configurate compulsory pump down control circuit for "brine refrigeration system". ② To make wiring compulsory pump down control circuit for "brine refrigeration system".	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· Brine refrigeration trainer(KTE-6000BR) · Refrigeration real wiring training kit (KTE-4000SQ)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit

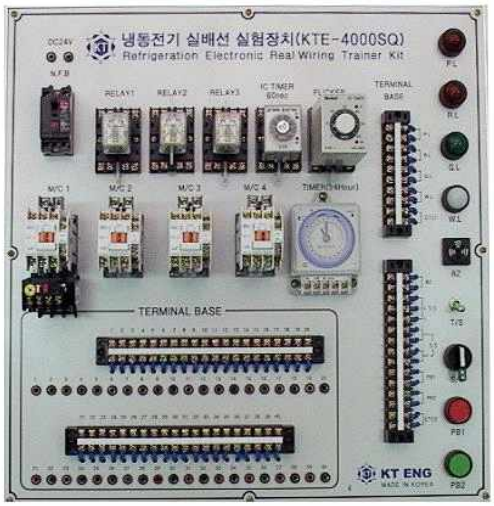


L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
MC-a : MC "a" contact
THR : Thermal Relay
COMP : Compressor Motor
LPS : Low Pressure S/W
HPS : High Pressure S/W

PB : Push Botton S/W
SV : Solenoid V/V
Ry-a : Relay"a"contact
Ry-b : Relay"b"contact
Ry : Relay Coil
MC : Magnetic Contactor Coil

B : Buzzer
FR : Flicker Relay
TC : Temperature control S/W
CFM : Condenser Fan Motor
RL : Red Lamp
PL : Power Lamp

Brine refrigeration trainer
(KTE-6000BR)



Refrigeration real wiring training kit
(KTE-4000SQ)

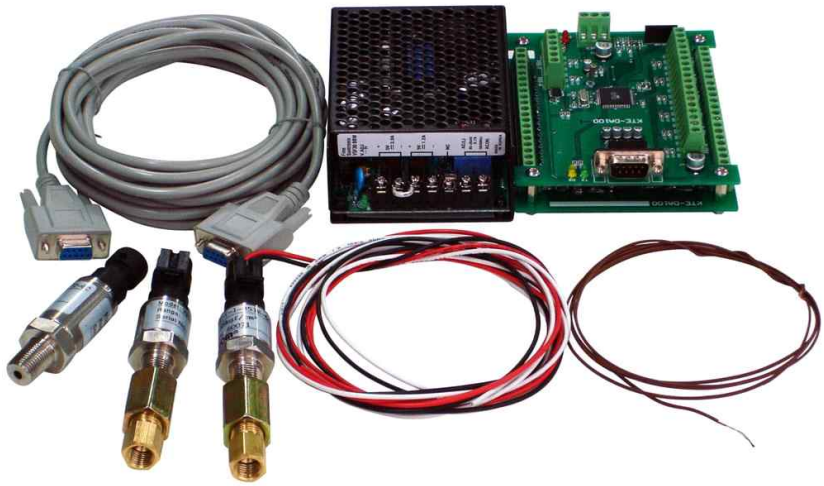
· Check Point

1. Check tools and materials.
2. Understand the function of operating circuit.
   ① Explain the progress when PB_1 is pushed.
   ② Explain the progress that the system operates during compulsory pump down.
   ③ Adjust pressre,temperature S/W during compul내교 pump down operation.
   ④ Explain the progress that refrigerator starts when PB_2 is pushed.
3. Explain "a" and "b" contact.
4. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
5. Configurate circuit using real wires and operate using banana jacks with experiment equipments, tools and materials.

Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 10)	Task attitude and safety	5					
		Application and standstill of tools	5					
	Time (Point 20)	· Demerit mark Point ( ) in every ( ) minute after finish			Work	Task	Time	Total

Chapter 4. Data Acquisition device between PC and machine

1. Component and Feature of Refrigerator Performance Automatic Measuring Equipment



1-1. Mother board and CPU

(1) Size: L130 mm×W100mm
(2) ATMEGA128, TQFP Type, 1EA
(3) 30p, 2012 chip capacitor Type, 2EA
(4) 103, 2012 chip capacitor Type, 1EA
(5) 10uF, SMD Type, 1EA
(6) 104, 2012 chip capacitor Type, 15EA
(7) 100uF, SMD Type, 2EA
(8) 10/16V, SMD Type, 4EA
(9) 3AG3HD00, Green LED 3Φ Type, 1EA
(10) 3AR4PD00, Led LED 3Φ Type, 1EA
(11) 1N4148, SMD Type, 1EA
(12) 3AR4PD00, Led LED 3Φ Type, 2EA
(13) Box Header 10pin, 1EA
(14) BR-500C (3pin), 8EA
(15) HB-1S3216-100, Chip bid Type, 1EA
(16) DS1037-09M (Nut angle), 1EA
(17) 10k, 2012 Chip resistance Type, 3EA
(18) 560, 2012 Chip resistance Type, 3EA
(19) 1k, 2012 Chip resistance Type, 8EA
(20) TCN75, SMD Type, 1EA
(21) MAX232, SMD Type, 1EA
(22) 32.768KHz, (TH) Type, 1EA
(23) 7.3728MHz ATS Type, 1EA

1-2. Sensor Board

(1) Size: L130 mm×W100mm
(2) 103, 2012 chip capacitor Type, 20EA
(3) 10uF, SMD Type, 20EA
(4) 104, 2012 chip capacitor Type, 45EA
(5) 100uF, SMD Type, 2EA
(6) BR-500C (2pin), 20EA
(7) Box Header 10pin, 1EA
(8) 10k, 2012 Chip resistance Type, 60EA
(9) 10k, 1/8W 1% 2012 Chip resistance Type, 10EA
(10) 240, 1/8W 1% 2012 Chip resistance Type, 20EA
(11) 3.3k, 1/8W 1% 2012 Chip resistance Type, 10EA
(12) 4.7k, 2012 Chip resistance Type, 2EA
(13) INA128U, SMD Type, 20EA
(14) NE5532, SMD Type, 10EA
(15) ADS7828E, 3EA

1-3. Others

(1) 5V/1A 2channel S.M.P.S, 1EA
(2) Seriel FX Cable 5M, 1EA

1-4. Whole size

(1) L130mm × W100mm × H48mm

1-5. Being registered with patent in Korea.

2. Data Acquisition and System Monitoring Program

2-1. Function

(1) Monitoring the measured data of temperature and pressure in real time.
(2) Monitoring the measured data of enthalpy on a diagram of Standard refrigeration system in real time.
(3) Monitoring factors like as refrigeration effect, compressor work, condensing heat in condenser, evaporating latent heat, amount of flash gas at expansion V/V outlet, dry ratio at expansion V/V outlet, humidity at expansion V/V outlet, coefficient of performance in the abstract with temperature and pressure data which are measure in real time
(4) Being saved Being saved data all of temperature, pressure and enthalpy on every minute as excel
(5) Evaporation experiment: Various evaporation load, various evaporation pressure, various evaporation temperature and super heating.
(6) Condensation experiment: Over condensing operation and over condensing load operation.
(7) Compressing experiment: wet compressing operation, super heat compressing operation and dry saturation compressing operation.

2-2. Composition

(1) Main Page
(2) Sector for display of temperature data
(3) Sector for graph chart of temperature
(4) Sector for display of pressure data
(5) Sector for graph chart of pressure
(6) Sector for flow diagram of Standard refrigeration system
(7) Sector for display the P-H chart of Standard refrigeration system on real time.
(8) Sector of setting interval for saving data.
(9) Sector of starting operation

2-3. Being registered with KoreaSoftwareCopyrightCommittee.

3. INSTALL SOFTWARE for KTE-DA100

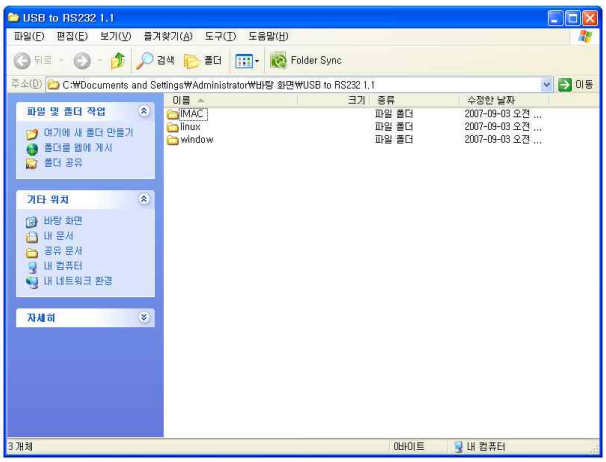
3-1. INSTALL USB TO SERIAL

- Communication is connected by RS232 protocol.
- When serial port is used in PC computer, USB To Serial is not needed.
- If your computer has no serial port, please install as following steps.

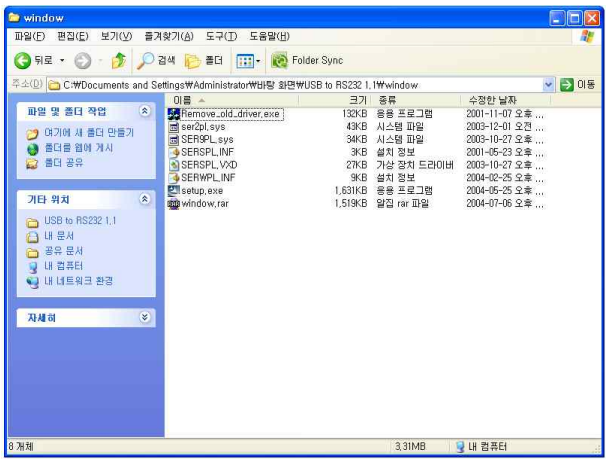
(1) Insert CD install driver into CD-ROM.

(2) After reading CD-ROM DIRECTORY, you can see follow screen.

(3) Double clik folder 'window' as like follow screen.



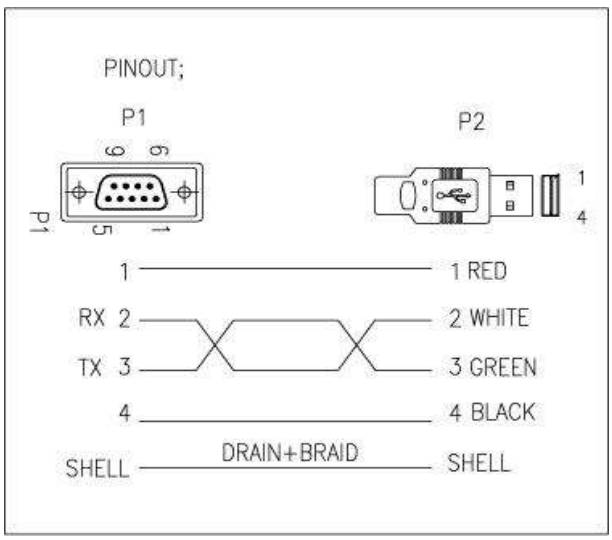
(4) Check follow file in folder 'Window' , and then make setup.exe.



(5) Click 'Next', install the program.

(6) After complete install, follow screen shown.

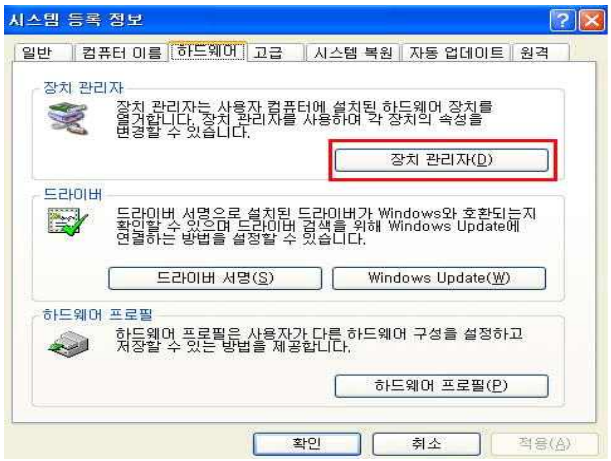
(7) USB TO SERIAL PORT wire diagram



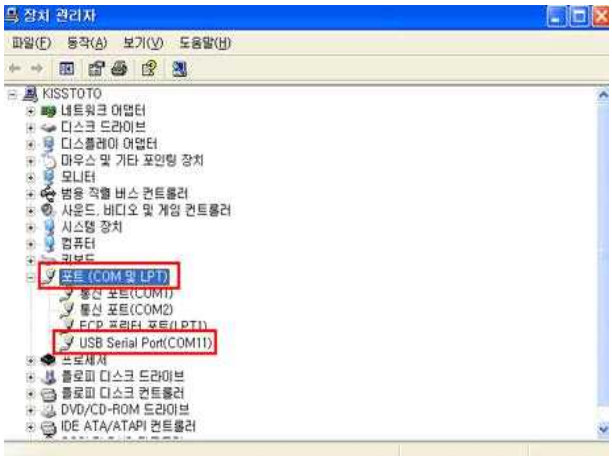
(8) Set communication port

Start // Setting // Control panel, and then double click 'control panel'.

(9) Click 'Hardware'.

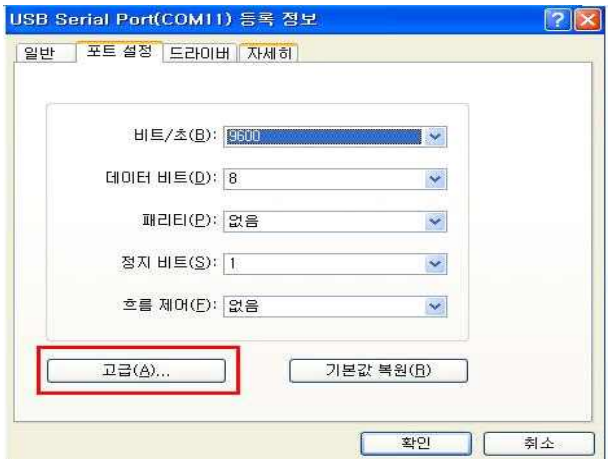


(10) Click 'Device Manager'.



(11) Double click 'Set Port', and you can see USB SERIAL PORT . Click right USBSERIALPORT,andcheckproperty.

(12) Click 'Set port'.

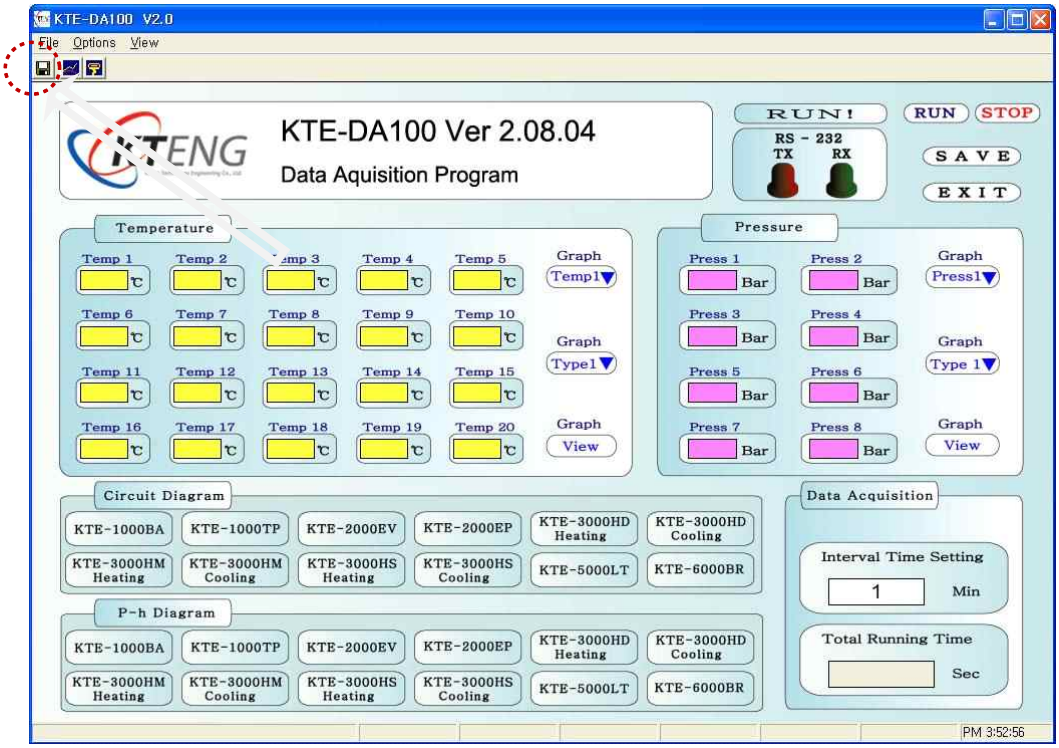


(13) Click 'Advanced'

(14) Select suitable Port as user`s computer, and complete setting.

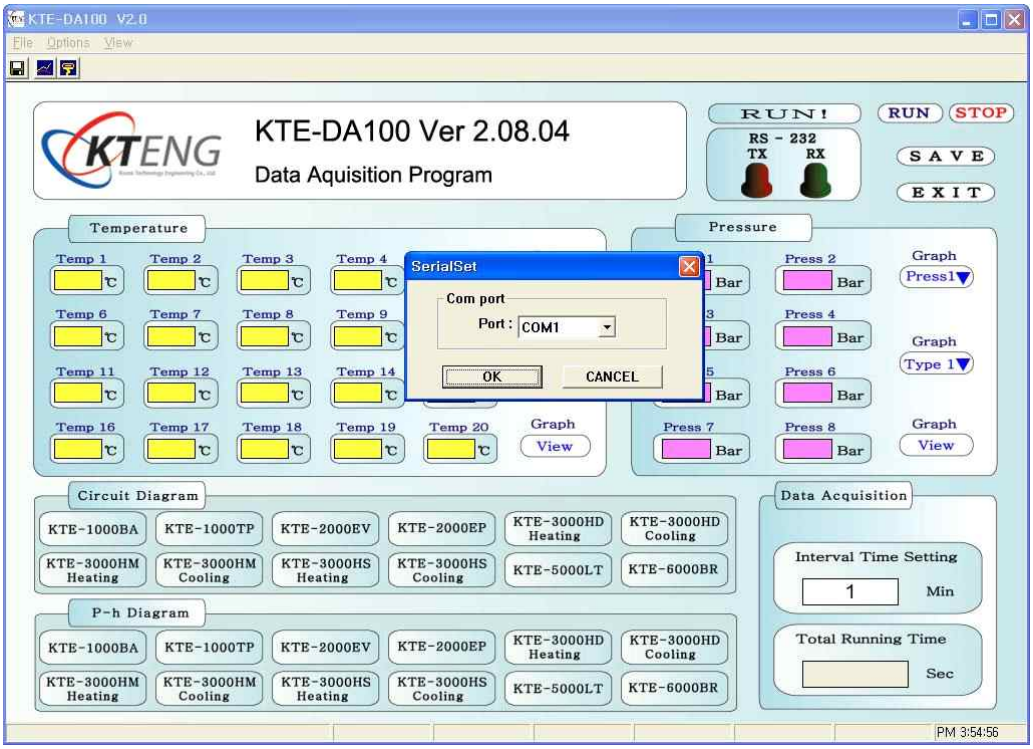
3-2. Set communication portofDA100

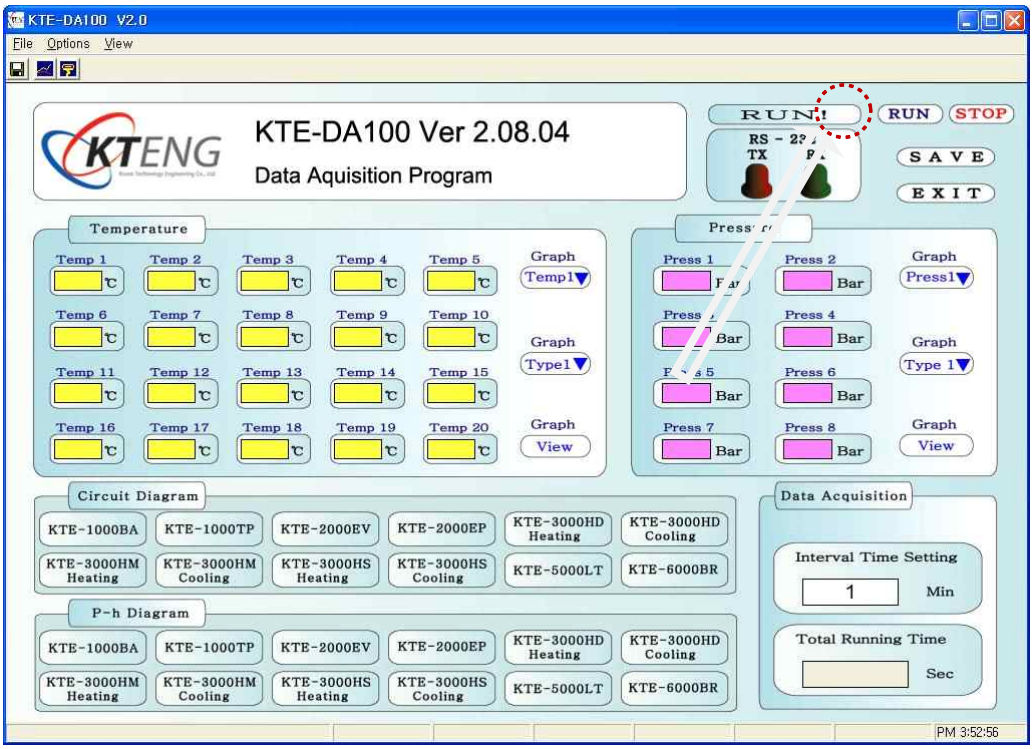
(1) Connection USB TO SERIAL cable and COM1



 click

(2) Select COM1 in follow Serial Set.(Notice: As each computer system, COM# is different. So you have to make same COM#)





RUN Click and run the program.

(3) If data communication is normal, 'TX' and 'RX' signals shown like follow.

After data communication, choose and click the suitable 'circuit diagram' or 'P-h diagram' as refrigeration system equipment. And then observe and save the data.

3-3. Attentions for use USB TO SERIAL PORT.

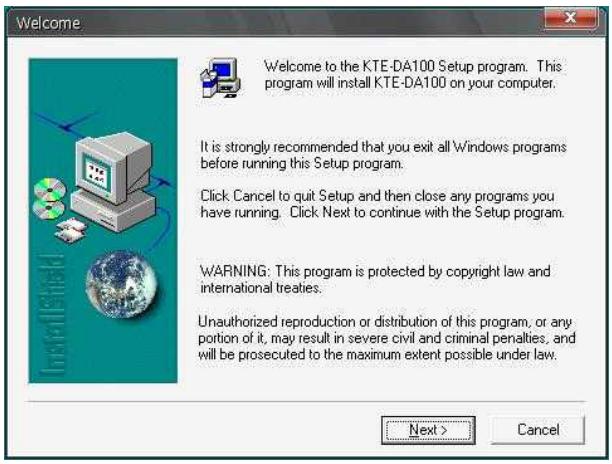
(1) This cable port is interface for adaptable cable.(Need install driver)
(2) Using computer has to interface KW-825 USB port.
(3) Using computer has to have COM serial port.
(4) No using print port by LPT port.

4. Install and how to use KTE-DA100

4-1. Installation KTE-DA100

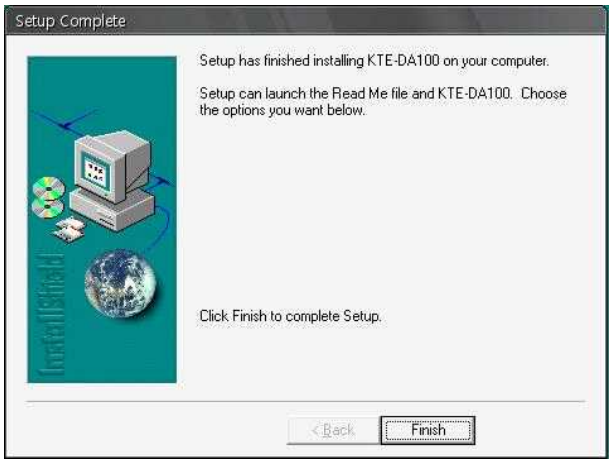
(1) Insert install CD in CD-ROM, and open it, shown like follow picture. Run SETUP.EXE.

(2) When shown like as follow, click 'Next'.

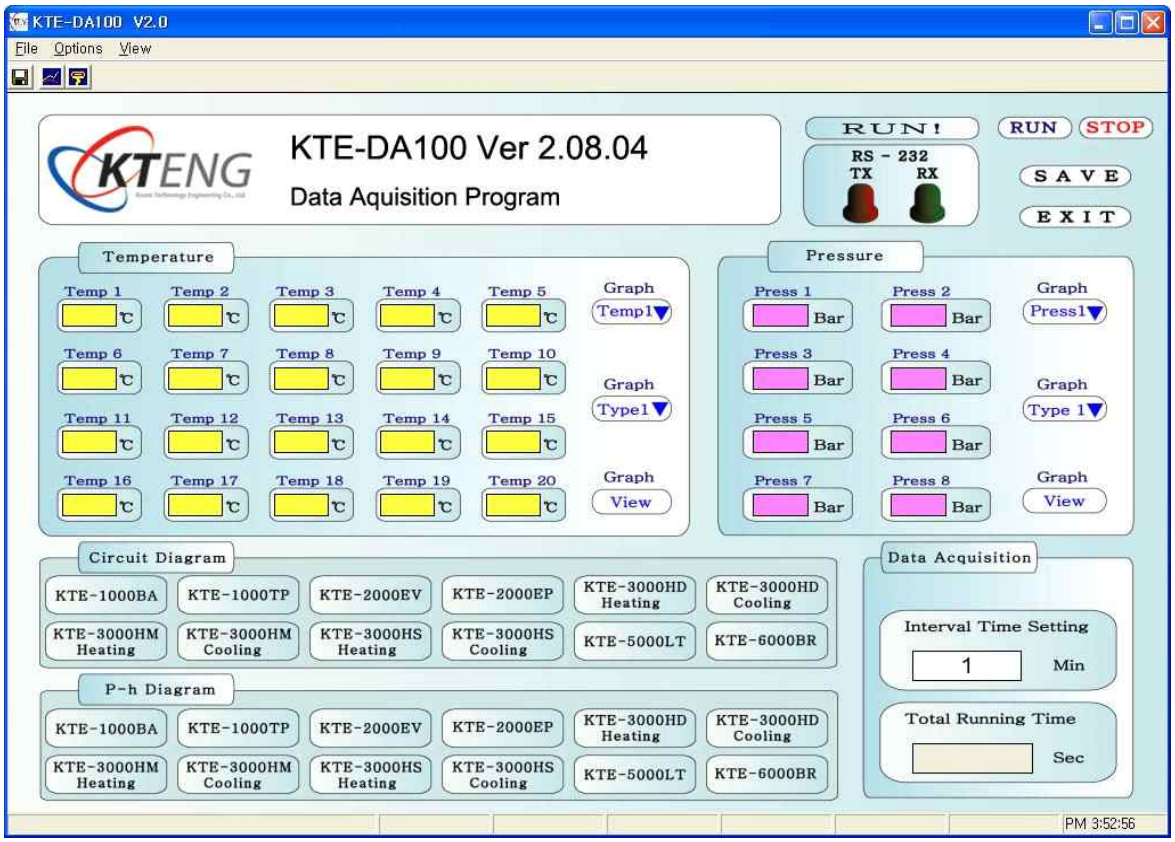


(3) After decision save directory, click 'Next'.

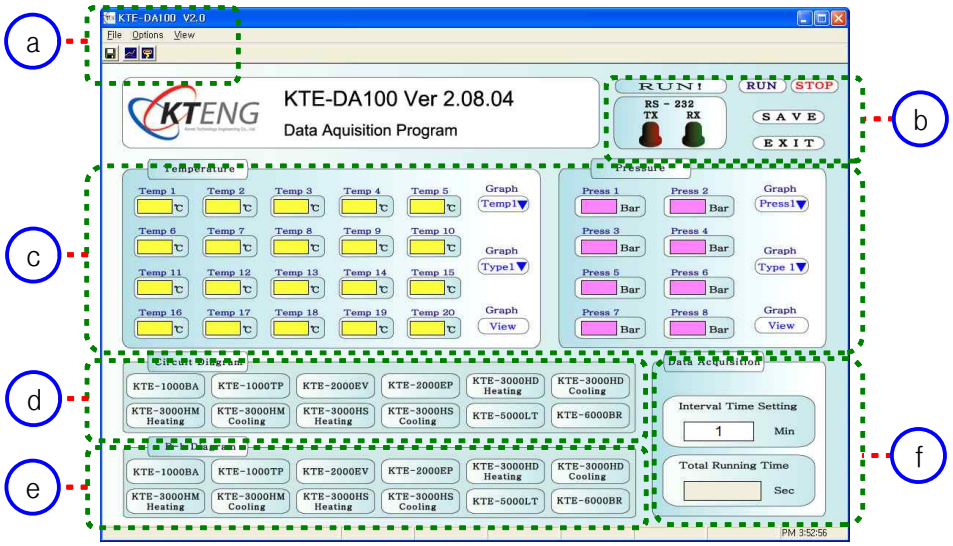
(4) For complete, click 'Finish'.



(5) Run KTE-100 , follow page will be shown.



4-2. Description of main view



ⓐ Main Menu, it is for setting of software or hardware, and initialization of resister information.

ⓑ It is for start, stop, save data and finish of program, and observe running statues.

ⓒ The temperature and pressure data are shown, and also drawing graph of the data.

ⓓ It is for select flow chart of each refrigeration system.

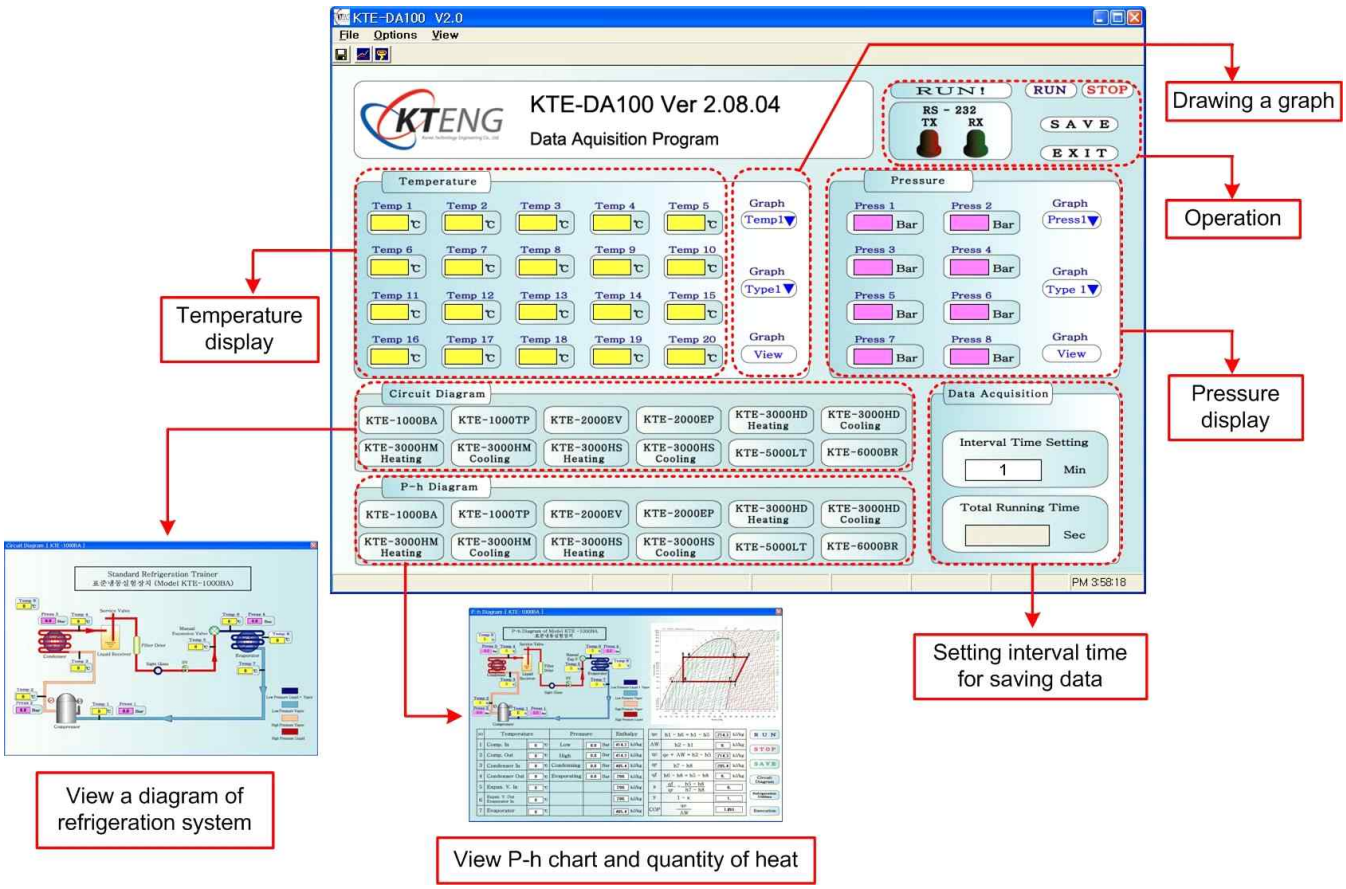
ⓔ It is for select flow chart, every parameters of each refrigeration system.

ⓕ It is for setting saving interval, and showing whole running time.

5. Software program

5-1. Detail description of KTE-DA100 Software

(1) Main view



(2) Main Control

	File Save Exit	Options Serial Temp Offset Delete registry	View SaveBuffer

- Save : Save as Excel microsoft
- Exit : Finish

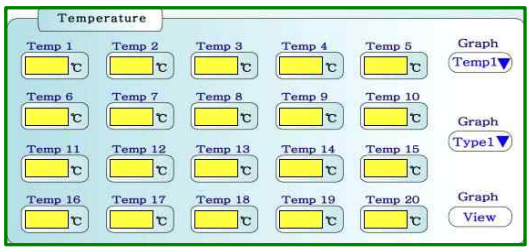
- Serial : Set port for connection between PC and DAQ
- Temp Offset : For temperature revision of DAQ equipment
  (Notice, when shipping goods, it had already revised temperature therefore no need more revision later.)
- Delete registry : Function to delete data automatically that is saved at registry memory. Use under restart new experiment.

- SaveBuffer : Command to show data of temp. pressure in real time that is saved at buffer memory.

(3) Control section

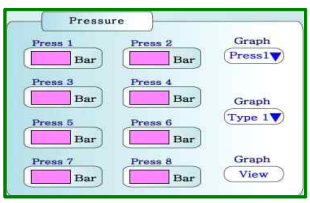
- Save : Save data
- Exit : Finish program
- RUN : Start to get acquisition data
- STOP : Stop acquisition data

(4) Temp. display section



- Display at each position
- Graph Temp1... : To select color of each temp. line on graph
- Graph Type1 : To select graph style
- Graph View : To be shown graph

(5) Display pressure section



- Display at each position
- Graph Press1... : To select color of each pressure line on graph
- Graph Type1 : To select graph style
- Graph View : To be shown graph

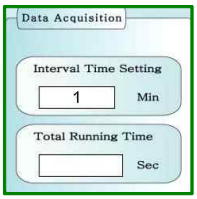
(6) View data through Diagram

- KTE-1000BA : Standard (Basic) Refrigeration system
- KTE-1000TP : Temp. Pressure, & Defrost Refrigeration system
- KTE-2000EV : Refrigerant Parallel Expansion Refrigeration system
- KTE-2000EP : Evaporation Pressure Parallel Control (EPR) Refrigeration system
- KTE-3000HD Heating : 4way reversing v/v control Heat Pump Heating system
- KTE-3000HD Cooling : 4way reversing v/v control Heat Pump Cooling system
- KTE-3000HM Heating : Stop v/v control Heat Pump Heating system
- KTE-3000HM Cooling : Stop v/v control Heat Pump Cooling system
- KTE-3000HS Heating : Solenoid v/v control Heat Pump Heating system
- KTE-3000HS Cooling : Solenoid v/v control Heat Pump Cooling system
- KTE-5000LT : Binary (Extreme low temperature) Refrigeration system
- KTE-6000BR : Brine (Ice Maker) Refrigeration system

(7) View PH diagram and variable enthalpy value as data in real time at each position

- KTE-1000BA : Standard (Basic) Refrigeration system
- KTE-1000TP : Temp. Pressure, & Defrost Refrigeration system
- KTE-2000EV : Refrigerant Parallel Expansion Refrigeration system
- KTE-2000EP : Evaporation Pressure Parallel Control (EPR) Refrigeration system
- KTE-3000HD Heating : 4way reversing v/v control Heat Pump Heating system
- KTE-3000HD Cooling : 4way reversing v/v control Heat Pump Cooling system
- KTE-3000HM Heating : Stop v/v control Heat Pump Heating system
- KTE-3000HM Cooling : Stop v/v control Heat Pump Cooling system
- KTE-3000HS Heating : Solenoid v/v control Heat Pump Heating system
- KTE-3000HS Cooling : Solenoid v/v control Heat Pump Cooling system
- KTE-5000LT : Binary (Extreme low temperature) Refrigeration system
- KTE-6000BR : Brine (Ice Maker) Refrigeration system

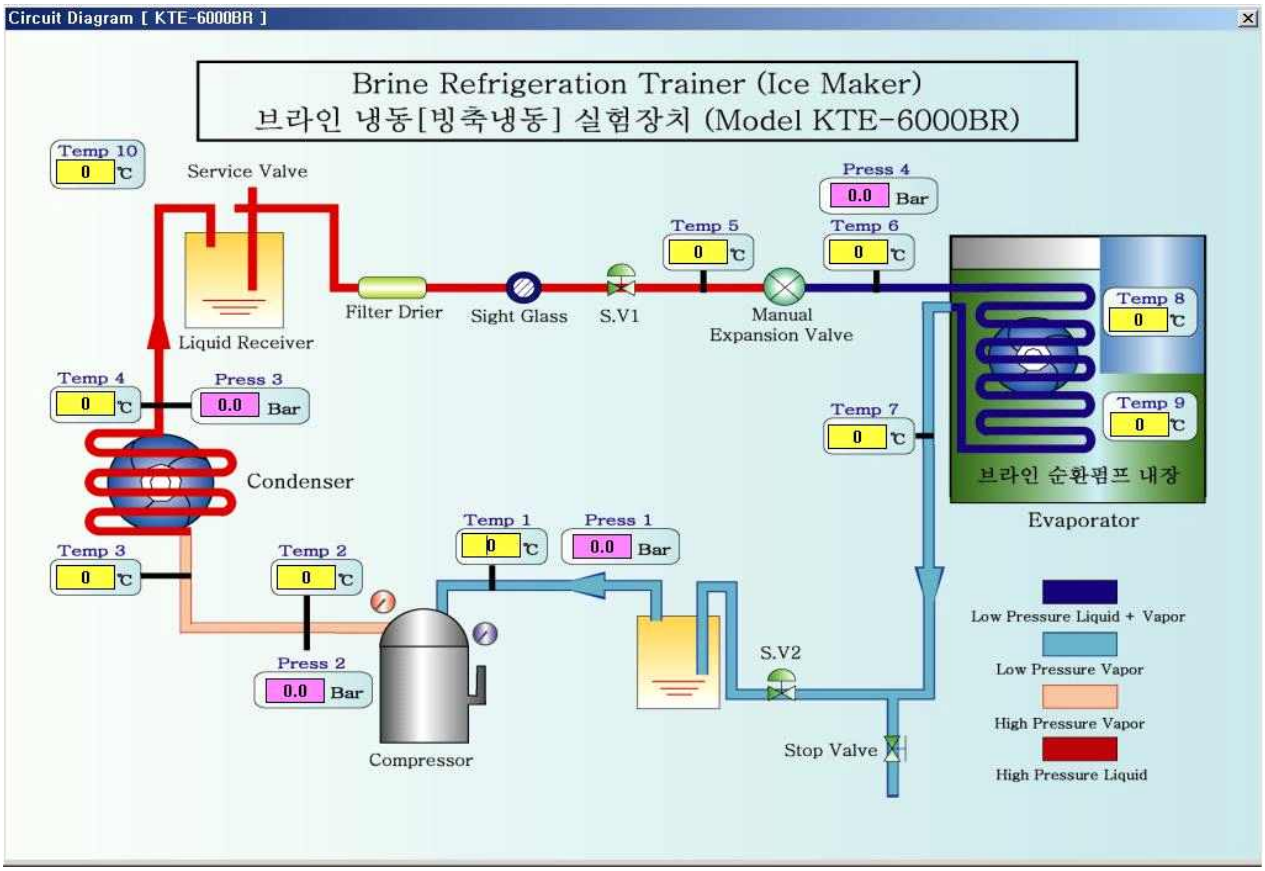
(8) Set up saving interval time and display running time

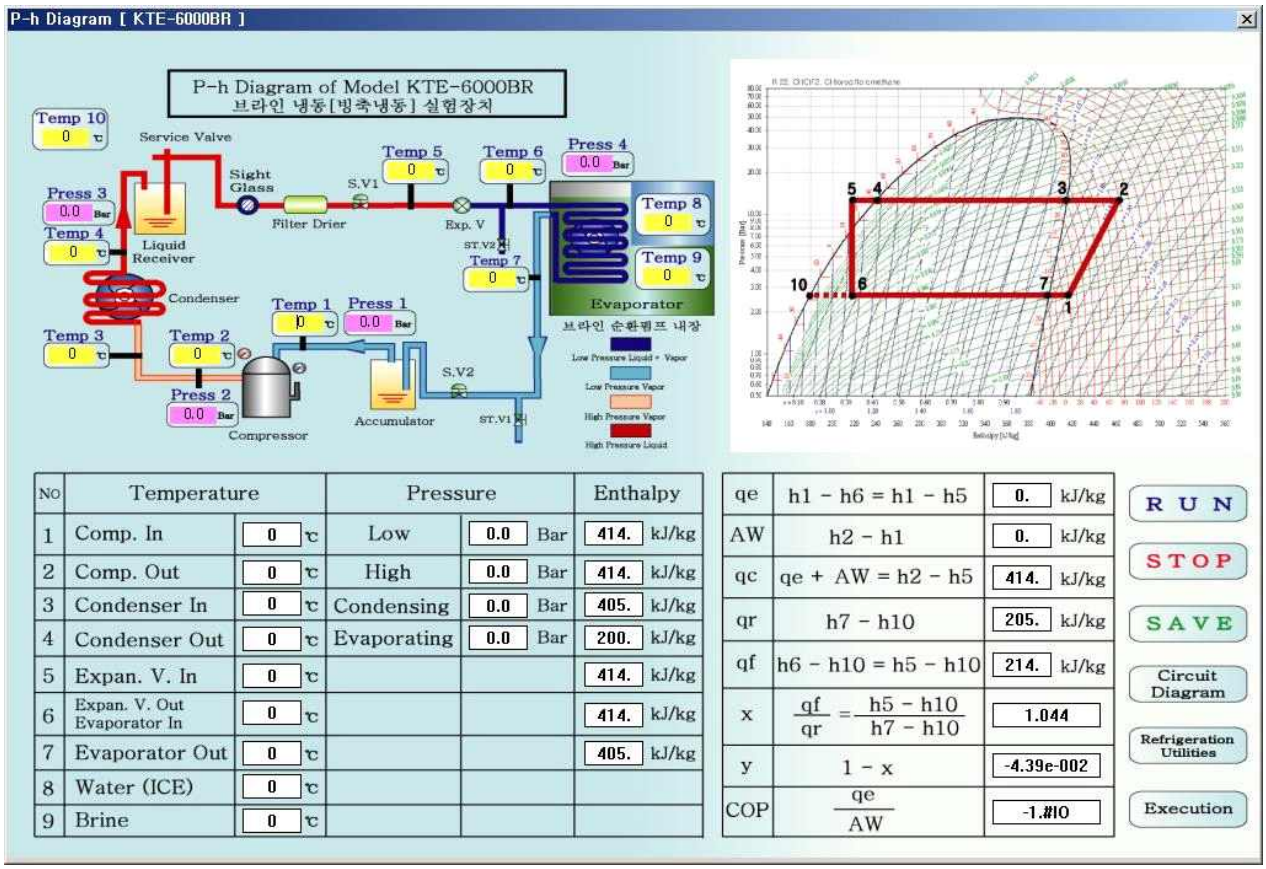


- Interval Time Setting : Set in every second basically

- Total Running Time : Running time of the system

(9) View total status of each system





No	Temperature		Pressure		Enthalpy
1	Comp. In	0 ℃	Low	0.0 Bar	414. kJ/kg
2	Comp. Out	0 ℃	High	0.0 Bar	414. kJ/kg
3	Condenser In	0 ℃	Condensing	0.0 Bar	405. kJ/kg
4	Condenser Out	0 ℃	Evaporating	0.0 Bar	200. kJ/kg
5	Expan. V. In	0 ℃			414. kJ/kg
6	Expan. V. Out Evaporator In	0 ℃			414. kJ/kg
7	Evaporator Out	0 ℃			405. kJ/kg
8	Water (ICE)	0 ℃			
9	Brine	0 ℃			

qe	h1 - h6 = h1 - h5	0. kJ/kg
AW	h2 - h1	0. kJ/kg
qc	qe + AW = h2 - h5	414. kJ/kg
qr	h7 - h10	205. kJ/kg
qf	h6 - h10 = h5 - h10	214. kJ/kg
x	$\frac{qf}{qr} = \frac{h5 - h10}{h7 - h10}$	1.044
y	1 - x	-4.39e-002
COP	$\frac{qe}{AW}$	-1.#IO

RUN
STOP
SAVE
Circuit Diagram
Refrigeration Utilities
Execution

6. Application Refrigeration Utility Program

6-1. How to applicate the program

(1) Choose your respecting refrigeration system cycle on 'Select cycle type'

① One stage cycle

② Two stage cycle

(2) Evaporating Temperature (℃) or evaporating pressure (bar) on running.

(3) Condensing Temperature (℃) or condensing pressure (bar) on running.

(4) Superheat : Superheating temperature (˚K) from outlet of evaporator to inlet of compressor.

(5) Sub Cooling : Sub cooling temperature (˚K) from outlet of condenser (or saturating line on p-h chart) to in front of expansion valve.

(6) DP Evaporator : Temperature (or pressure) Difference between outlet of expansion valve and outlet of evaporator.

(7) DP Condenser : Temperature (or pressure) Difference between inlet of condenser and inlet of expansion valve.

(8) DP Suction line : Temperature (or pressure) Difference between outlet of evaporator and inlet of compressor.

(9) DP Liquid line : Temperature (or pressure) Difference at inlet of expansion valve after isolation expansion process.

(10) DP Discharge line : Temperature (or pressure) Difference between outlet of compressor and inlet of condenser.

6-2. Refrigeration cycle and P-h diagram

(1) Refrigeration cycle

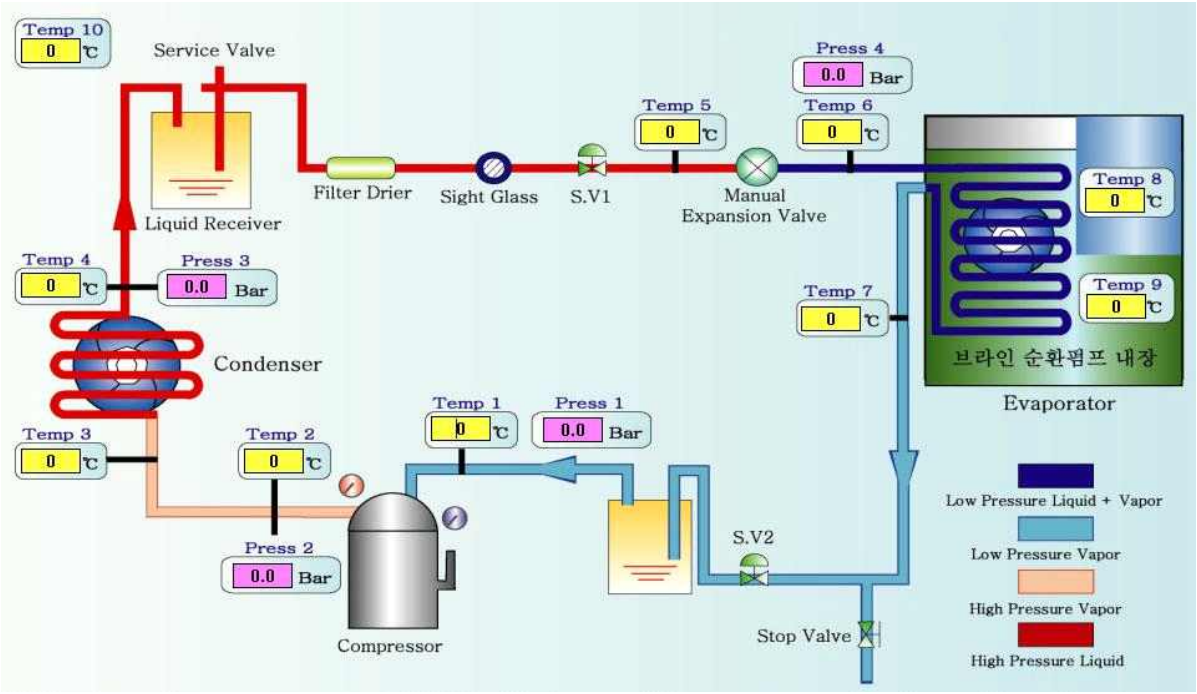


Fig. 4-1. Refrigeration cycle

(2) P-h diagram

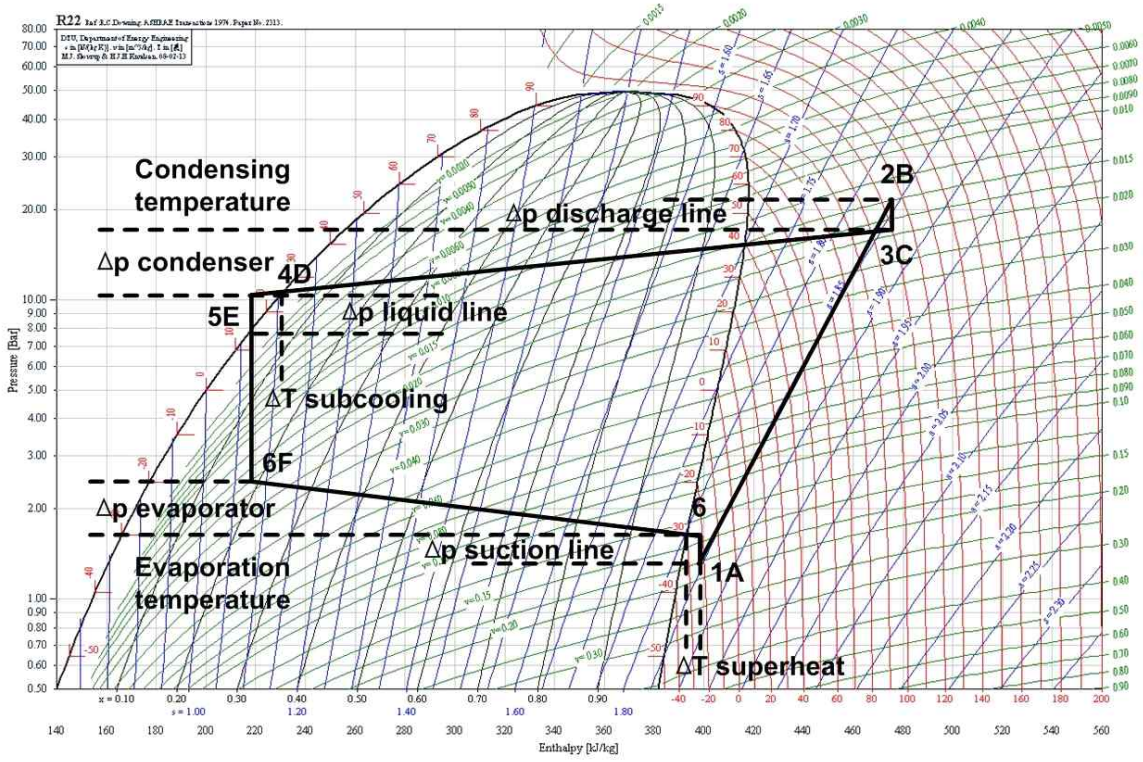


Fig. 4-2. P-h 선도표

(3) Drawing P-h diagram

1) Data Table

Table 4-1. Data Table

Data point	Table1	Table2	Table3	Table4	Table5	Remark
Evaporation Temperature						
Superheat						
DP Evaporator						
DP Suction line						
DP Discharge						
Condensing Temperature						
Sub Cooling						
DP Condenser						
DP Liquid Line						

2) Calculate heat amount and performance note Table

Table 4-2. Calculating of heat amount and Note Table of performance

Oper Station	Compression Ratio	Refrigerating Effect		condensation Capacity		COP	Work by Compressor
		KJ/kg	Kcal/kg	KJ/kg	Kcal/kg		Kcal/kg
Table1							
Table2							
Table3							
Table4							
Table5							

6-3. Example drawing a P-h diagram

(1) Data measuring

Table 4-3. Data measurement

Data point	Table1	Table2	Table3	Table4	Remark
Evaporation Temp	-15℃	-20℃	-21℃	-28.4℃	
Superheat	2 ° K	1 ° K	1 ° K	8.2 ° K	
Dp Evaporator	2 ° K	3 ° K	4.2 ° K	11.9 ° K	
Dp Suction line	0.2Bar	0.2Bar	0.2Bar	0.2Bar	
Dp Discharge line	2 ° K	2 ° K	1.3 ° K	1.9 ° K	
Condensing Temp	45℃	44℃	45℃	45℃	
Sub Cooling	22 ° K	20 ° K	21.5 ° K	21.3 ° K	
Dp Condenser	10 ° K	10 ° K	10 ° K	10 ° K	
Dp Liquid line	26 ° K	29 ° K	30 ° K	28.7 ° K	

(2) Drawing solution P-h diagram

1) Drawing solution about No.1 on Table 4-3.

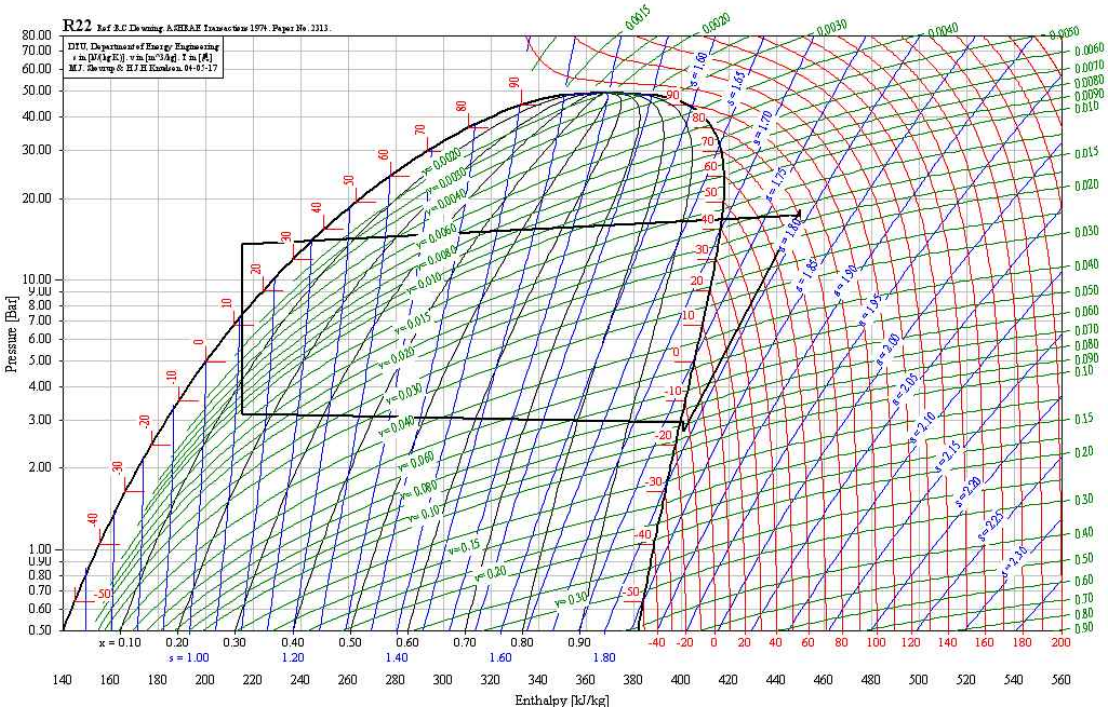


Fig. 4-3. Solution about No.1 on Table 4-3

2) Drawing solution about No.2 on Table 4-3.

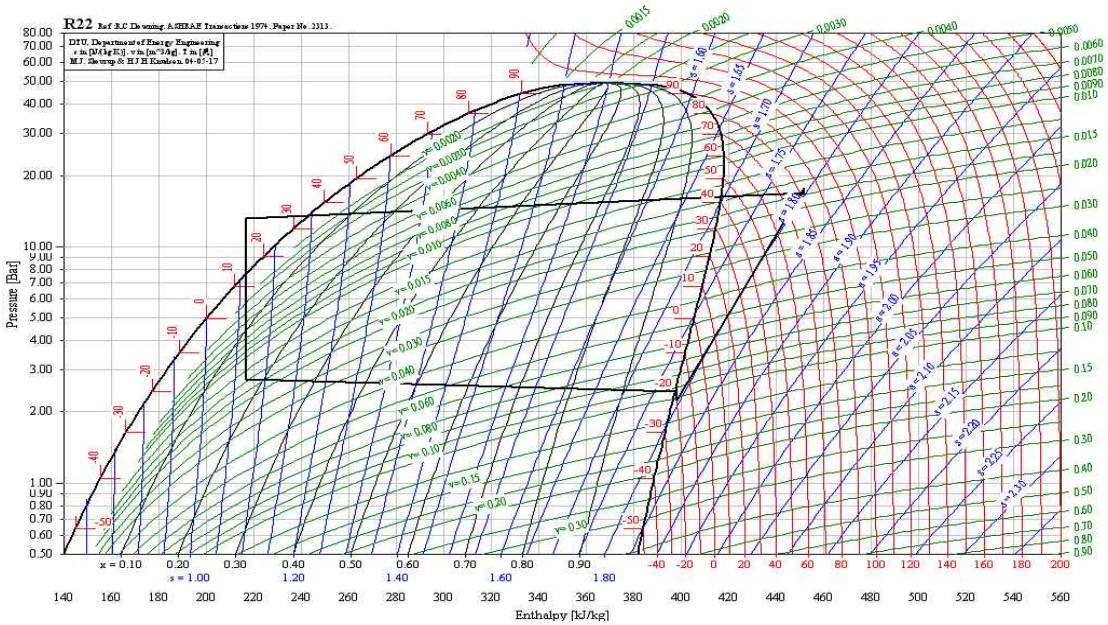


Fig. 4-4. Solution about No.2 on Table 4-3

3) Drawing solution about No.3 on Table 4-3.

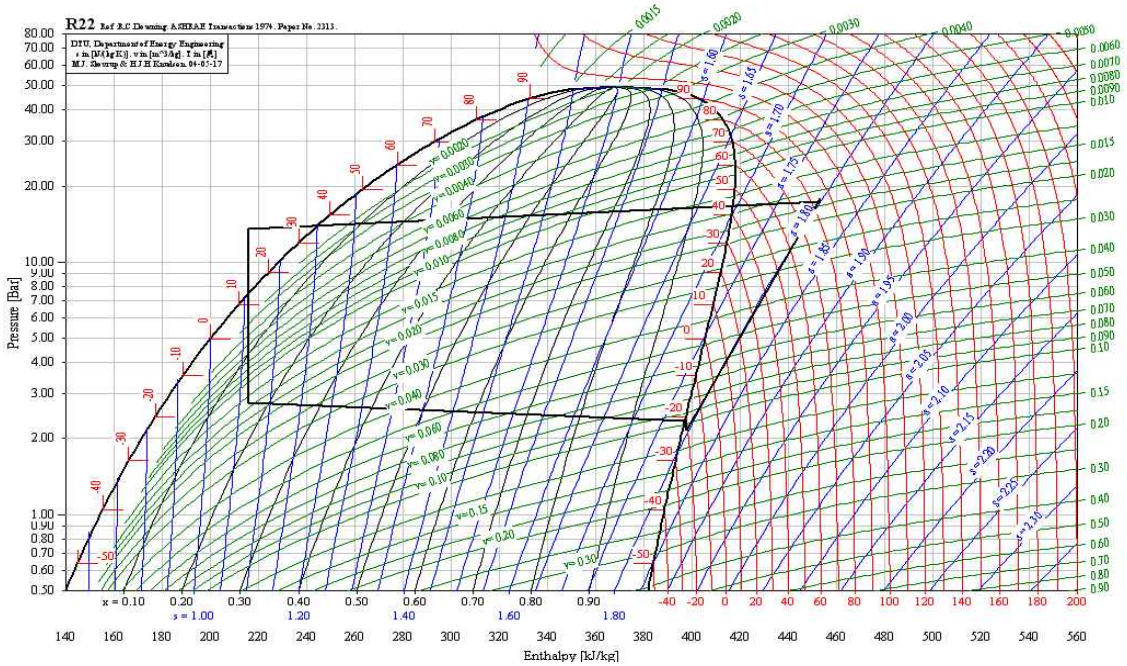


Fig. 4-5. Solution about No.3 on Table 4-3

4) Drawing solution about No.4 on Table 4-3.

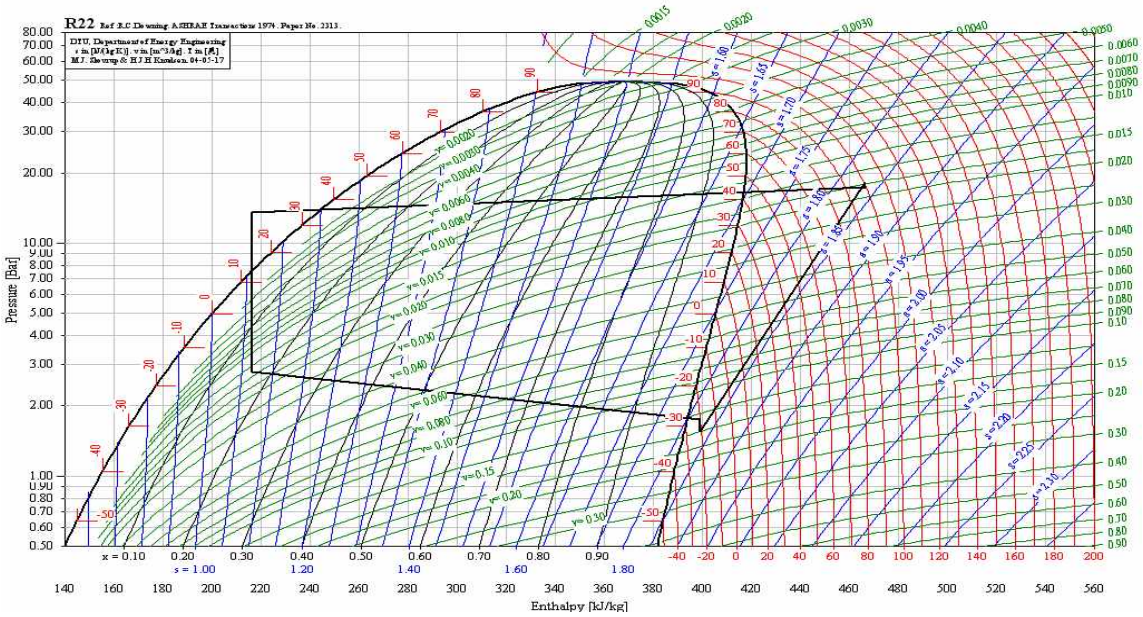


Fig. 4-6. Solution about No.4 on Table 4-3

(3) Duplication drawing P-h diagram

1) Duplication drawing P-h diagram

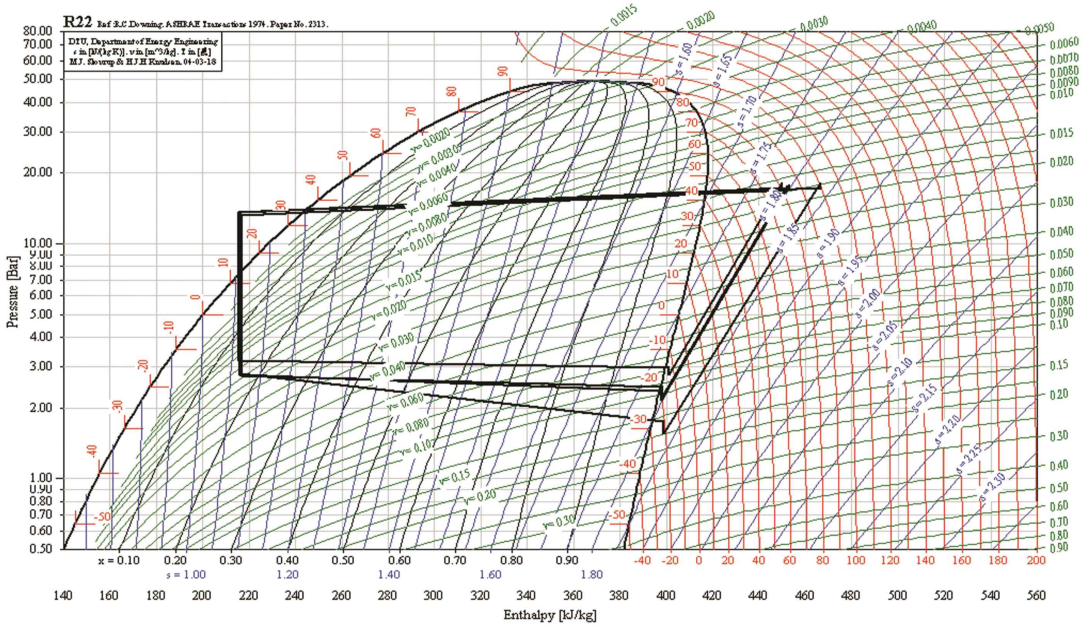


Fig. 4-7. Duplication drawing solution about No.1,2,3,and 4 on Table 4-3

2) Note a performance test result

Table 4-4. Note a performance test result

Oper Station	Compression Ratio	Refrigerating Effect		condensation Capacity		COP	Work by Compressor
		KJ/kg	Kcal/kg	KJ/kg	Kcal/kg		Kcal/kg
Table1							
Table2							
Table3							
Table4							
Table5							

6-4. Drawing each P-h diagram as each refrigerant

(1) Condition

1) Evaporating temperature : -15℃

2) Condensing temperature : 30℃

3) Temperature at inlet of compressor: -15℃(Dry gas)

4) Temperature at inlet of expansion valve: -25℃(sub-cooling temp. 5℃)

(2) Formula

1) Refrigeration ability (Qe) = h_a — h_e

2) Compressor work (W) = h_b — h_a

3) Condensing load (Qc) = h_b — h_e = Qe + W

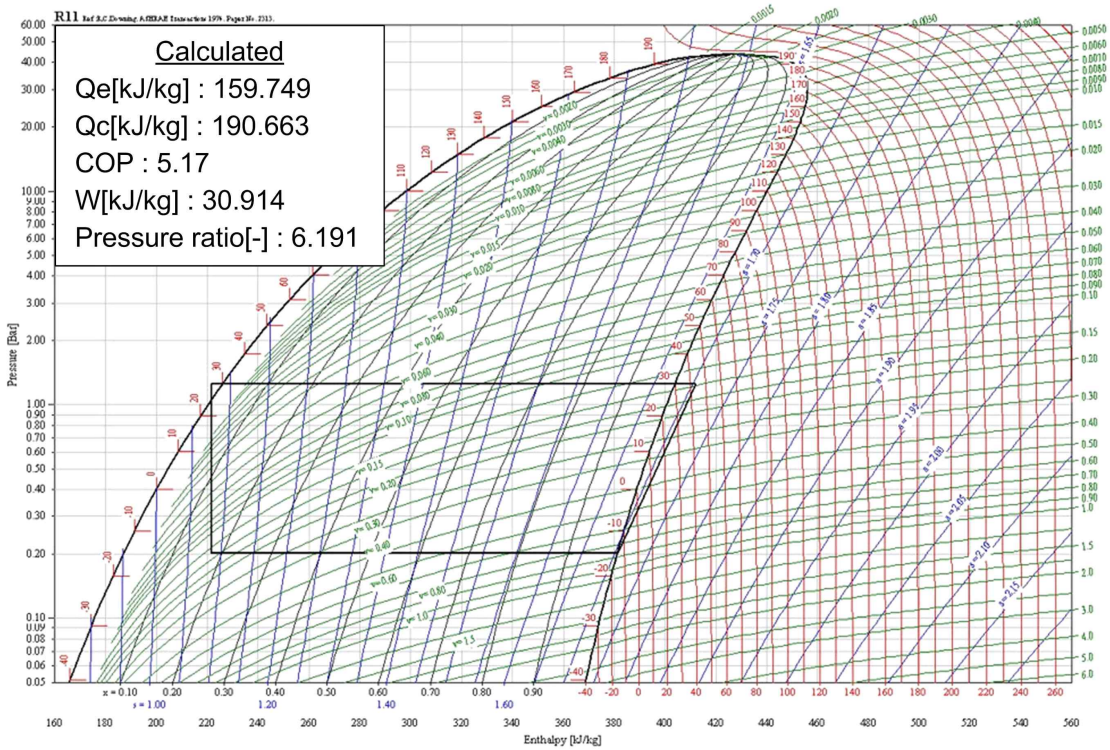
4) Coefficient of performance (COP) = Qe/W

5) Compression Ratio (Pr) = P_2/P_1

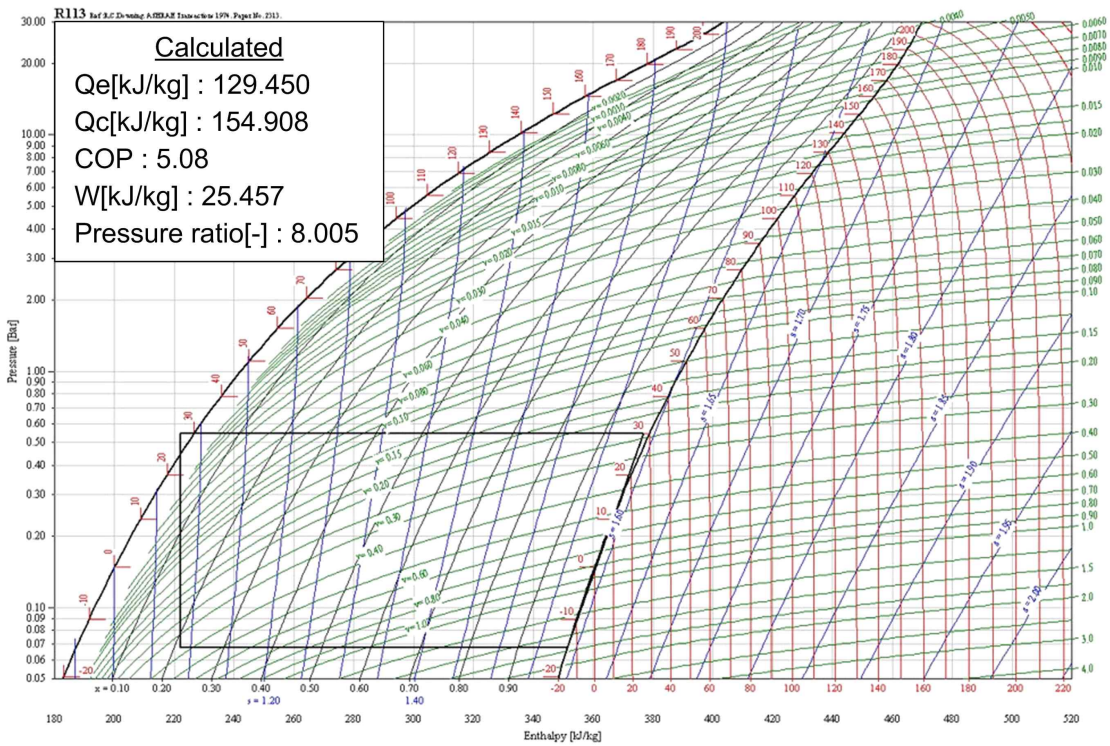
(3) Comparing each Coefficient of performance as each refrigerant

Table 4-5. Comparing each Coefficient of performance as each refrigerant

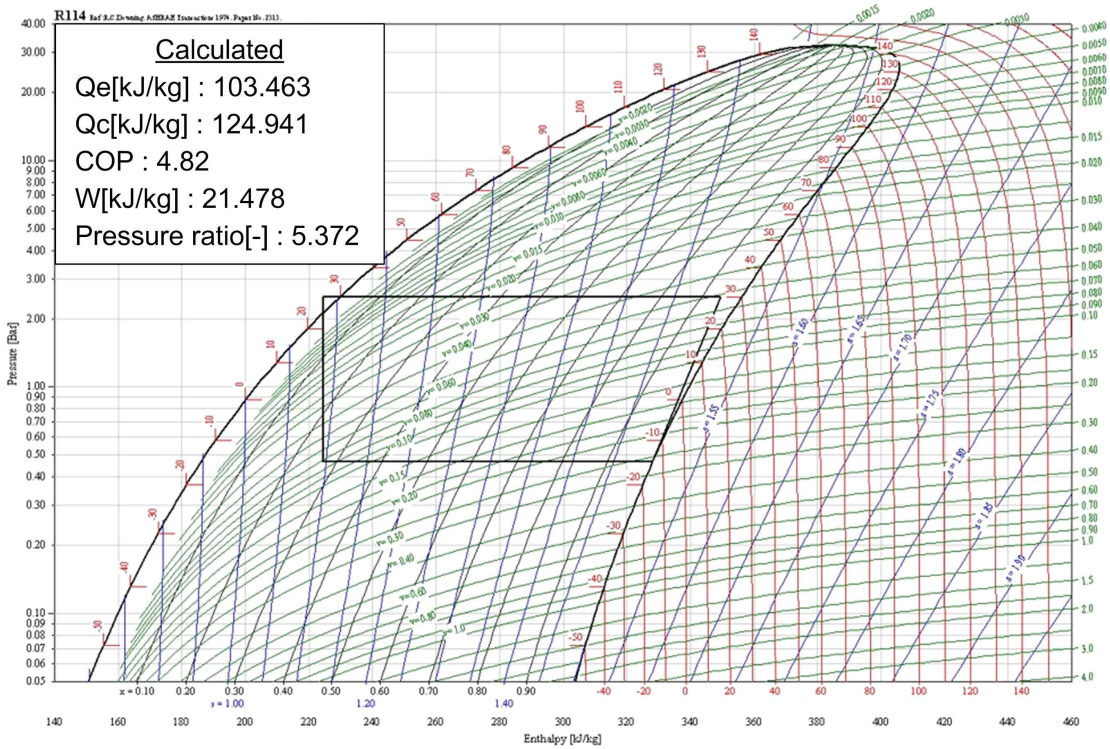
Refrigerant	Qe	Qc	COP	W	Pr
R-11 (CCI3F, Trichlorofluoromethane)	159.749	190.663	5.17	30.914	6.191
R-113 (CCI2FCCIF2, Trichlorotrifluoroethane)	129.450	154.908	5.08	25.457	8.005
R-114 (CCIF2CCIF2, Dichlorotetrafluoroethane)	103.463	124.941	4.82	21.478	5.372
R-12 (CCI2F2, Dichlorodifluoromethane)	121.284	146.024	4.90	24.740	4.079
R-123 (CHCI2CF3, Dichlorotrifluoroethane)	147.310	176.082	5.12	28.772	6.885
R-1270 (CH3CH=CH2, Propene (propylene))	300.752	363.752	4.77	63.001	3.588
R-134a (CH2FCF3,1,1,1,2-tetrafluoroethane)	154.023	185.913	4.83	31.889	4.692
R-152a (CH3CHF2,1,1-difluoroethane)	254.328	304.795	5.04	50.467	4.530
R-170 (CH3CH3, Ethane)	198.987	258.244	3.36	59.257	2.883
R-21 (CHCI2F, Dichlorofluoromethane)	198.987	258.244	3.36	59.257	2.883
R-22 (CHCIF2, Chlorodifluoromethane)	169.243	204.180	4.84	34.937	4.031
R-290 (CH3CH2CH3, Propane)	293.156	354.359	4.79	61.203	3.717
R-401A, R22/152a/124 (53/13/34), R401A	173.946	209.582	4.88	35.635	4.597
R-401B, R22/152a/124 (61/11/28), R401B	174.475	210.351	4.86	35.876	4.527
R-401C, R22/152a/124 (33/15/52), R401C	167.261	201.184	4.93	33.923	4.742
R-402A, R125/290/22 (60/2/38), R402A	121.226	147.912	4.54	26.686	3.881
R-402B, R125/290/22 (38/2/60), R402B	139.268	169.072	4.67	29.804	3.930
R-404A, R125/143a/134a (44/52/4), R404A	122.321	149.700	4.47	27.379	3.895
R-406A, R22/142b/600a (55/41/4), R406A	197.305	234.413	5.32	37.108	4.632
R-407A, R32/125/134a (20/40/40), R407A	160.990	195.456	4.67	34.466	4.390
R-407B, R-32/125/134a (10/70/20)	126.736	154.856	4.51	28.119	4.198
R-407C, R-32/125/134a (23/25/52)	175.779	212.765	4.75	36.987	4.468
R-408A, R22/143a/125 (47/46/7)	155.205	195.115	3.89	39.909	3.957
R-409A, R22/124/142b (60/25/15)	169.267	210.536	4.10	41.269	4.601
R-410A, R32/125 (50/50)	176.684	214.942	4.62	38.259	3.862
R-410B, R32/125 (45/55)	168.311	204.736	4.62	36.426	3.908
R-500, R12/152a (73.8/26.2)	147.010	177.105	4.88	30.095	4.105
R-502, R-22/115 (48.8/51.2)	110.620	134.616	4.61	23.996	3.784
R-507, R-125/143a (50/50)	125.721	152.951	4.62	27.229	3.852
R-600 (CH3CH2CH2CH3, Butane)	301.166	361.834	4.96	60.667	4.977
R-600a (CH(CH3)3, 2-methyl propane (isobutane))	277.180	333.691	4.90	56.511	4.560
R-717 (NH3, Ammonia)	1127.528	1358.669	4.88	231.141	4.940
R-718 (H20, Water)	2369.155	2959.889	4.01	590.734	25.687
R-744 (C02, Carbon dioxide)	161.693	210.777	3.29	49.084	3.143
RC318 (C4F8, Octafluorocyclobutane)	43.696	60.481	2.60	16.785	5.386



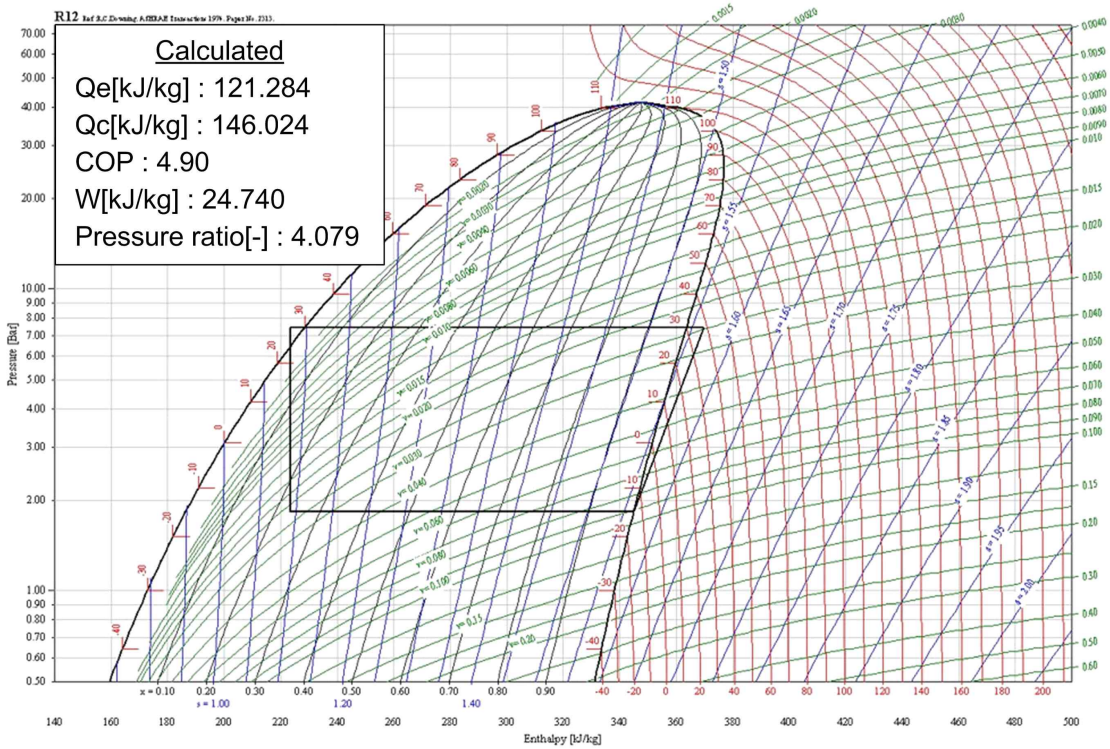
R-11, CCl3F, Trichlorofluoromethane



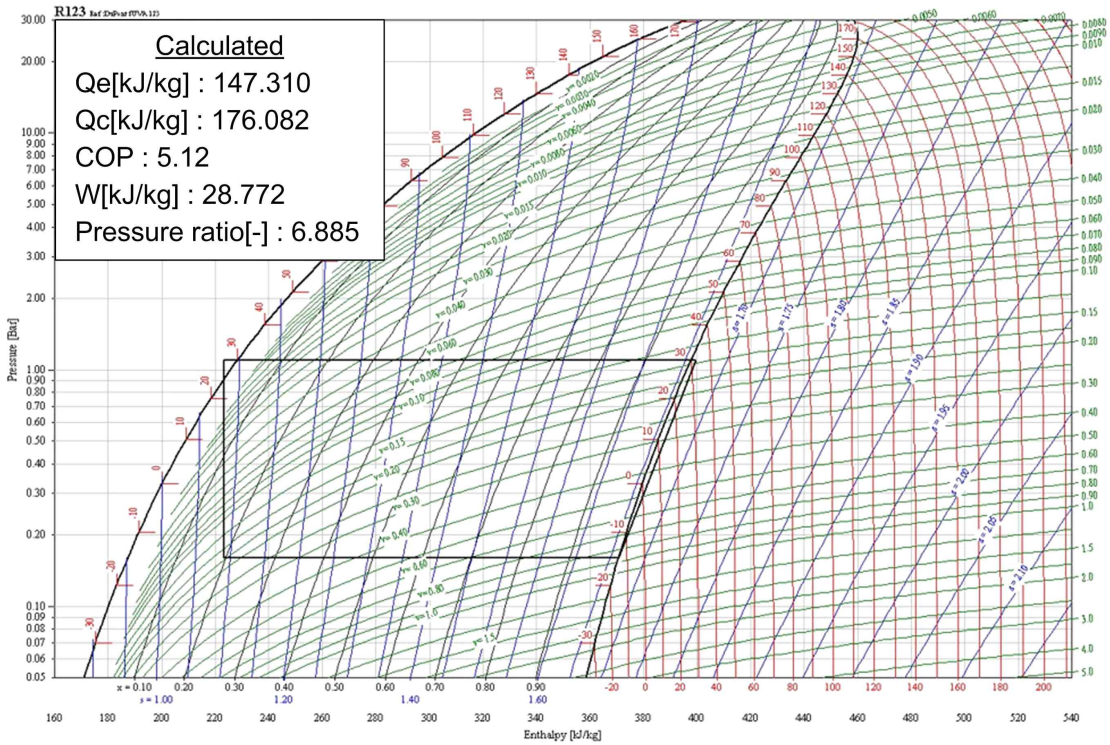
R-113, CCl2FCClF2, Trichlorotrifluoroethane



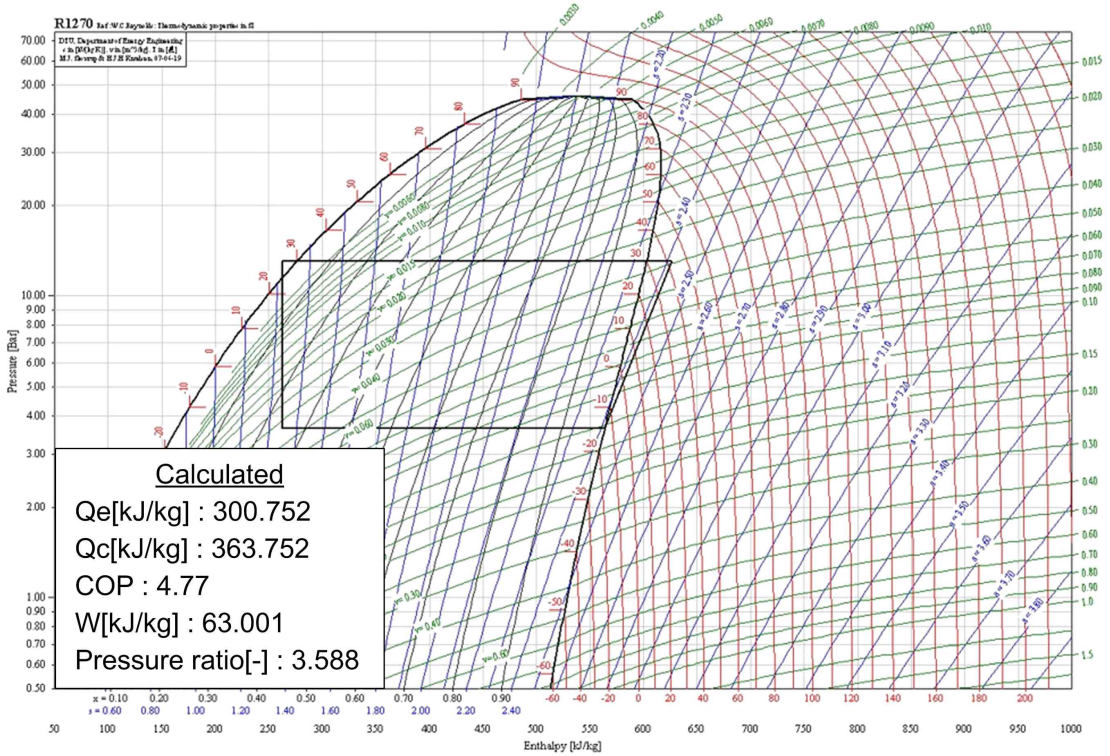
R-114, CCIF2CCIF2, Dichlorotetrafluoroethane



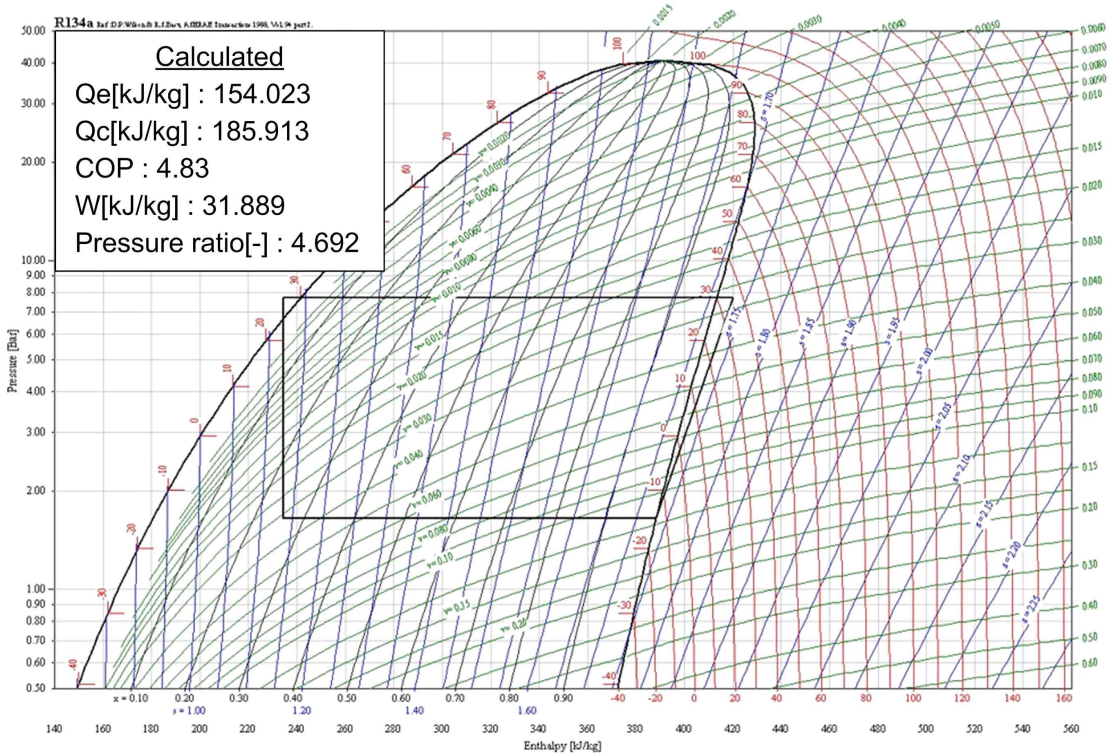
R-12, CCI2F2, Dichlorodifluoromethane



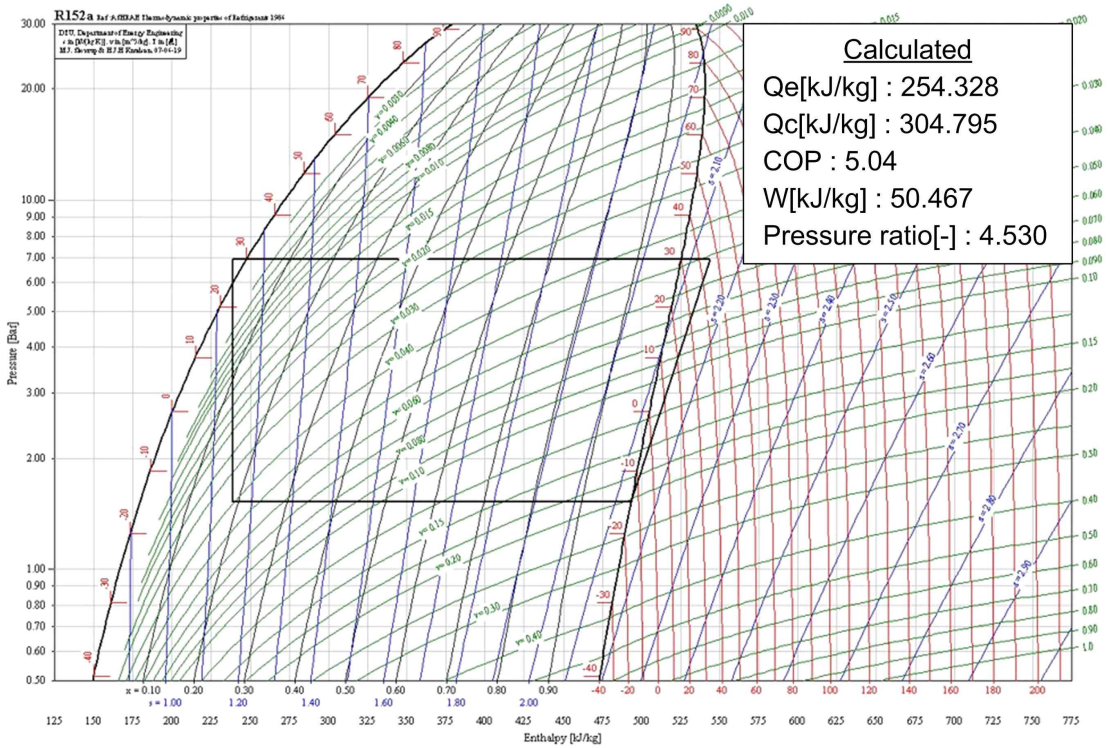
R-123, CHCl2CF3, Dichlorotrifluoroethane



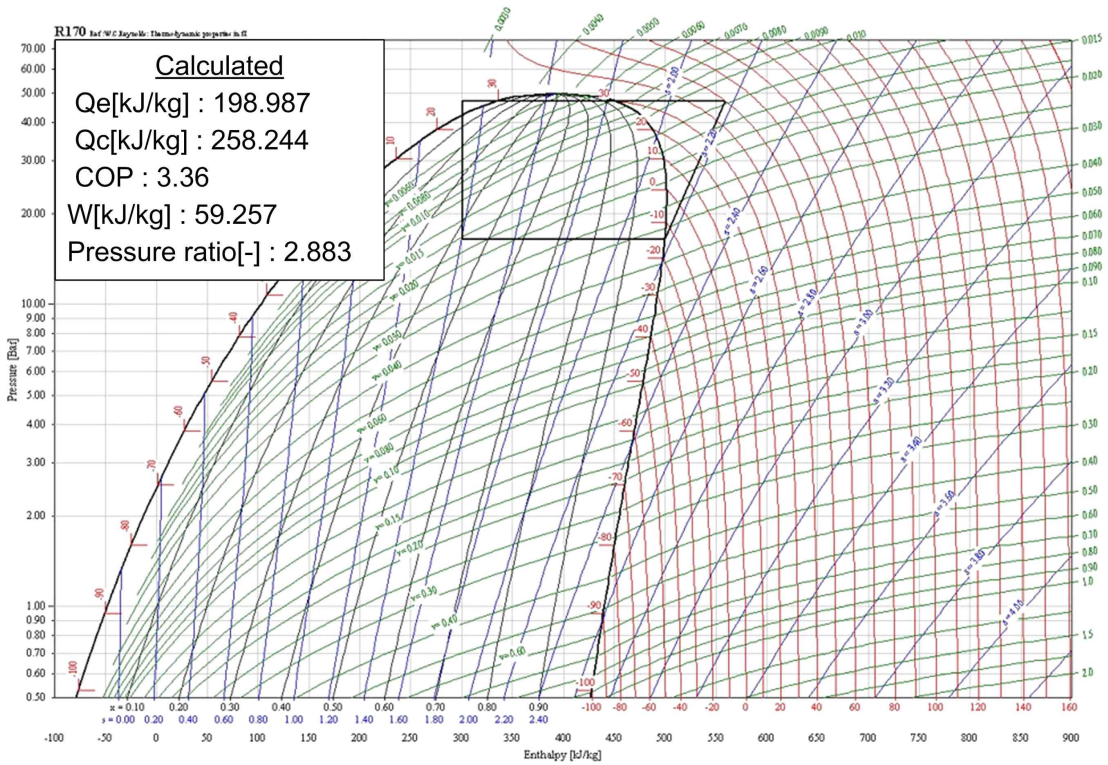
R-1270, CH3CH=CH2, Propene (propylene)



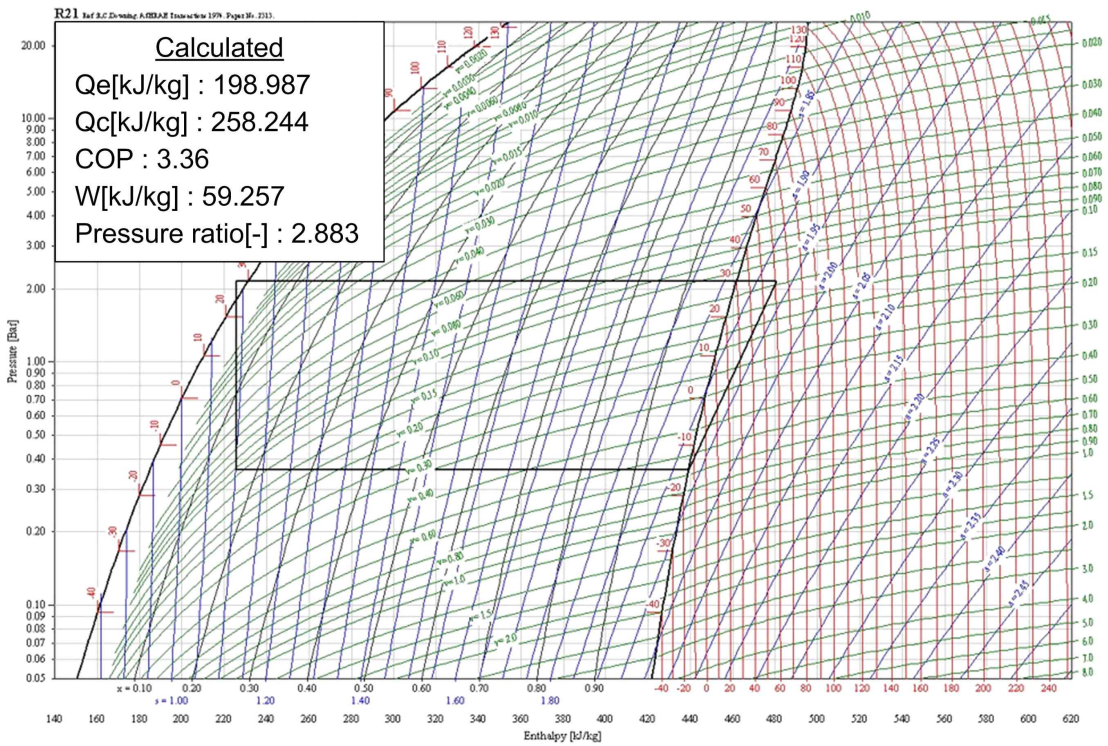
R-134a, CH2FCF3,1,1,1,2-tetrafluoroethane



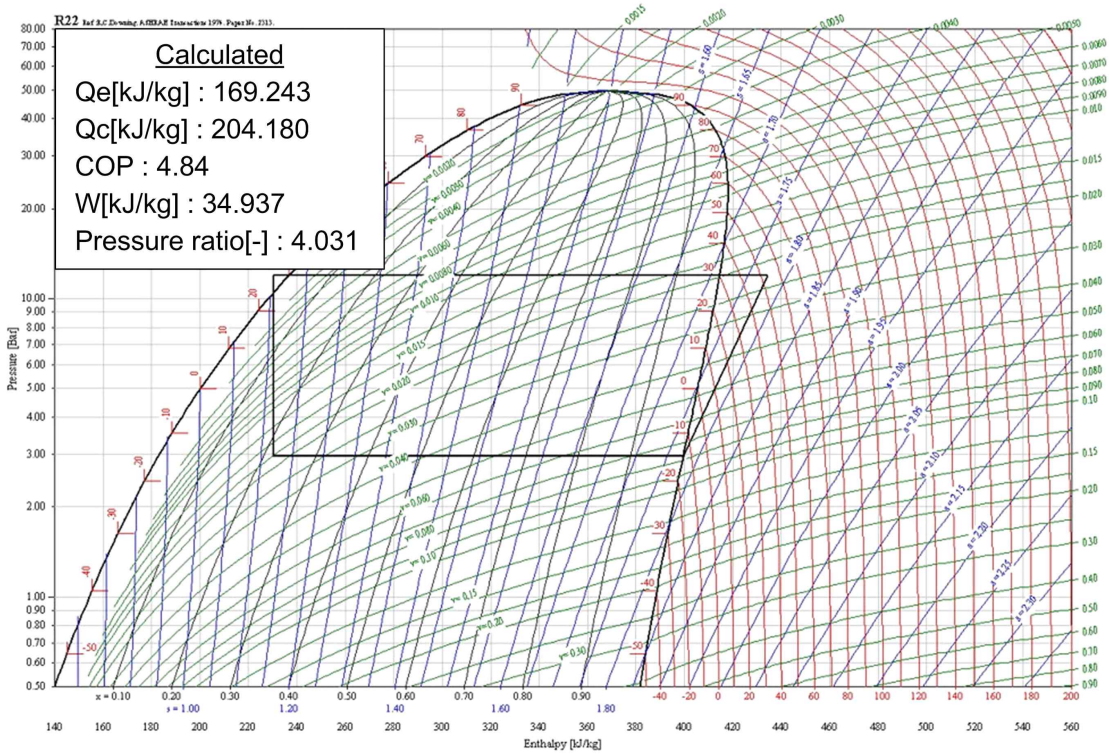
R-152a, CH3CHF2,1,1-difluoroethane



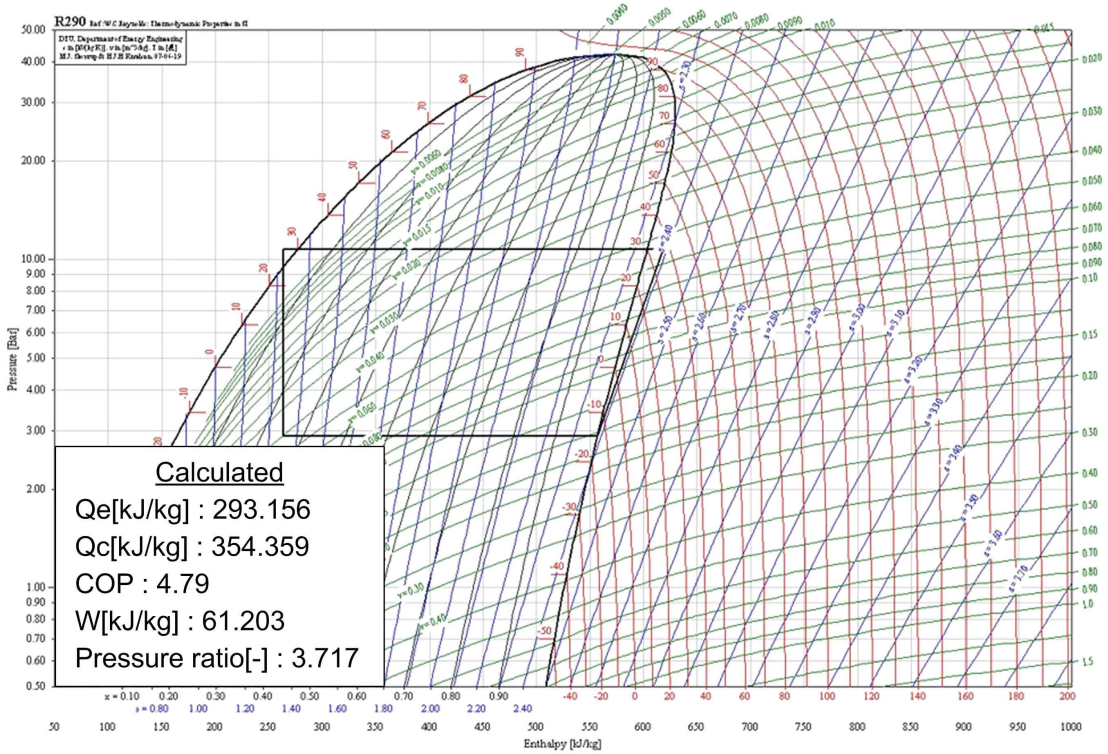
R-170, CH3CH3, Ethane



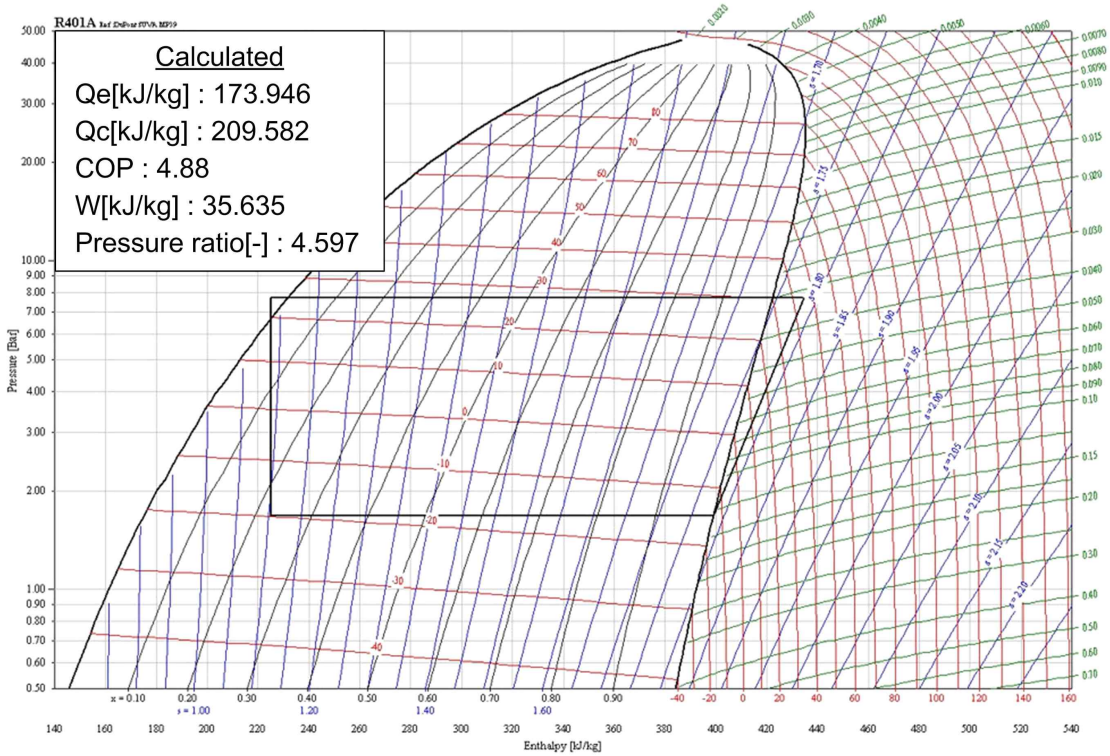
R-21, CHCl2F, Dichlorofluoromethane



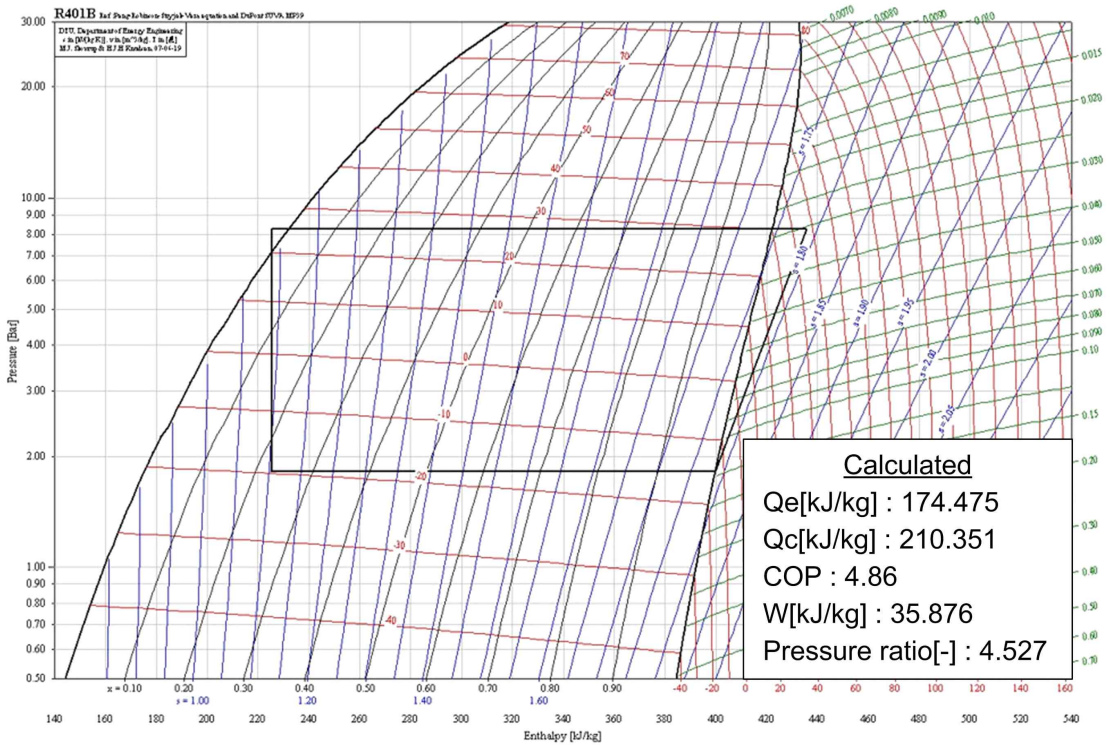
R-22, CHCIF2, Chlorodifluoromethane



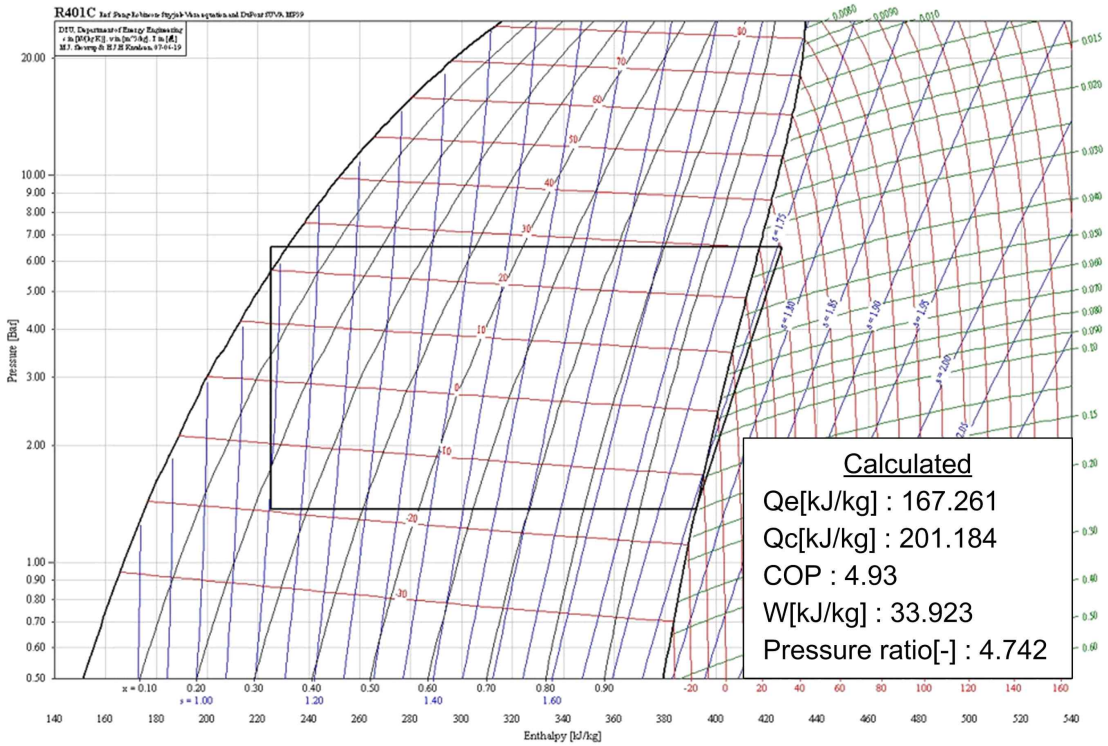
R-290, CH3CH2CH3, Propane



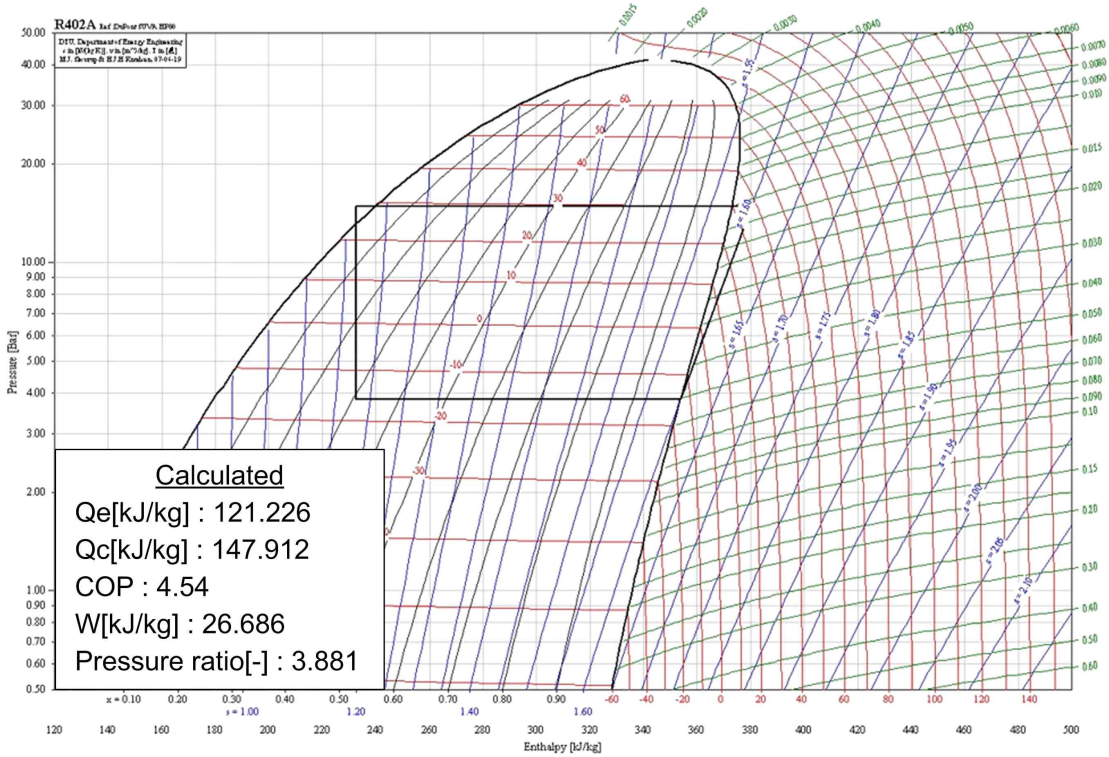
R-401A, R22/152a/124 (53/13/34), R401A



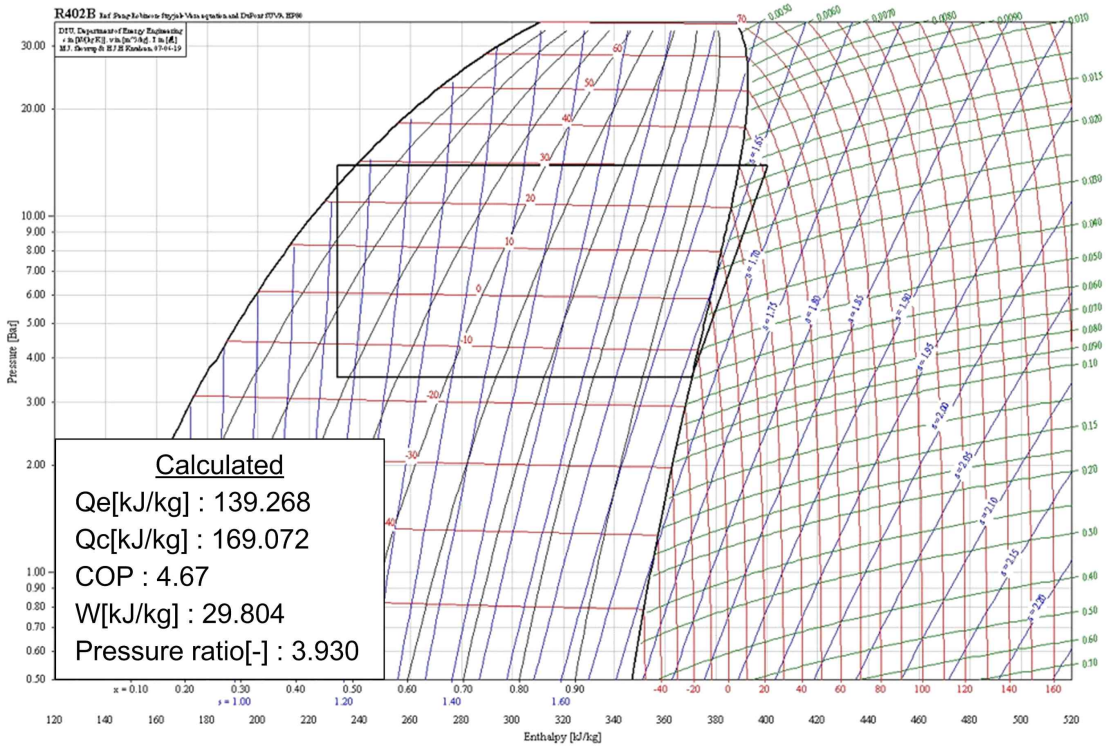
R-401B, R22/152a/124 (61/11/28), R401B



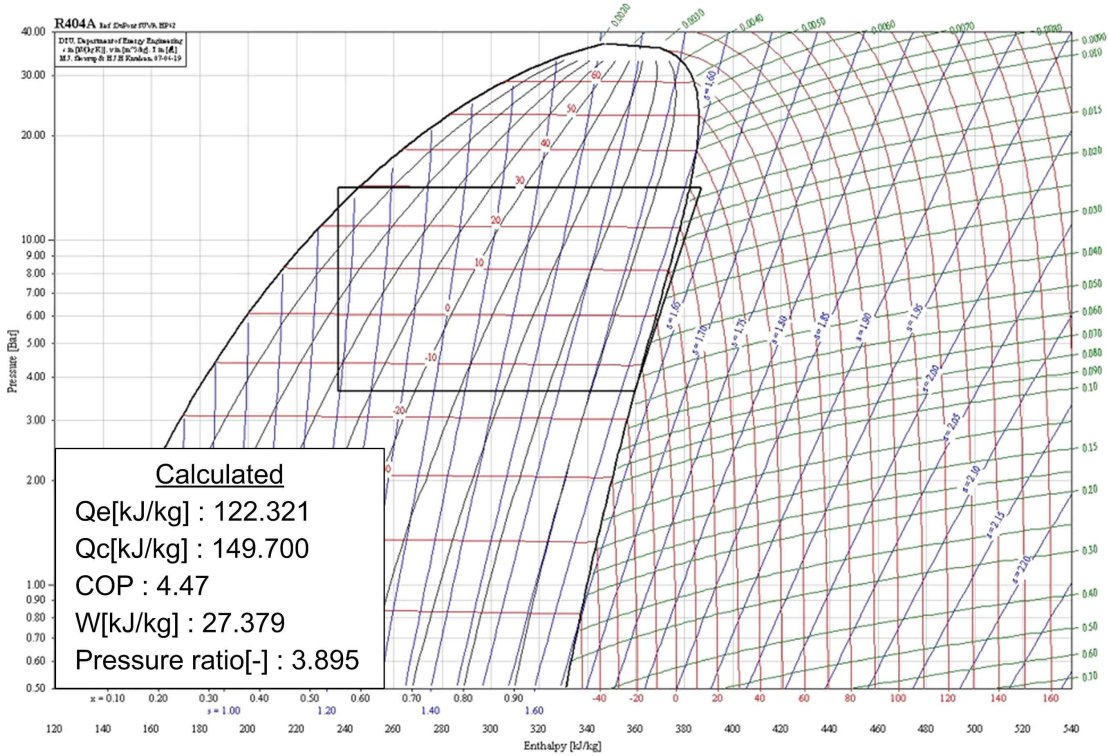
R-401C, R22/152a/124 (33/15/52), R401C



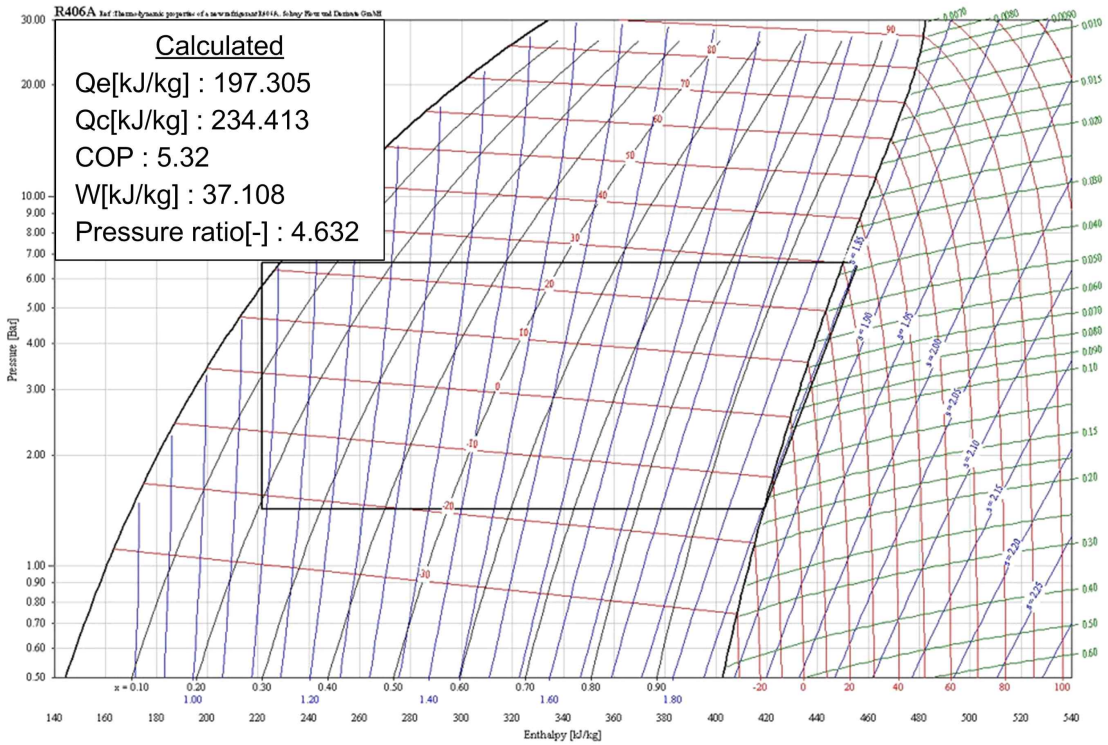
R-402A, R125/290/22 (60/2/38), R402A



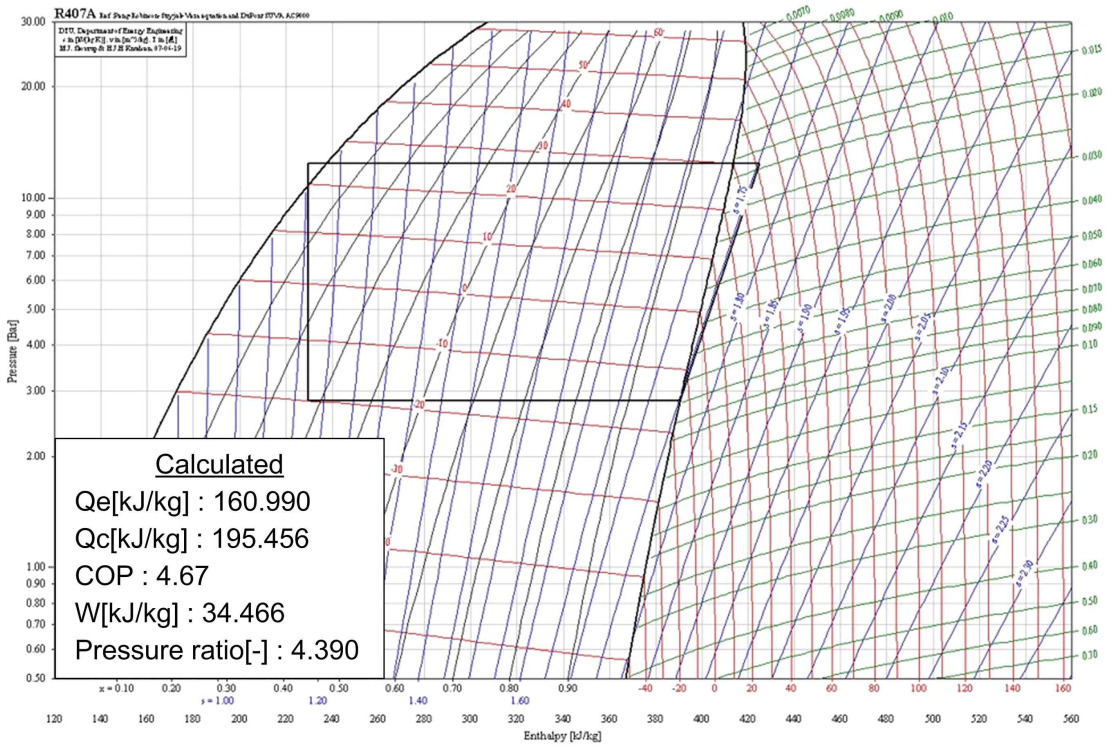
R-402B, R125/290/22 (38/2/60), R402B



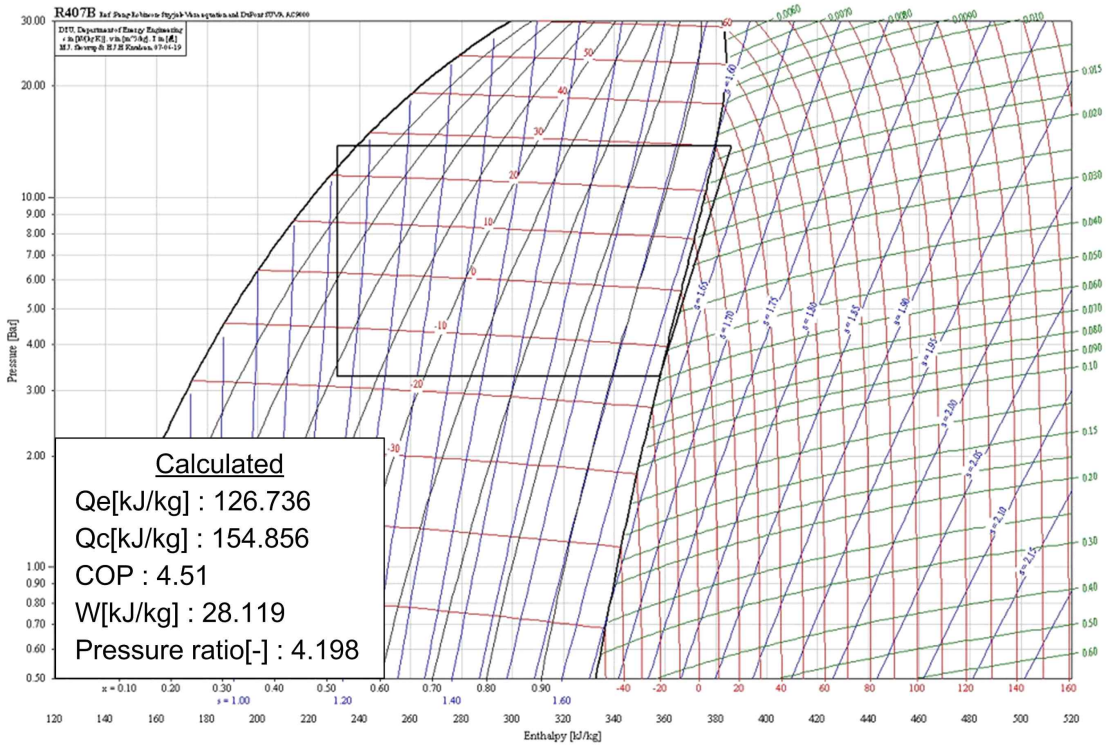
R-404A, R125/143a/134a (44/52/4), R404A



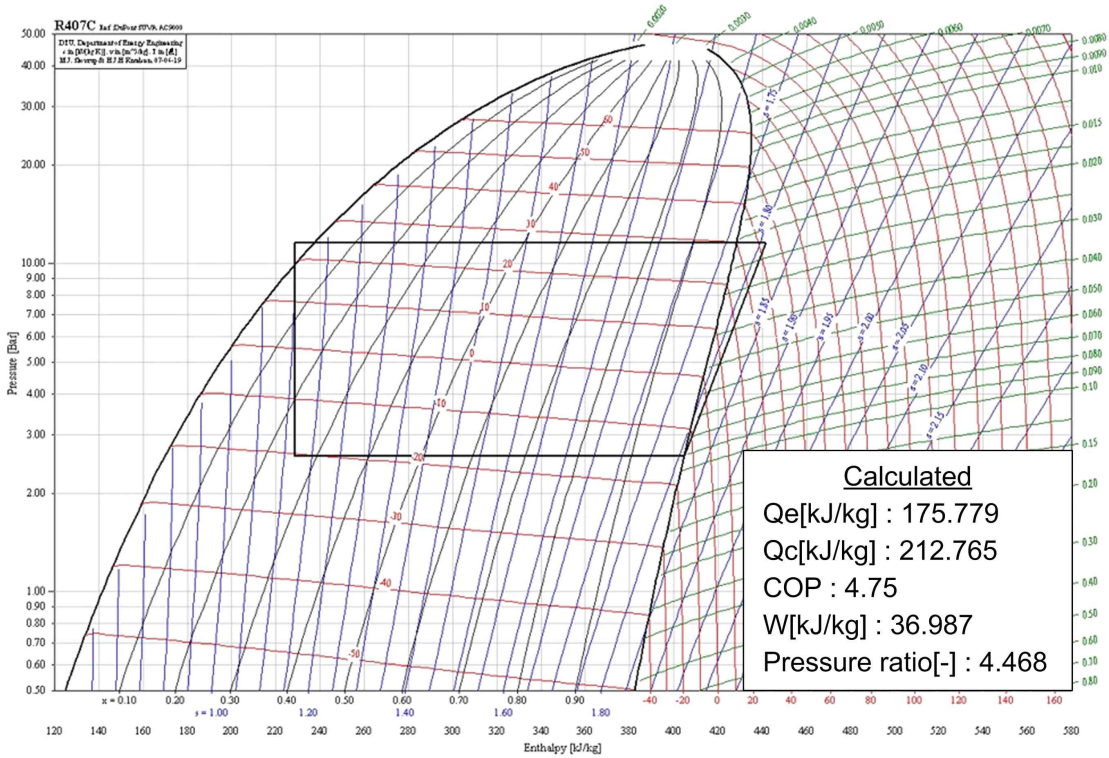
R-406A, R22/142b/600a (55/41/4), R406A



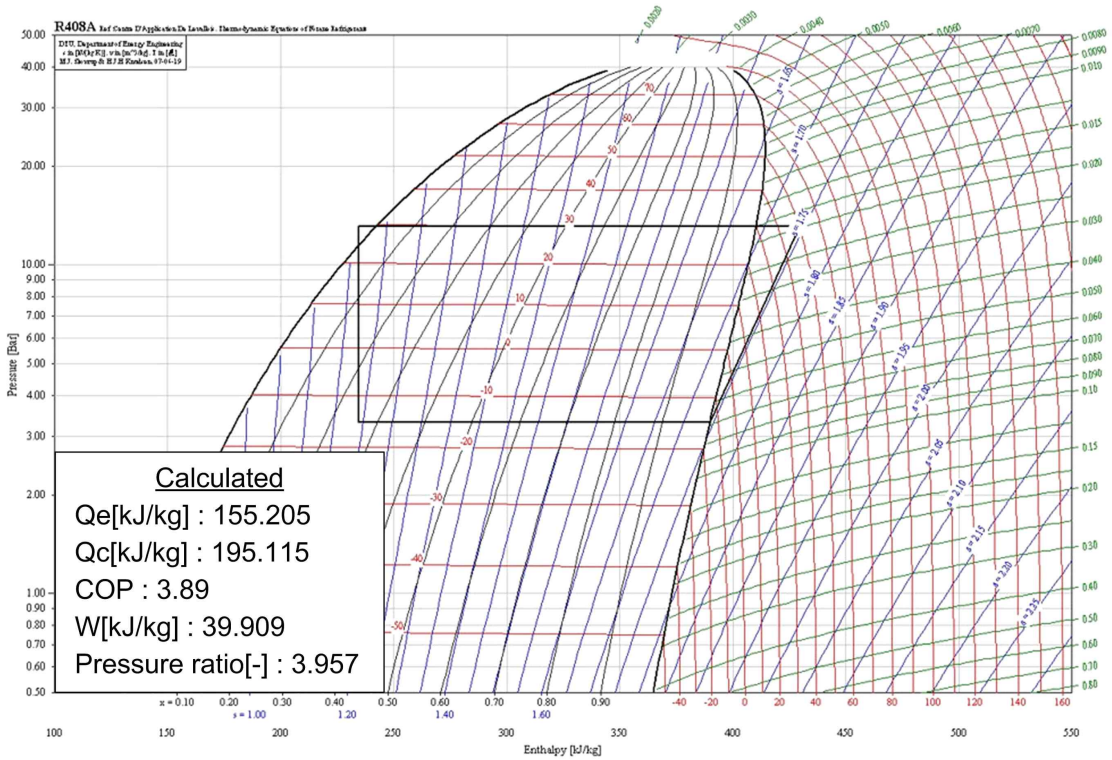
R-407A, R32/125/134a (20/40/40), R407A



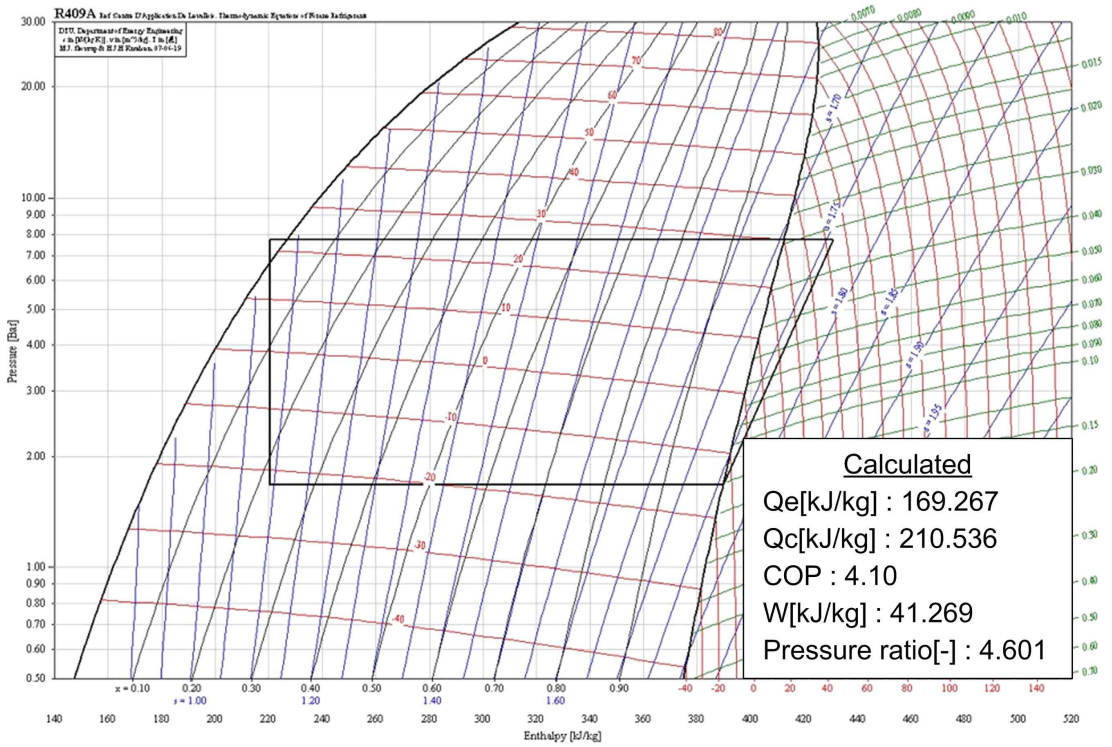
R-407B, R-32/125/134a (10/70/20)



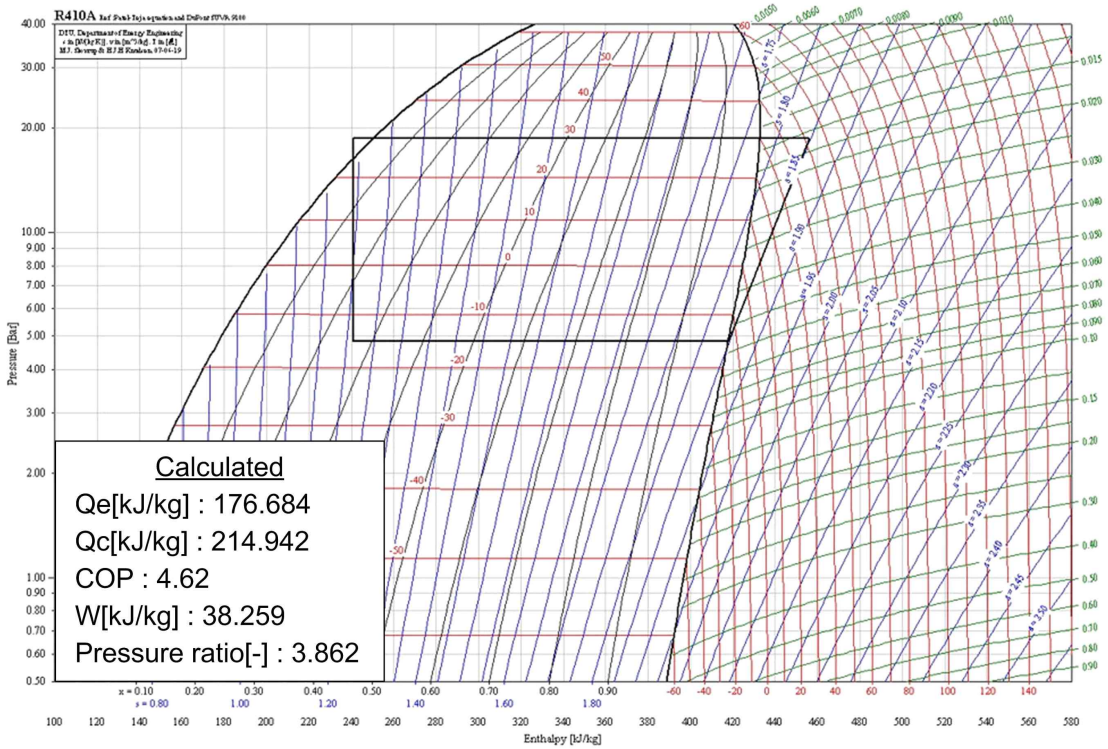
R-407C, R-32/125/134a (23/25/52)



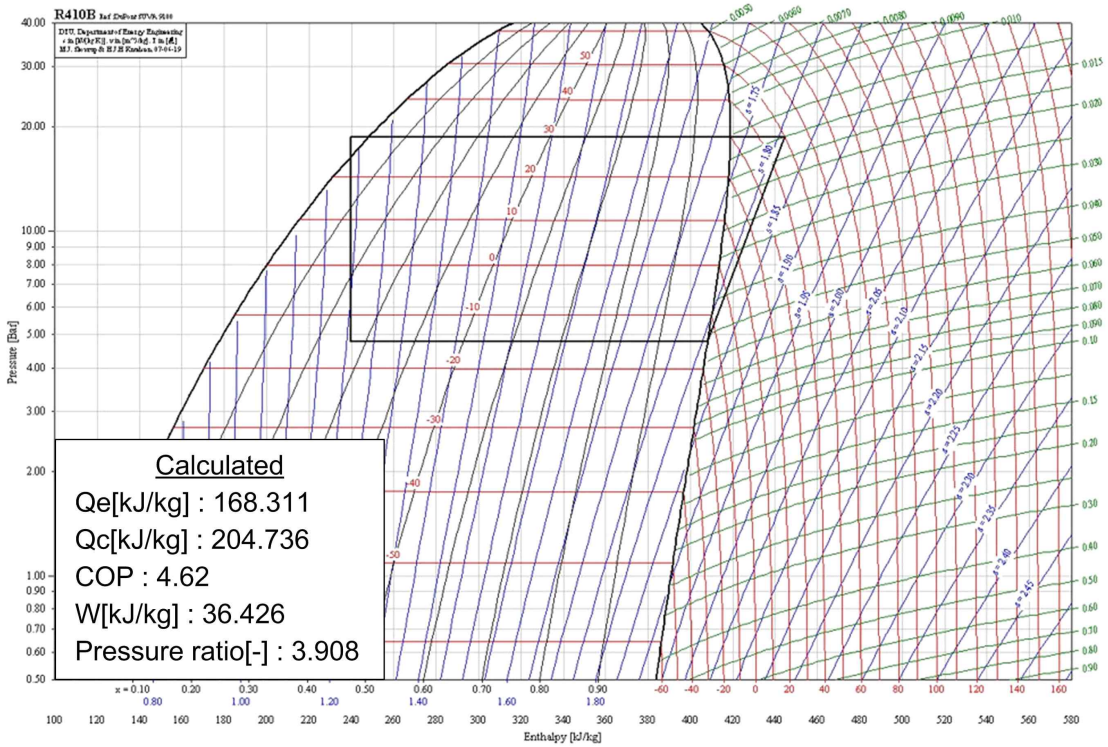
R-408A, R22/143a/125 (47/46/7)



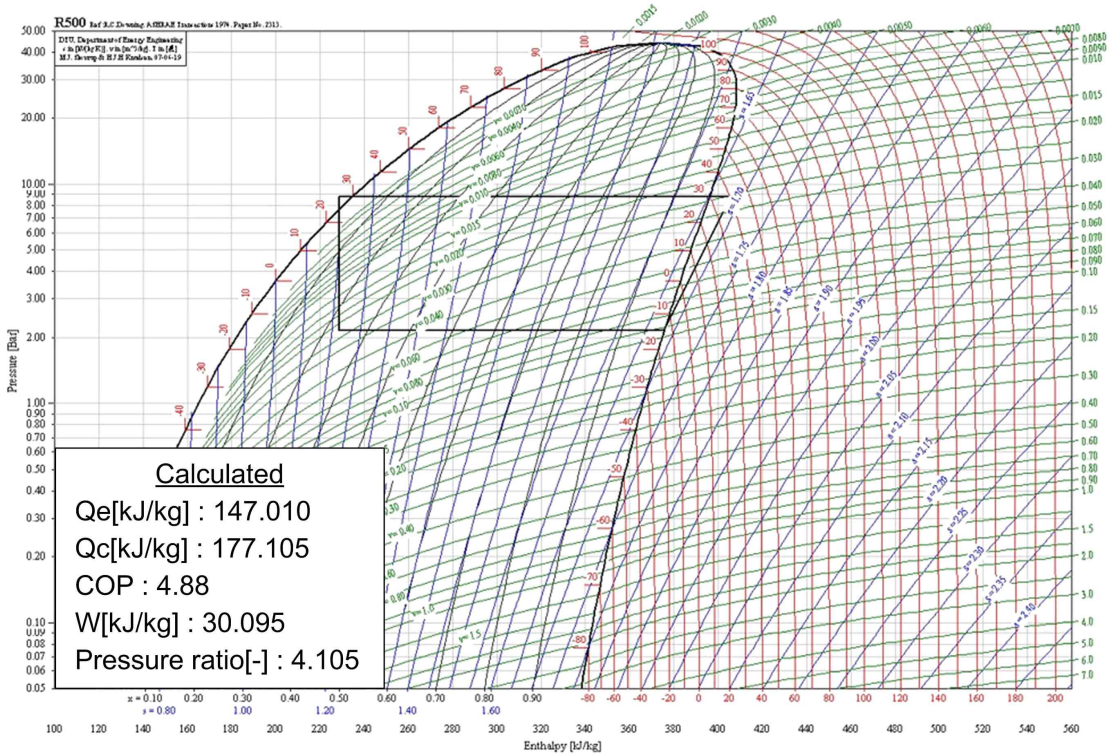
R-409A, R22/124/142b (60/25/15)



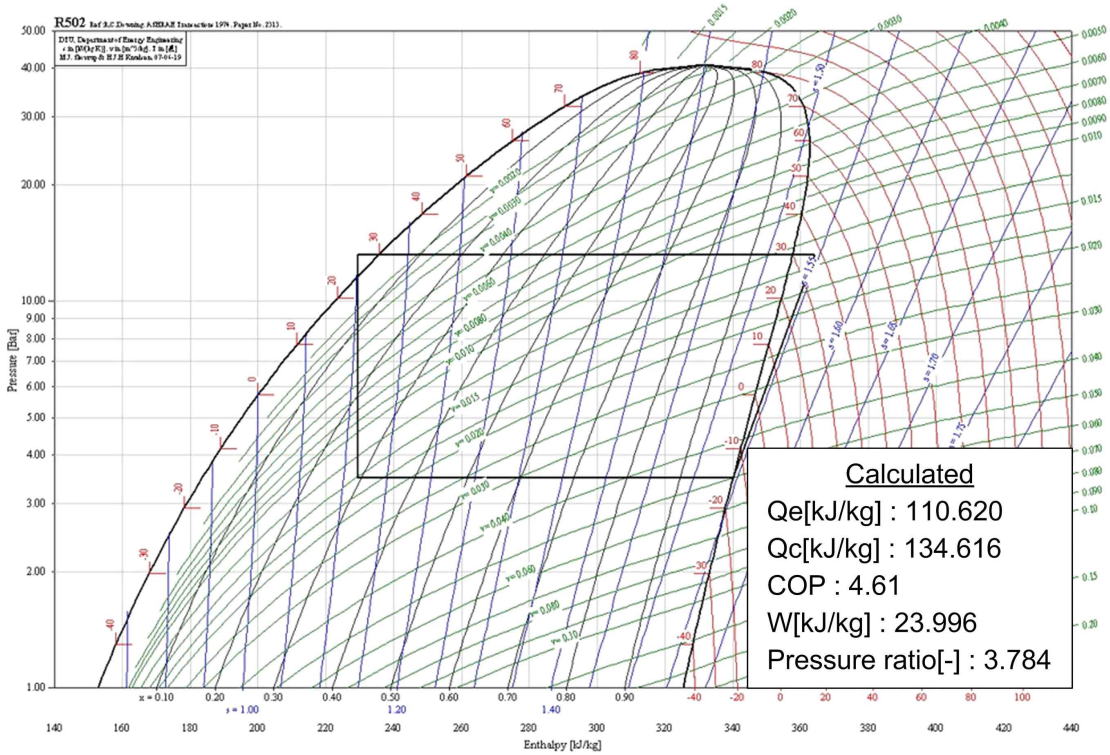
R-410A, R32/125 (50/50)



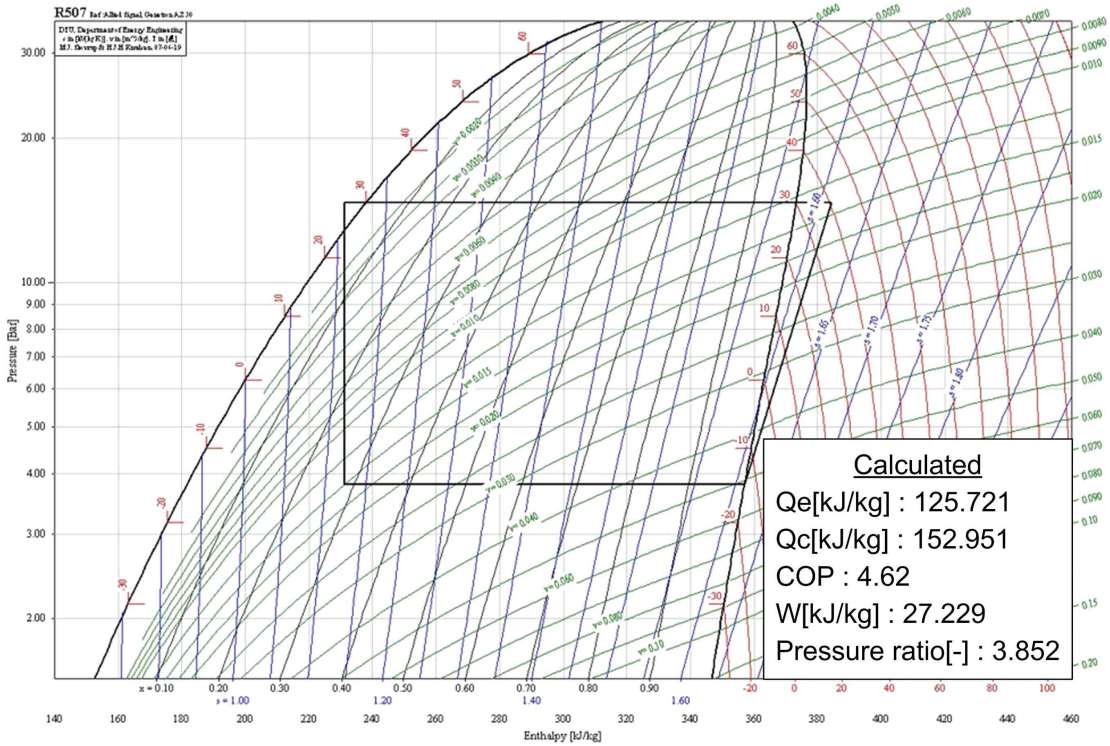
R-410B, R32/125 (45/55)



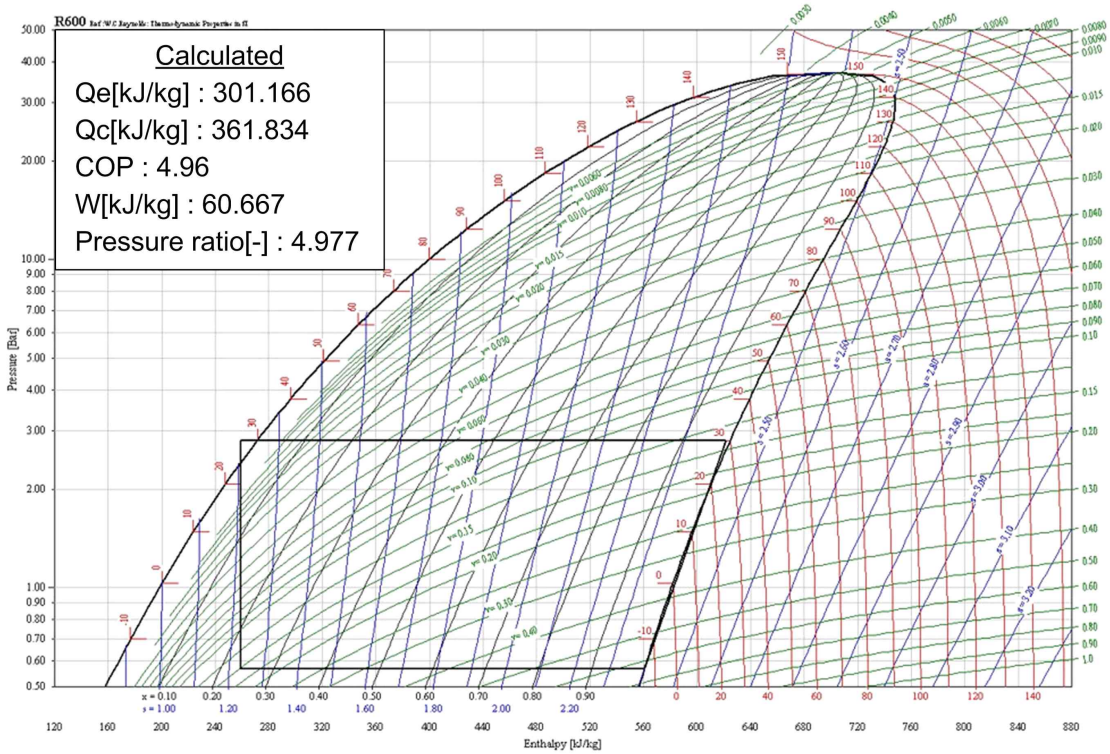
R-500, R12/152a (73.8/26.2)



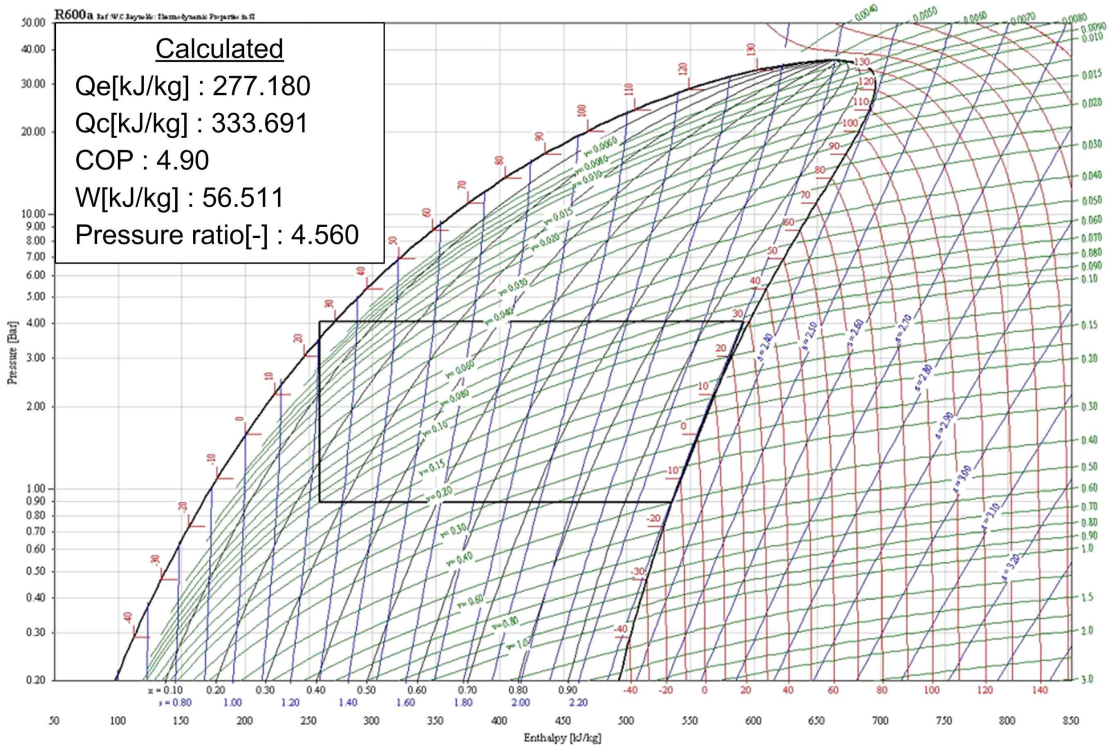
R-502, R-22/115 (48.8/51.2)



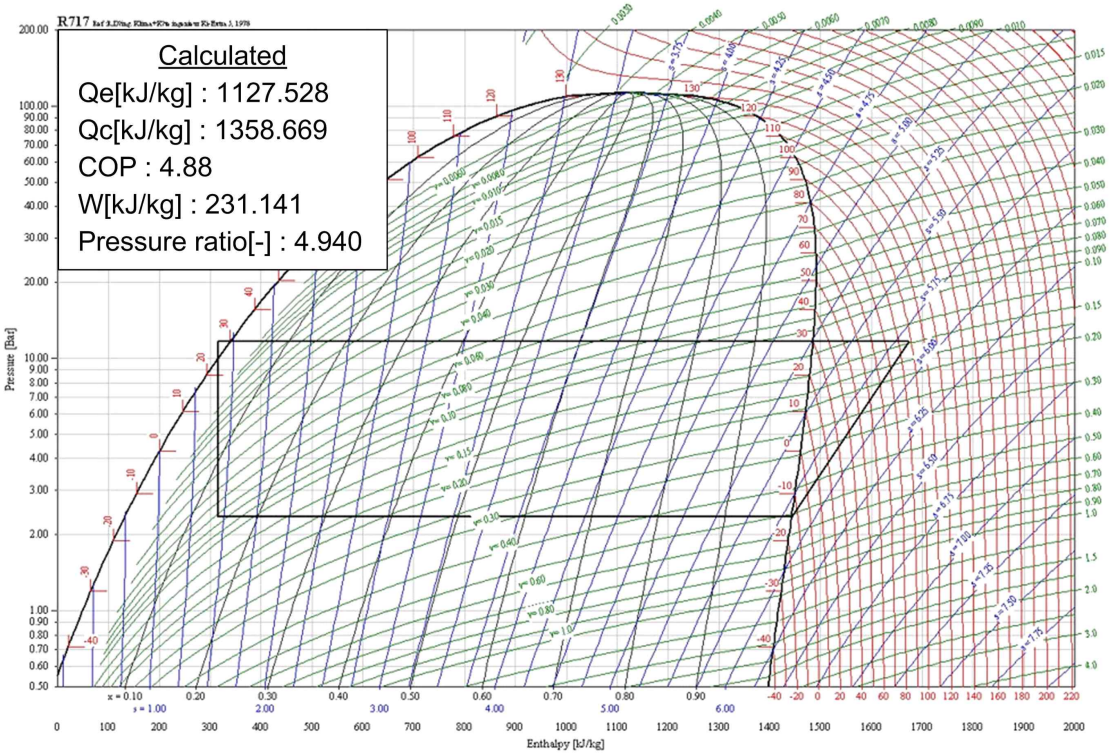
R-507, R-125/143a (50/50)



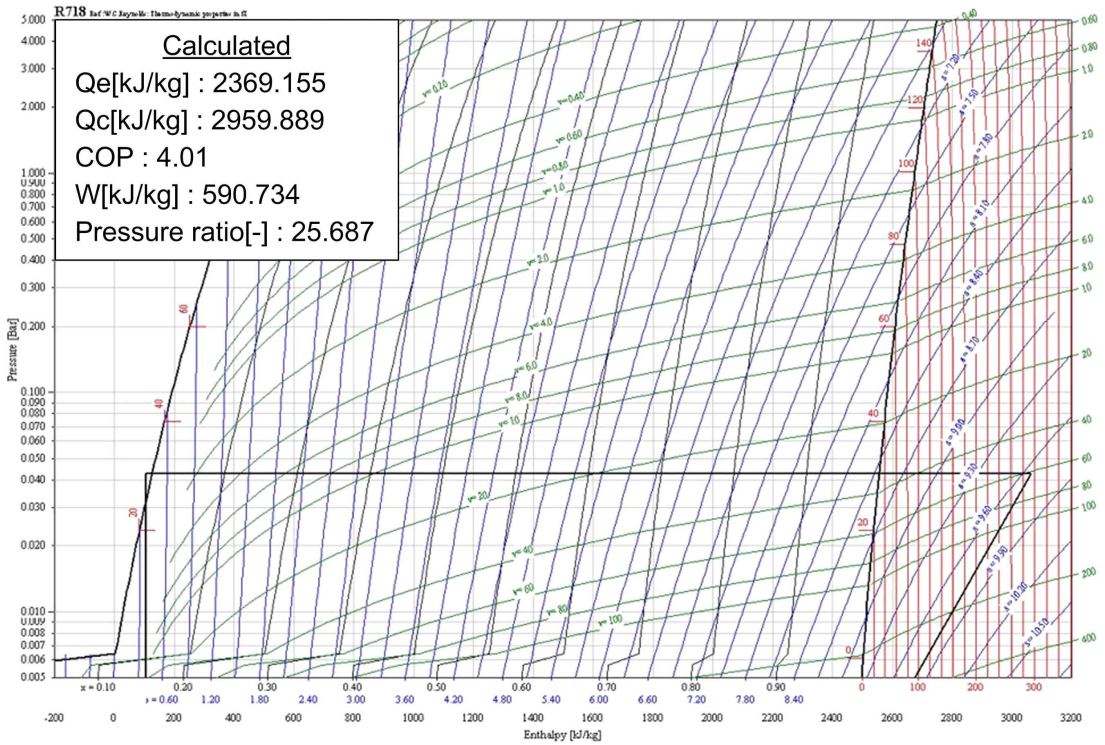
R-600, CH3CH2CH2CH3, Butane



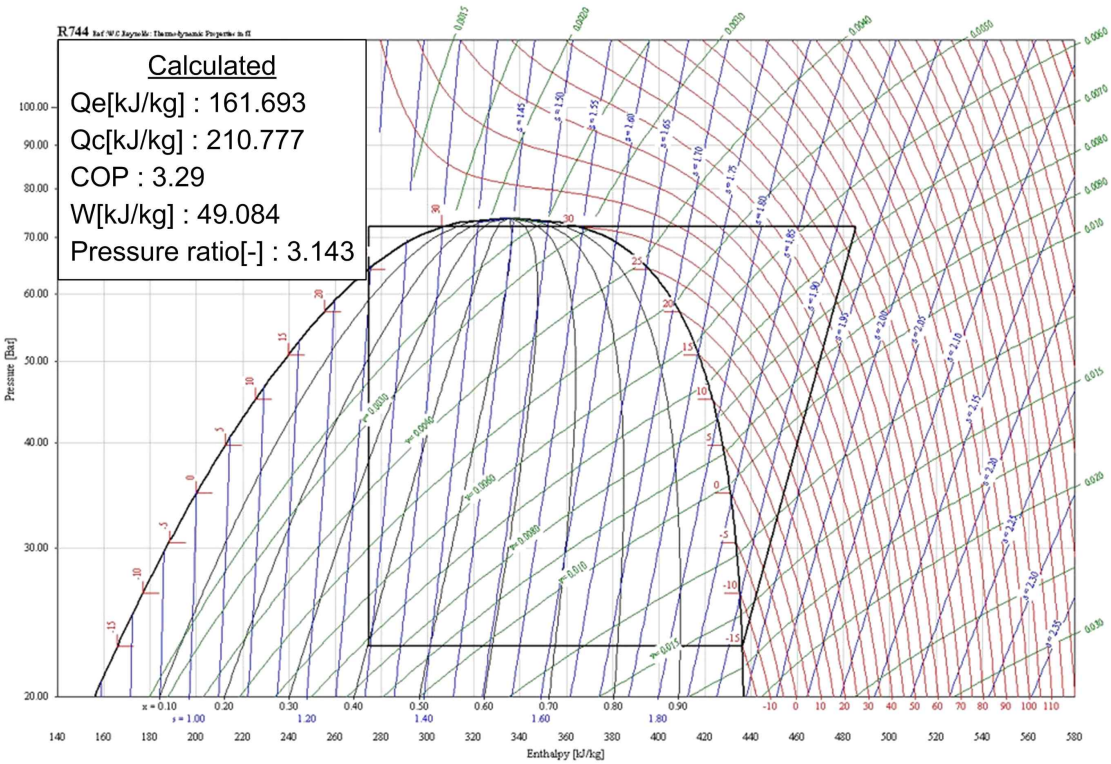
R-600a, CH(CH3)3, 2-methyl propane (isobutane)



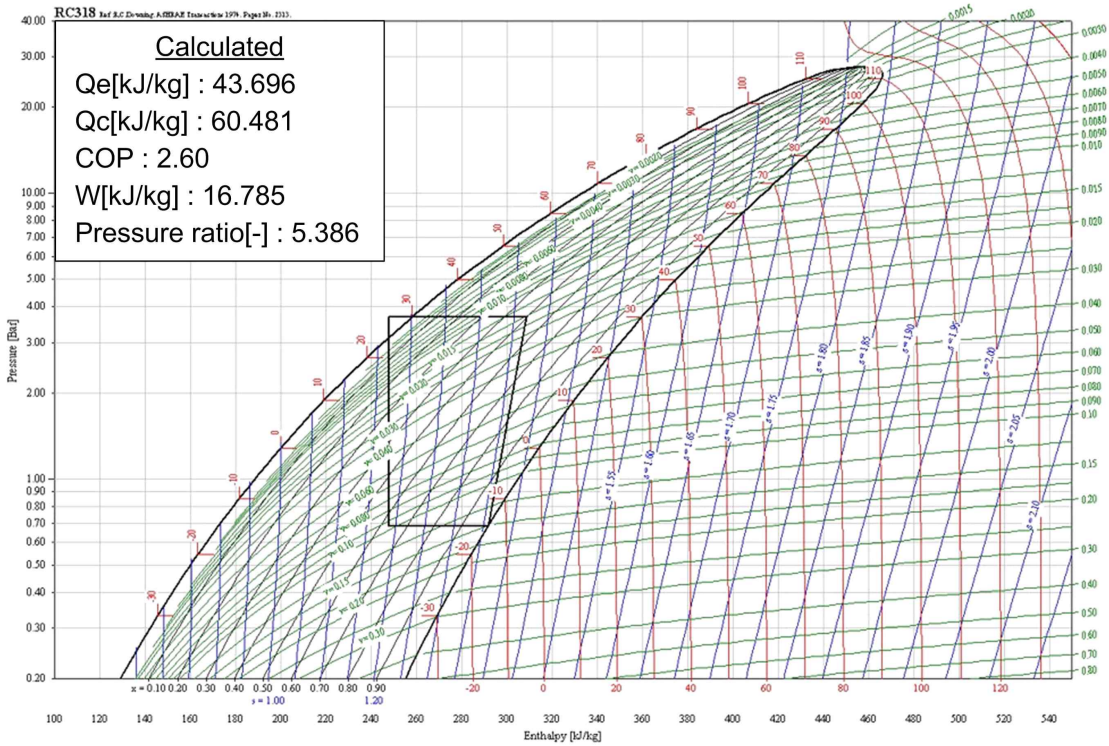
R-717, NH3, Ammonia



R-718, H20, Water



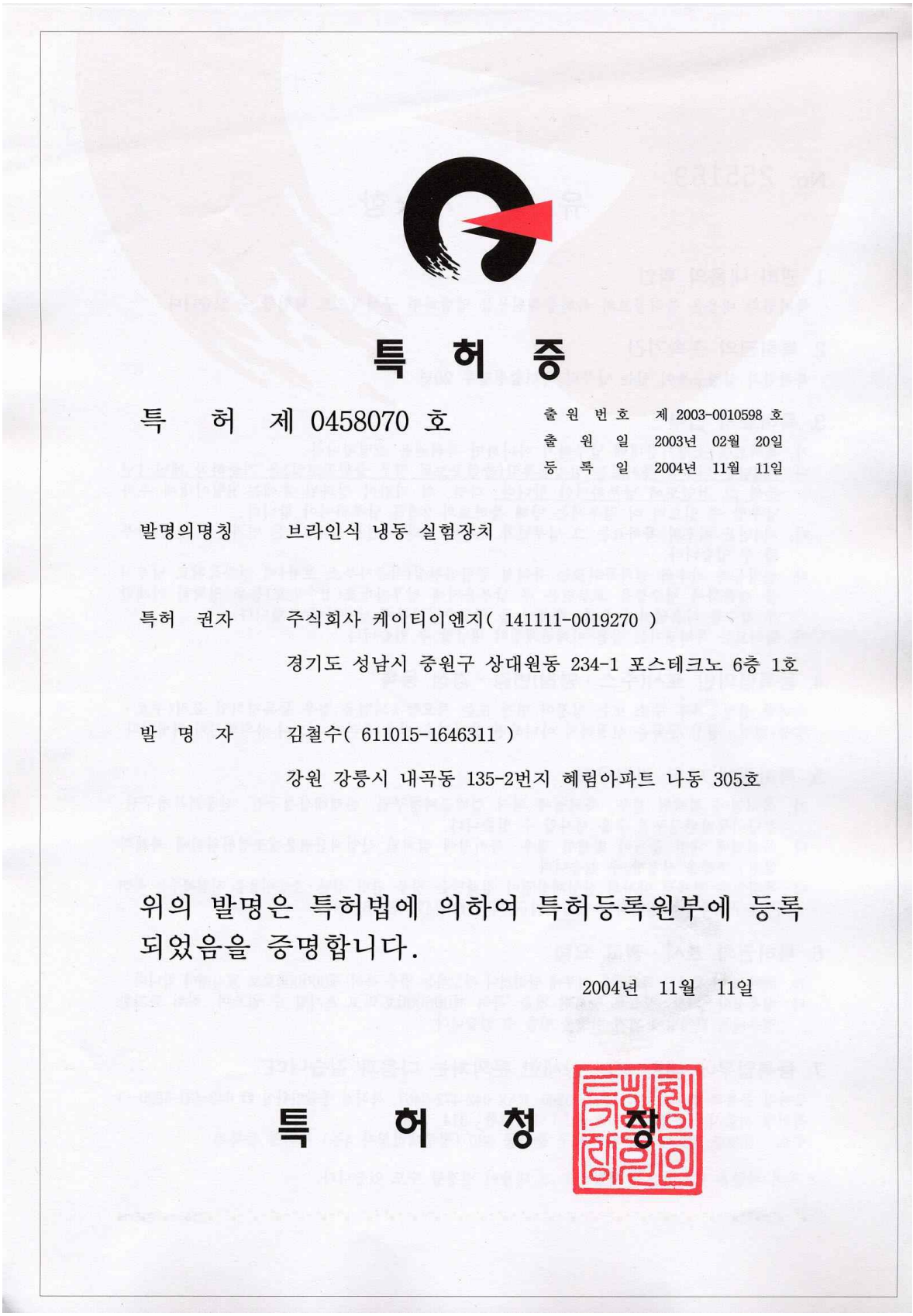
R-744, C02, Carbon dioxide



RC318 C4F8, Octafluorocyclobutane

Chapter 5. Certificate of Patent

1. Brine Refrigeration Experimental Equipment (Patent)



특 허 증

특 허 제 0458070 호

출원번호 제 2003-0010598 호
출 원 일 2003년 02월 20일
등 록 일 2004년 11월 11일

발명의명칭 브라인식 냉동 실험장치

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위의 발명은 특허법에 의하여 특허등록원부에 등록되었음을 증명합니다.

2004년 11월 11일

특 허 청 장

Renewable Energy / Refrigeration & Air-conditioning & Welding
Automation controls(PLC) / Robot controls / Electric & Electronics(LED lighting)
Firefighting & safety / Big data & ICT / Automobile & ship / Nano chemical

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