Model : KTE-3000HD

4-WAY REVERSE VALVE CONTROL HEAT PUMP HEATING & COOLING EXPERIMENT EQUIPMENT

KTENG CORPORATION

Korea Technology Institute of Energy Convergence

Korea Technology Engineering Co.,Ltd.

CONTENT

Chapter 1. Description of an Heat pump cooling & heating apparatus

Chapter 2. Component of an Heat pump cooling & heating apparatus

Chapter 3. Construction and Operation as circuit

Chapter 4. Experimental and Using DA100

Chapter 5. Notice and Guarantee

Chapter 1. Description of an Heat pump cooling & heating apparatus

1. Heat Pump Refrigeration Experiment Equipment

1-1. System Description of 4-Way Reverse Valve Heat Pump Training Equipment

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.

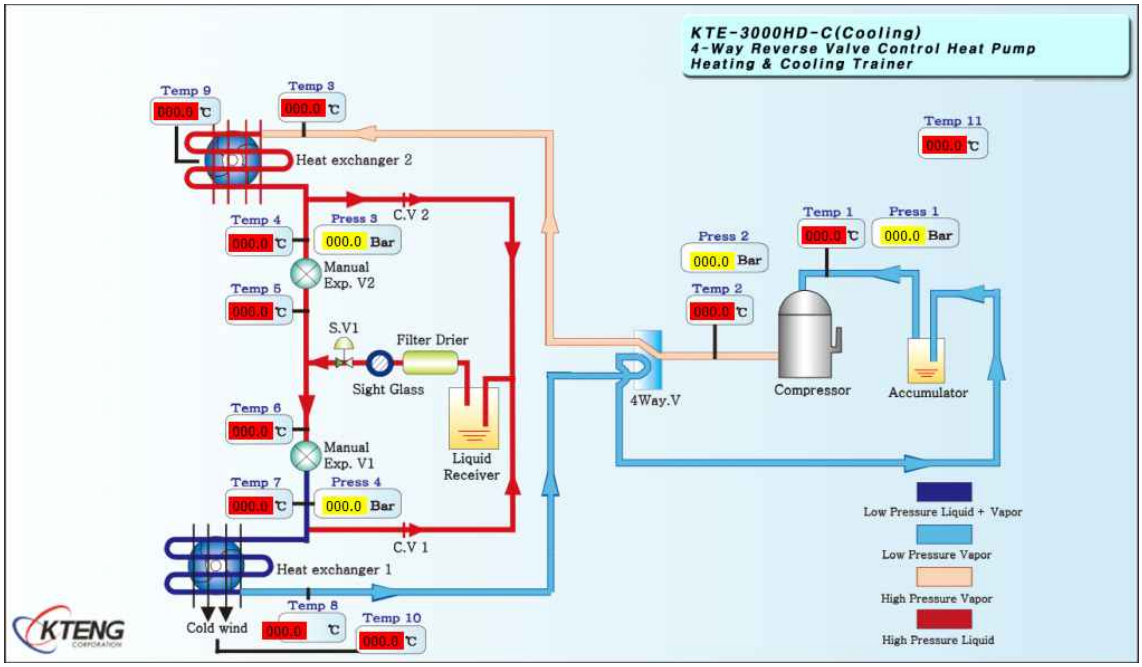
2. MECHANICAL REFRIGERATION : Composition with Compressor, Condenser(with fan motor), Receiver, Filter-dryer, Sight glass, Solenoid Valve, Manual expansion Valve, Evaporator(with fan motor), Reversing Valve, Accumulator, High · Low pressure gauge, Check Valve, etc, these devices run as set up circuit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

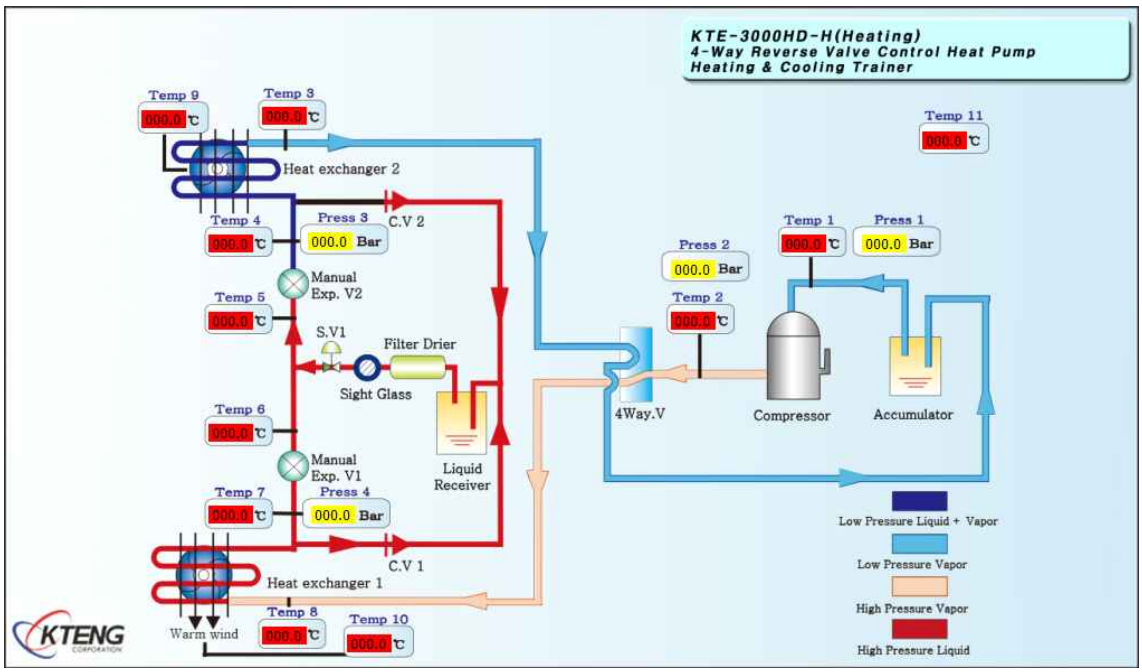
3. SOFTWARE P/G : KTE-DA100(Software) supply tools with that temperature, pressure, enthalpy, amount of the exchanged heat in each position can be measured in real time, and then saved by Microsoft excel, so that the saved data can be show and analysis by graph.

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. System cycle and Measuring device for temp.& pressure

(1) Cycle diagram of Heat Pump Heating & Cooling Refrigeration system

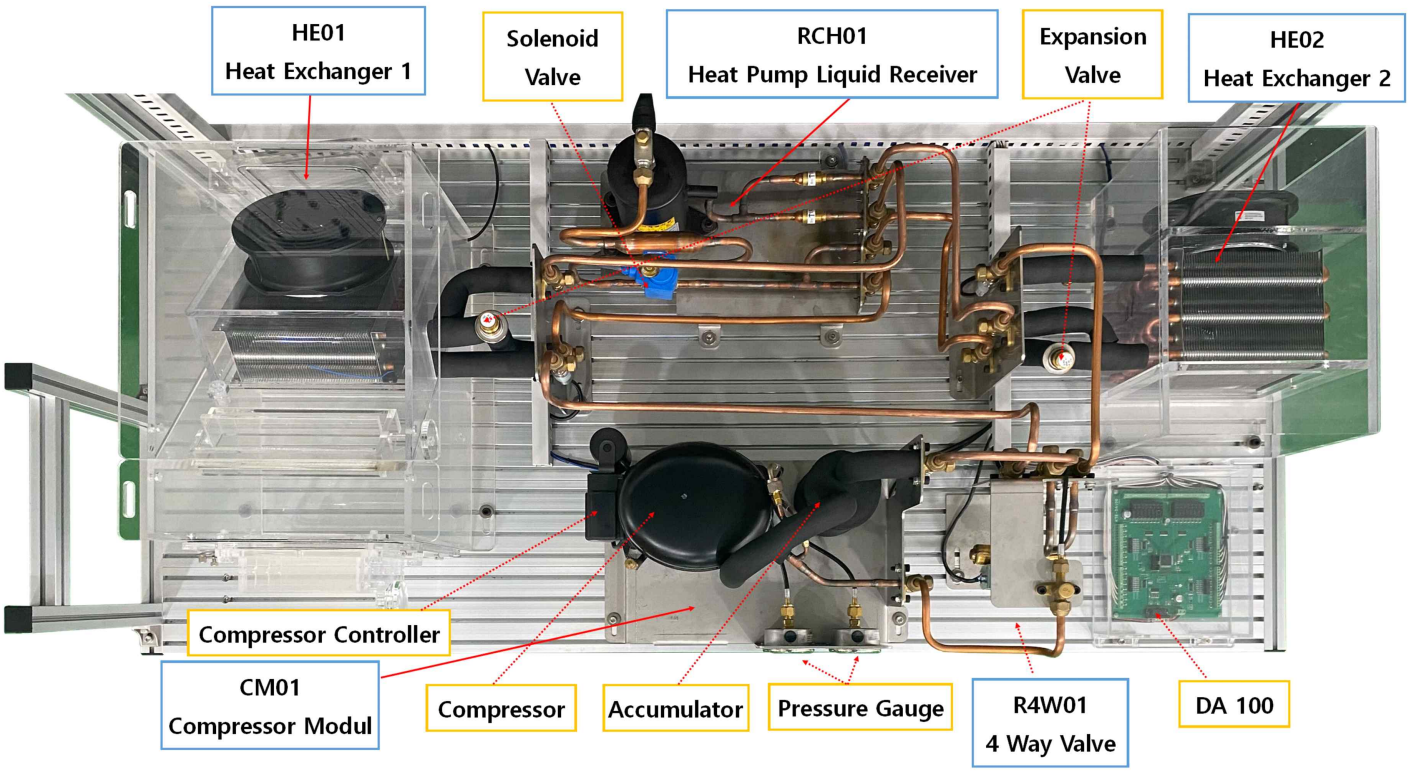




(2) Temperature, Pressure position for measurement in Heat Pump Heating & Cooling Refrigeration system

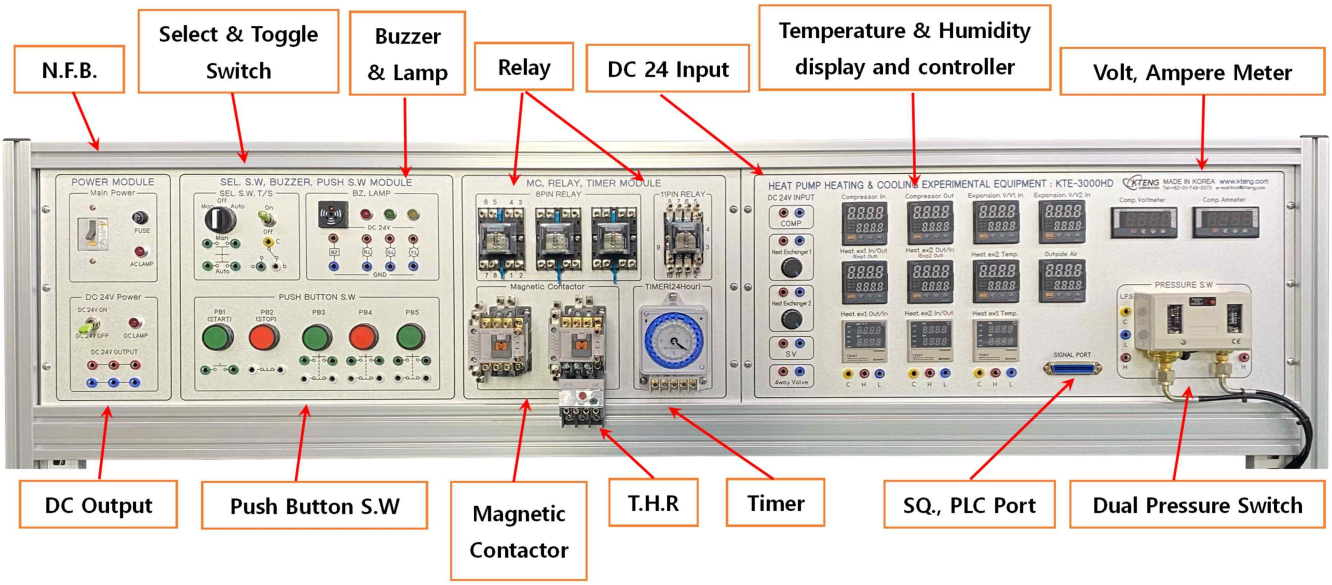
Measuring point	Remark
Temp 1, Press 1	Compressor in
Temp 2, Press 2	Compressor out
Temp 3	Condenser in(Cooling), Evaporator out(Heating)
Temp 4, Press 3	Condenser out(Cooling), Evaporator in(Heating)
Temp 5, Temp 6	Expansion Valve in
Temp 7, Press 4	Evaporator in(Cooling), Condenser out(Heating)
Temp 8	Evaporator out(Cooling), Condenser in(Heating)
Temp 9, Temp 10	Evaporator Room Temp.

1-3. Mechanical refrigeration device component



① Compressor
② Compressor Controller
③ High Pressure Gauge
④ Low Pressure Gauge
⑤ DA100 Hardware
⑥ Expansion Valve 1
⑦ Heat Exchanger 1
⑧ Heat Exchanger 2
⑨ Expansion Valve 2
⑩ Solenoid Vave
⑪ Sight glass
⑫ Filter drier
⑬ Receiver
⑭ 4 way valve
⑮ Liquid seperator

1-4. Control panel device component for Heat Pump



① Main Power
② DC 24V Power & Power Lamp
③ Select Switch & Toggle Switch
④ Buzzer & RL, GL, YL
⑤ Push Button
⑥ 8 Pin Relay
⑦ 11 Pin Relay
⑧ T.H.R
⑨ Magnetic Contactor
⑩ Timer
⑪ DC 24V Input
⑫ 36 Pin Connector
⑬ Temperature Indicator
⑭ Temperature Indicator & Controller
⑮ Comp Am, Vm
⑯ Pressure Switch

Chapter 2. Component of an Heat pump cooling & heating apparatus

1. Mechanical device component

(1) Compressor

※ Specification

- Model : P-12TN(ACC)
- 1/3HP
- Range : Medium, High temperature
- Eva Temp. : -25℃~10℃
- Motor Type : CSR
- Refrigerant : R-134a
- Single phase 220V, 50-60 Hz
- 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) Charging Nipple

The charging nipple is the requisite to use the manifold gauge for the airtight and vacuum tests and refrigerant filling and transferring of the standard refrigeration test equipment. It is attached to the low and high pressure ducts on the mechanical compressor output and input sides. Before soldering the charging nipple to the high and low pressure ducts on the compressor output and input sides, the internal rubber(for keeping the airtight state) ring is removed and set again after refrigeration.

(3) Liquid Receiver

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.

(4) 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.

(5) Solenoid Valve

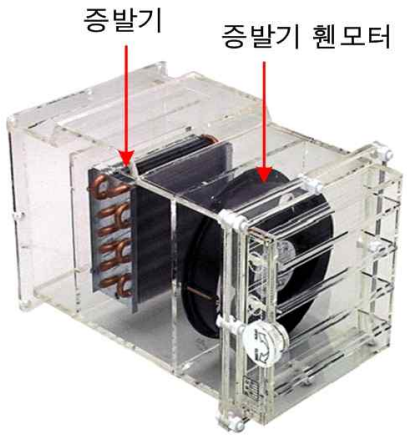
The electronic valve for main duct controls the refrigerant flow as it is opened or closed depending on the power input. It is connected to the temperature switch in series during the pump-down operation. In this case, the pump-down operation is processed by the opening or closing of the electronic valve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

(6) 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.

Manual Expansion Valve

(7) Heat Exchanger and Fan Motor



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).

(8) High Pressure Gauge

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

(9) Low Pressure Gauge

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

(10) 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.

(11) Liquid Separator

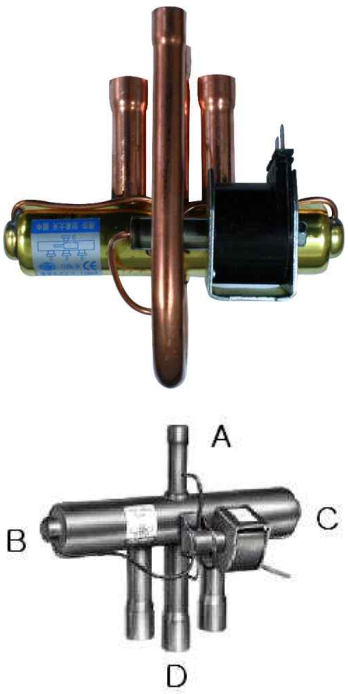
Accumulators have been used for years on original equipment. More recently they have been field installed. The significance with respect to accumulator and system performance has never been clarified. Engineers have been foreced to evaluate each model in terms of the system on which it is to be applied. 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.

(12) Check Valve

Some refrigeration systems are designed in which the refrigerant liquid or vapor flows to several components, but must never flow back through a given line. A check valve is needed in such installations. As its name implies, a check vavle checks or prevents the flow of refrigerant in one direction, while allowing free flow in the other direction. For example, two evaporators might be controlled by a single condensing system. In this case, a check valve should be placed in the line from the lower temperature evaporator to prevent the suction gas from the higher temperature evaporator from entering the lower temperature evaporator.

(13) 4-Way Valve

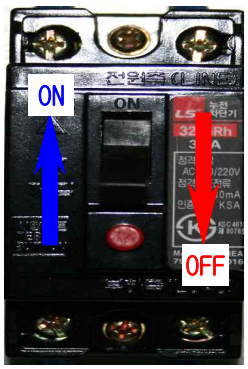


4way valve doesn‘t basically work when the pressure is not connected with high or low pressure. Surely Solenoid valves that control the direction work as signal, but real no there is any change direction inside its. In other words, its are designed to work under high or low pressure. as seeing the fig. its solenoid valves are connected with cross way A,B,C, and D. Inside 4way valve body there is a cab that has a size available to connect between line D and a line of right side or left, and designed to be shift right and left. Its principle is (In the fig. of 4way valve, A side is high pressure, D low.); when refrigeration cycle runs, if line A-B and line C-D opened by solenoid valve, line B becomes high pressure, line C Low, so that the given cab sticks to line C by different pressure. Then line A-B and C-D inside 4way valve become float line. On opposite way, when A & C, B & D are connected with each other, line A-C, B-D become float line, and then the flowing direction changes inside it.

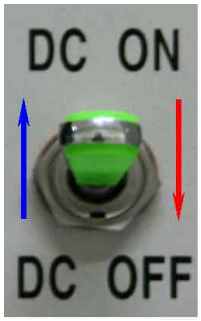
2. Automatic control device component

(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 and DC Ampere

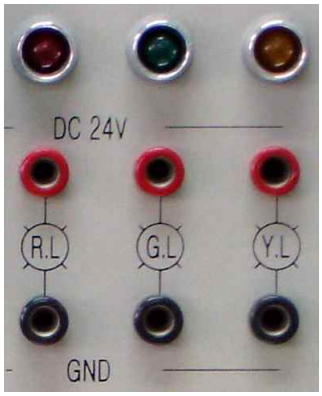
1. This device installed in equipment measures Voltage by DC.

2. This device installed in equipment measures current by DC.

(3) Buzzer

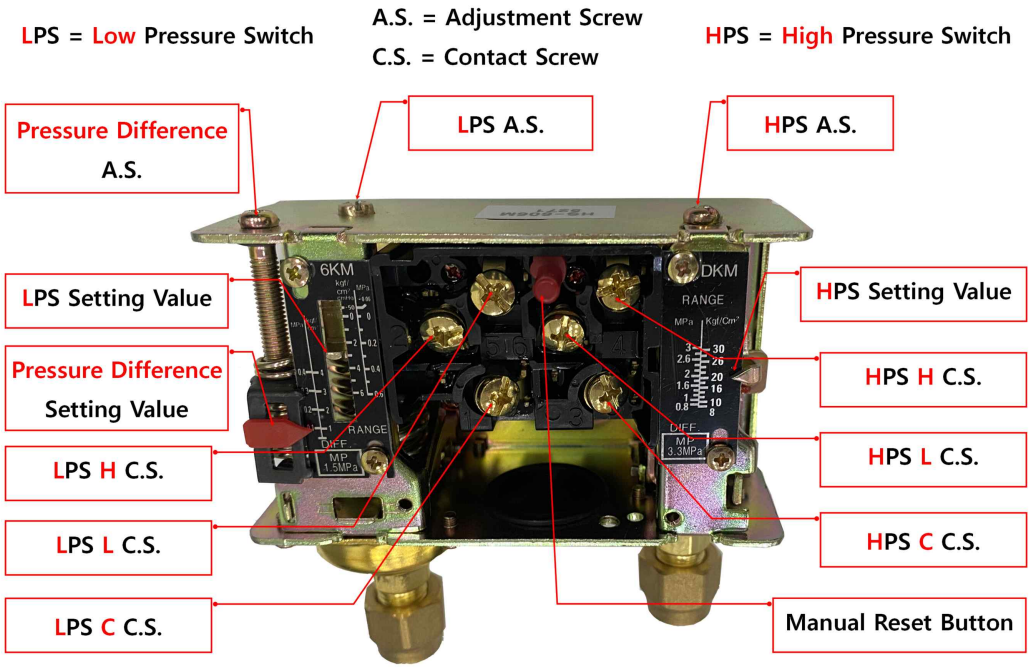
The buzzer and alarm lamp display the abnormal status when a thermal relay and safety devices(H.P.S) are working. That is, the alarm lamp is more effective than the buzzer in the noisy places and the buzzer is more effective than the alarm lamp for the color blind operators in the quiet working places.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

(4) 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.

(5) 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'.)

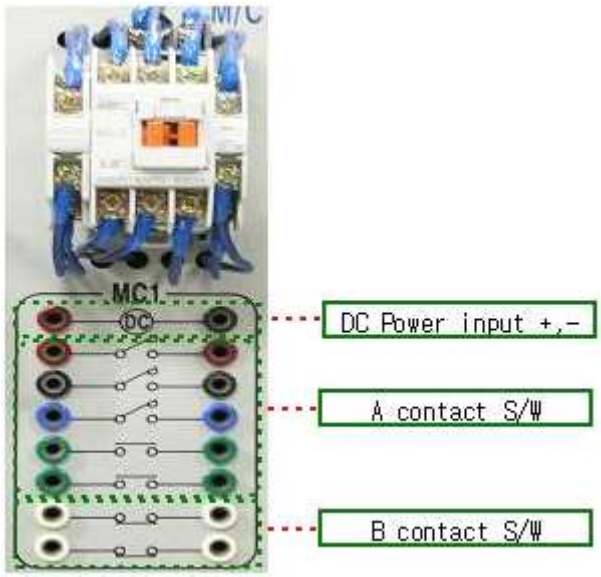
B. H.P.S High pressure control

Ⓐ 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.)

(6) Magnetic Contactor

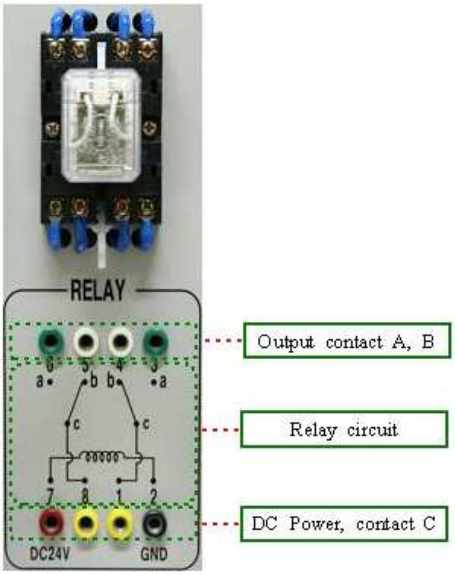


Magnetic contactor (MC) controls compressor motor, condenser motor, solenoid valve and evaporator motor through sequence circuit.

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.

(7) 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).

(8) 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.

(9) Temperature Indicator and Controller

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.

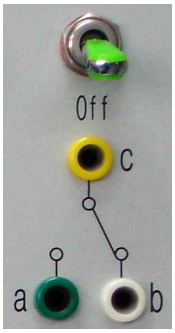
① Setting temperature value by push set button.
② Choose temperature value by push up or down button.
③ Setting deviation value.
④ Connect contactor 'com' and '+ '.
⑤ Connect contactor 'H' or 'L' and '+'.

(10) 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)

(11) Toggle Switch



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

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

(12) DC Power input

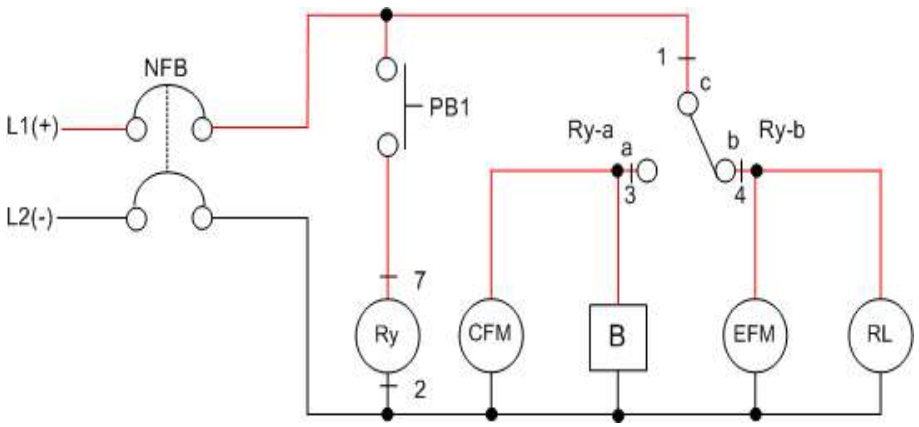
COMP : Compressor Motor
Heat ex1 : Heat Exchanger 1
Heat ex2 : Heat Exchanger 2
SV : Solenoid Valve
4-Way V/V : 4-Way Valve
Plug for electric circuit among each devices(Red plug +, Black - .)

Chapter 3. Construction and Operation as circuit

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
· 4-way reverse valve control heat pump training equipment (KTE-3000HD)	· 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 : Heat Exchanger 2
RL : Red Lamp
CFM : Heat Exchanger 1
PB : Push button

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.

・Check point

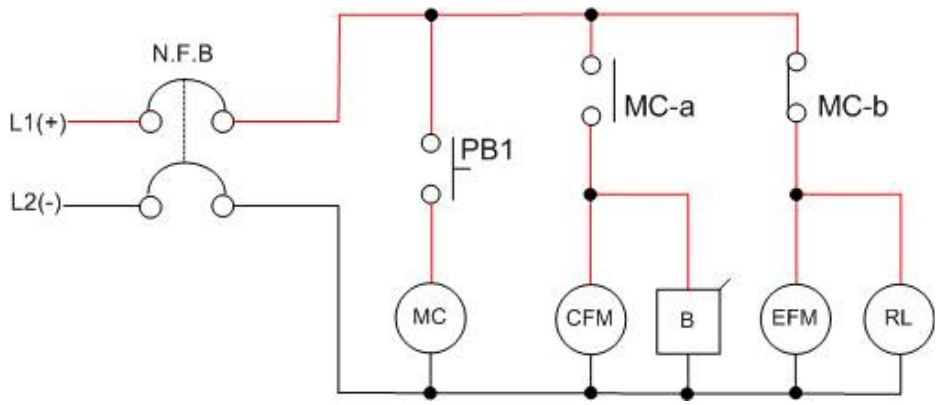
1. Checking tools and materials.
2 Practicing more 2 times through banana jacks using equipment(KTE-1000TP or KTE-1000BA), tools and materials.
3. Understanding construct and principal of MC.
4. Understanding the function of operating circuit.
   ① Explaining the running process when PB is pushed.
   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
· 4-way reverse valve control heat pump training equipment (KTE-3000HD)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

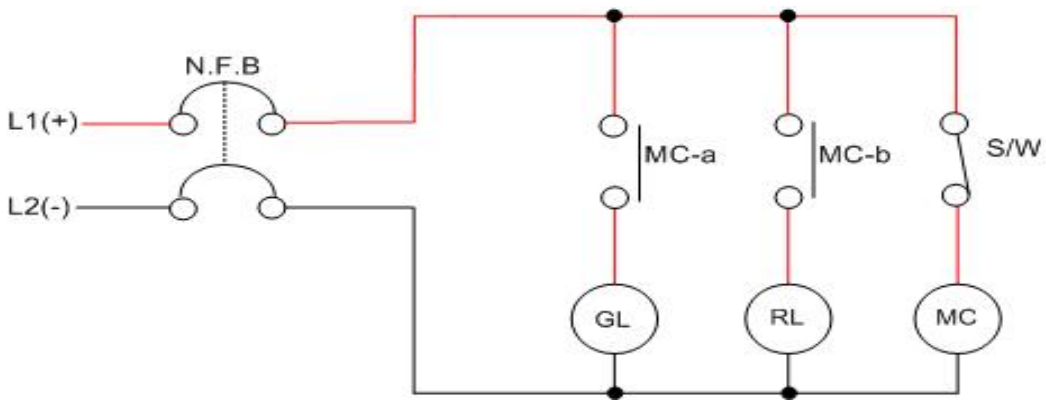
Control Circuit



L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
CFM : Heat Exchanger 1
EFM : Heat Exchanger 2
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"



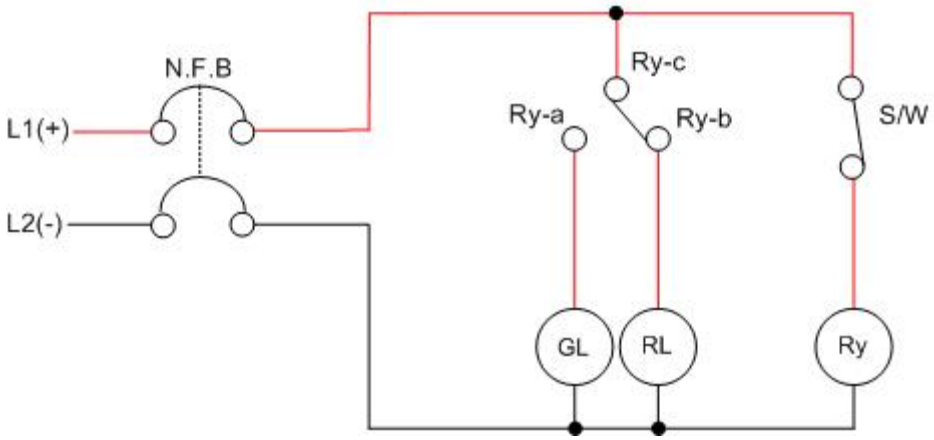
A. If NFB switch is on, MC-b contact is closed and RL is on , MC-a contact is opened and GL is off. (S/W opening state)

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".

・Check point

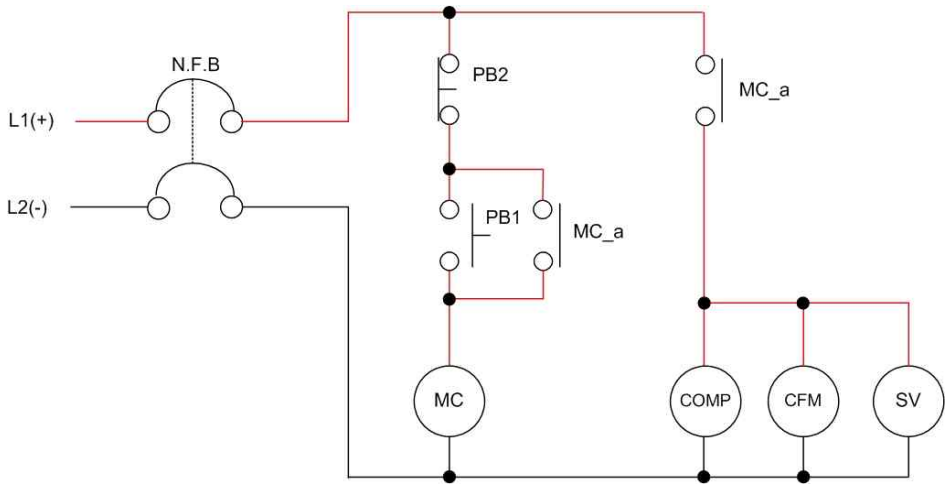
1. Checking tools and materials.
2 Practicing more 2 times through banana jacks using equipment(KTE-3000HD), tools and materials.
3. Understanding construct and principal of MC.
4. Understanding the function of operating circuit.
   ① Explaining the running process when PB is pushed.
   ② Explaining 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).

<table>
<tr><td rowspan="7">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="5"></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><td></td></tr>
</table>

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.	

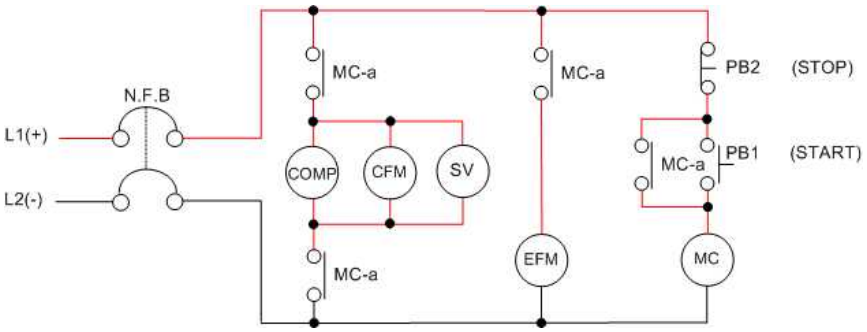
Experiment equipments	Tool & material	Spec of tools	Q'nty
· 4 way valve reverse valve control heat pump training equipment (KTE-3000HD)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit



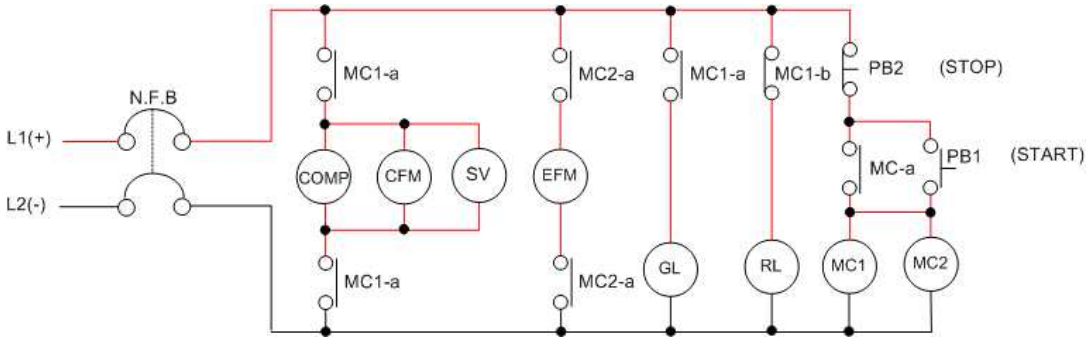
L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
MC : Magnet contactor coil
MC-a : MC "a" contact
CFM : Condenser Fan Motor
SV : Solenoid V/V
PB : Push button
COMP : Compressor motor

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.

・Check Point

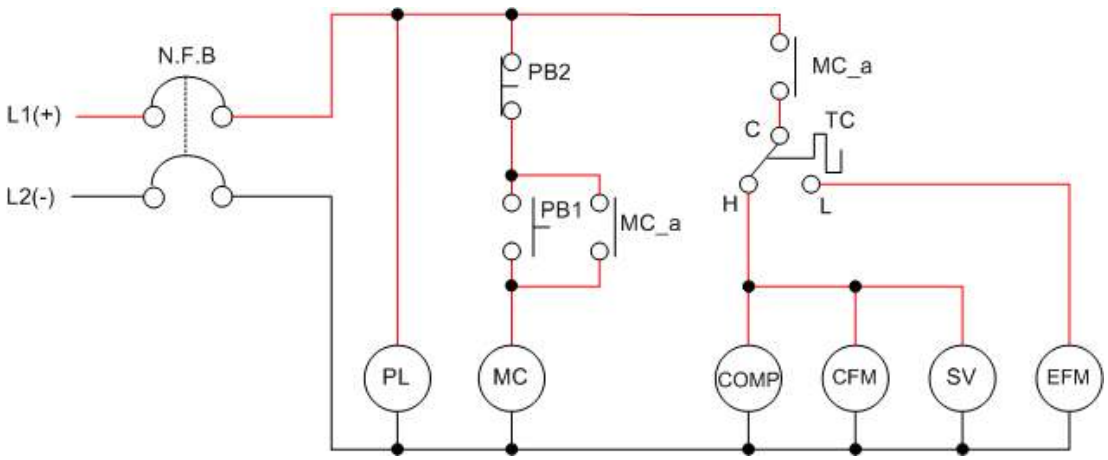
1. Checking tools and materials.
2. Configurating circuit of operation with banana jacks using tools and material.
3. Understanding the function of operating circuit.
   ① Explaining the process when NFB S/W is on.
   ② Explaining the process when PB1 is pushed.
   ③ Explaining the process when PB2 is 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.

<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="5"></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	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
· 4 way reverse valve control heat pump training equipment (KTE-3000HD)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

Control Circuit



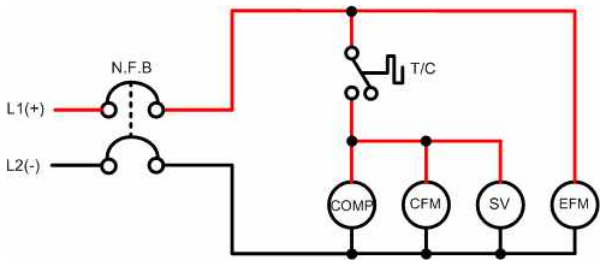
L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
PB : Push button
COMP : Compressor motor
MC-a : MC "a" contact
TC : Temperature control S/W
CFM : Heat Exchanger 1
SV : Solenoid V/V
MC : Magnet contactor coil
EFM : Heat Exchanger 2
PL : Power Lamp

distribution and variation of low temperature

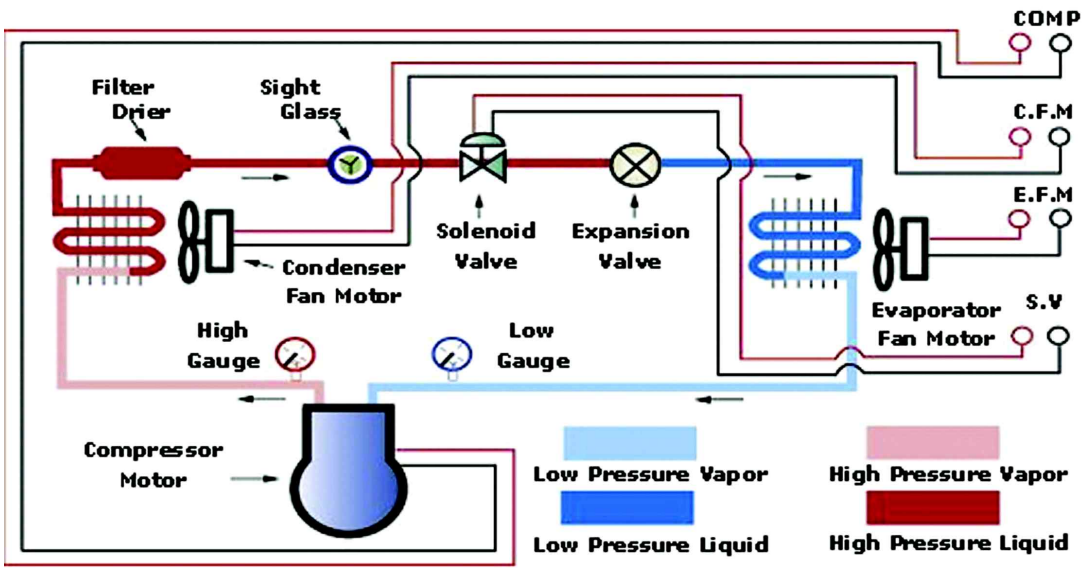
Test Steps	Temperature Setting	Temperature Deviation	In T	Out T	Actual Temperature	Adjustment
1	10	2				
2	9	2				
3	8	2				
4	7	3				
5	5	3				

[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

· Check Point

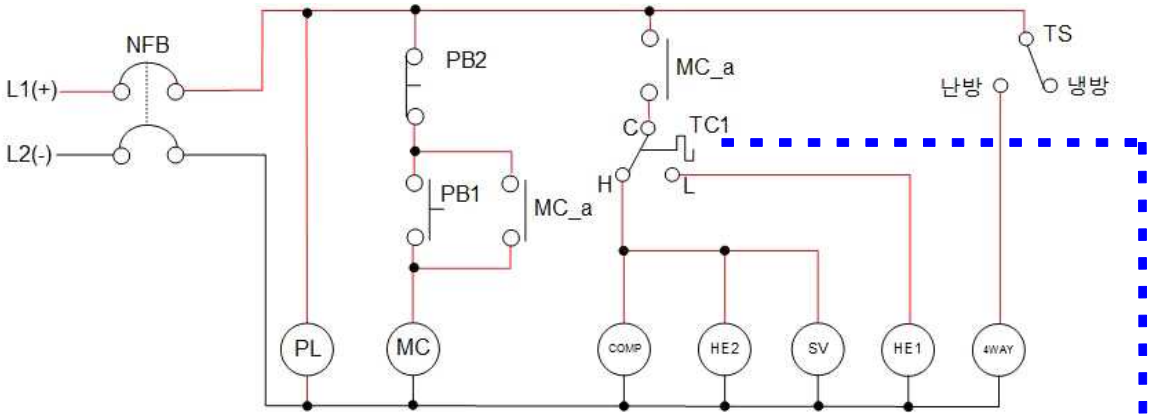
1. Checking tools and materials.
2. Configurating circuit of operation with banana jacks using tools and material.
3. Understanding the principal of temperature S/W as kinds of it, and setting the low temperature control value and explaining it.
4. Understanding the function of operating circuit.
   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

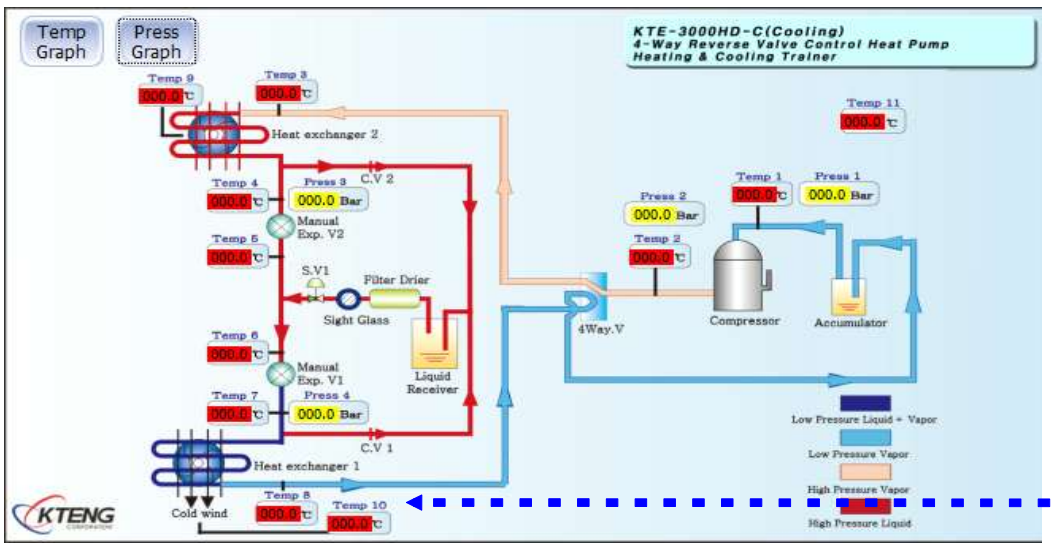
Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 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 temp configuration of temperature switch	Class time(hr)
		8
The object of experiment	① Adjusting principle of low-temp control of temperature switch. ② To configurate and operate circuit for low pressure control and understand.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· 4 way reverse valve control heat pump training equipment (KTE-3000HD)	· 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
COMP1 : compressor 1
MC-a : magnetic contact "a

CFM : Condenser fan motor
SV1 : solenoid valve 1
EFM : Evaporator fan motor
TC1 : Cascade1 output temp switch

No.	Temp	offset	In Temp	Out Temp	real temp	remarks
1	10	2				
2	8	2				
3	5	2				
4	0	3				
5	-2	3				

Temp setting → Cut Out Point reaches → Condensing Unit stop → Temp Cut In Point → Condensig Unit re-operate

On/Off operating in range of set temperature and diff(offset) range.

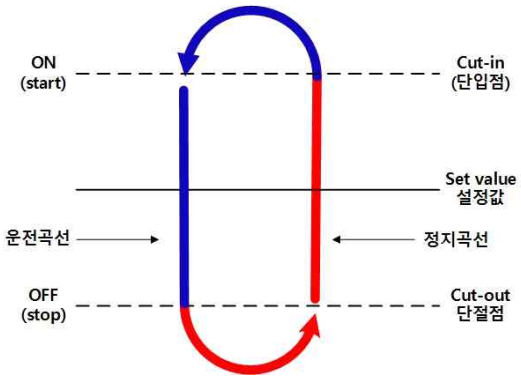
CUT-IN (stop → run) point = temp setting + offset

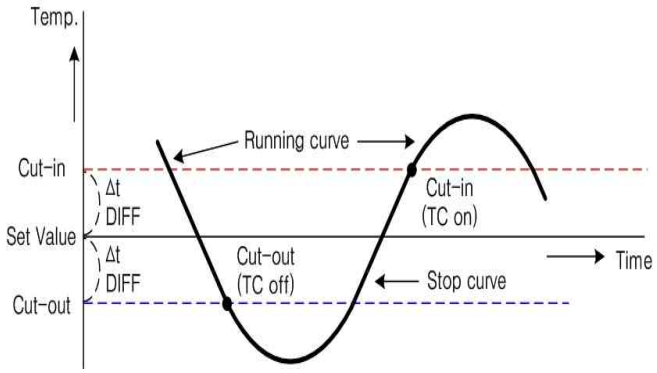
CUT-OUT (stop → run) point = temp setting - offset

ex) Temp set 2℃, offset 3℃,

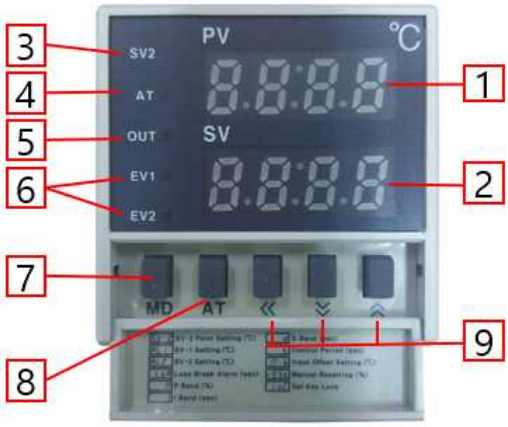
CUT-IN point 2 + 3 = 5[℃] , CUT-OUT point 2 - 3 = -1[℃].

* Temp control run/stop diagram





2.Temperature controller setting

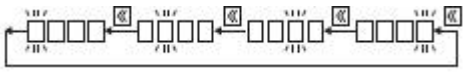


① PV: Measurement display (red)
Displays measured value.
Displays configuration subject in configuration mode.
② SV: Configuration value display (green)
Displays adjusting value.
Displays configuration subject in configuration mode.
③ SV2: SV2 on lamp
④ AT: auto-tuning on lamp
⑤ OUT: output on lamp
⑥ EV1,2: EVENT output display lamp
⑦ MD key: mode key
Press button for 3sec
⑧ AT key: Auto-tuning run key
⑨ ∧ ∨ 《: adjustment key

* Method

① Press 《 key to change value during operation.

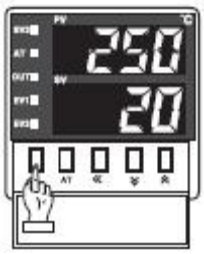
② Press 《 key to adjust other numbers.



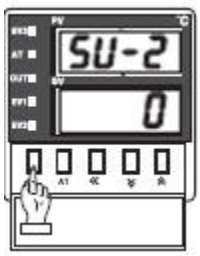
③ Press ∧∨ key to alter each value.

④ Press MD after adjustment.

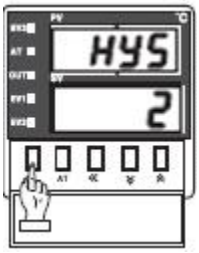
* Offset



① Press MD key for 3 sec during operation.



② Check SU-2 on display on PV and press MD 9 times until HYS appears.

 ③ Use ∧∨ key to adjust offset value (basic: 2℃). Can be adjusted between 1~100℃.	 ④ Press MD to return to operation mode.

※ Caution: Offset [Configuration value ± offset/2] can be varied between operation range.

ex) Configuration temp: 10 , Offset: 4 , In case of low temp control: starting at 10 + 2 = 12 [℃], stopping at 10 - 2 = 8 [℃]

· Check Point

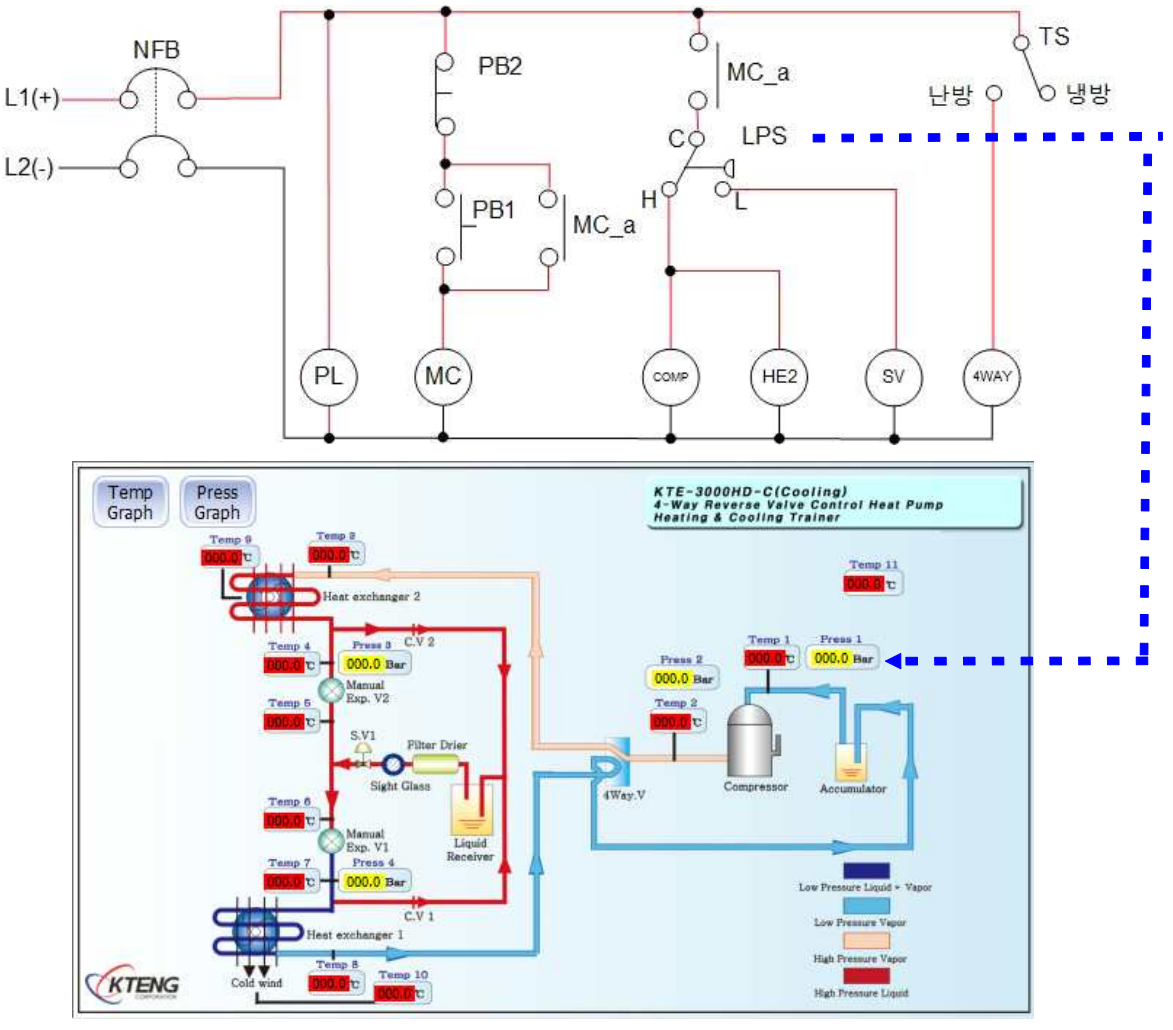
1. Checking tools and materials.
2. Setting the difference as the valves of LPS and explaining the operation principal of it .
3. Configurating circuit of operation with banana jacks using tools and material.
4. Understanding the function of operating circuit.
   ① Explaining the progress when PB1 is 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

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. Practicing pressure configuration of pressure switch	Class time(hr)
		8
The object of experiment	① Understanding principle of control system of low-pressure switch (LPS) ② To configurate and operate circuit for low pressure control and understand.	

Experiment equipments	Tool & material	Spec of tools	Q'nty
· 4 way reverse valve control heat pump training equipment (KTE-3000HD)	· 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 breaker
COMP1 : 1st stage comp
PB : push button
CFM : Condenser fan motor
SV1 : Solenoid valve 1
LPS : Low-pressure switch
MC : Magnetic contact

No.	Cut in P	D.P	Cut out P	Pressure gauge	Remarks
1	3	2	1		
2	3	1	2		
3	4	2	2		

Operating refrigeration on/off cycle upon configurations below.

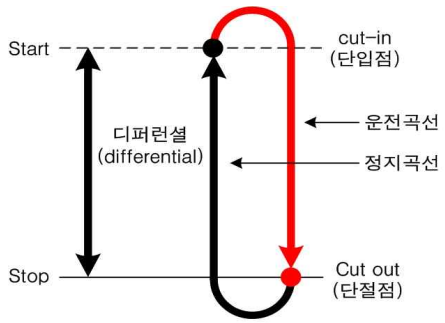
CUT-IN (stop → run) POINT = configuration pressure

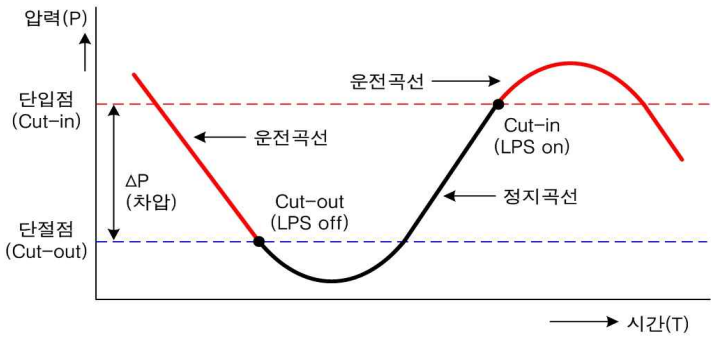
CUT-OUT (run → stop) POINT = configuration pressure - offset

ex) configuration pressure 5, offset 3 [bar]

CUT-IN point 5 = 5[bar] , CUT-OUT point 5 - 3 = 2[bar]

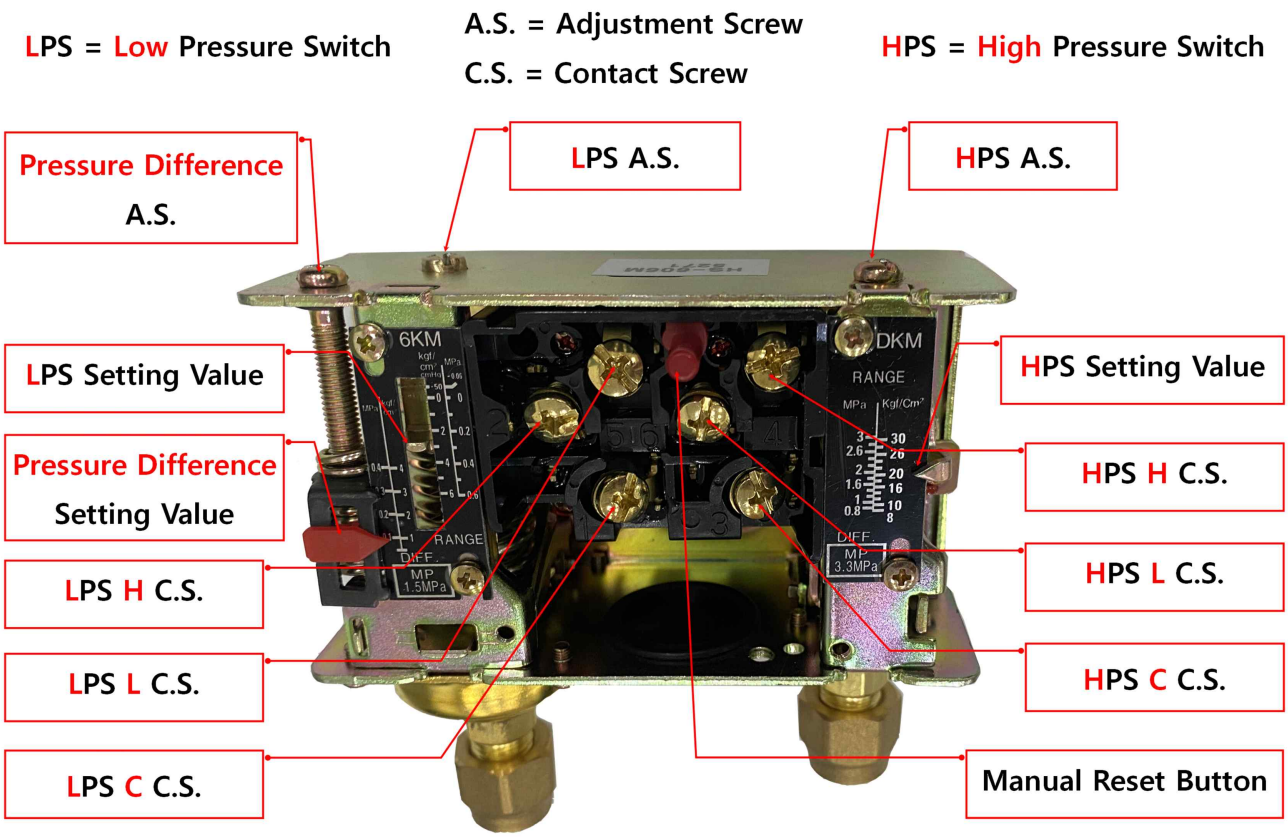
* LPS run/stop curve





2. LPS setting

* Dual Pressure Switch (DPS)



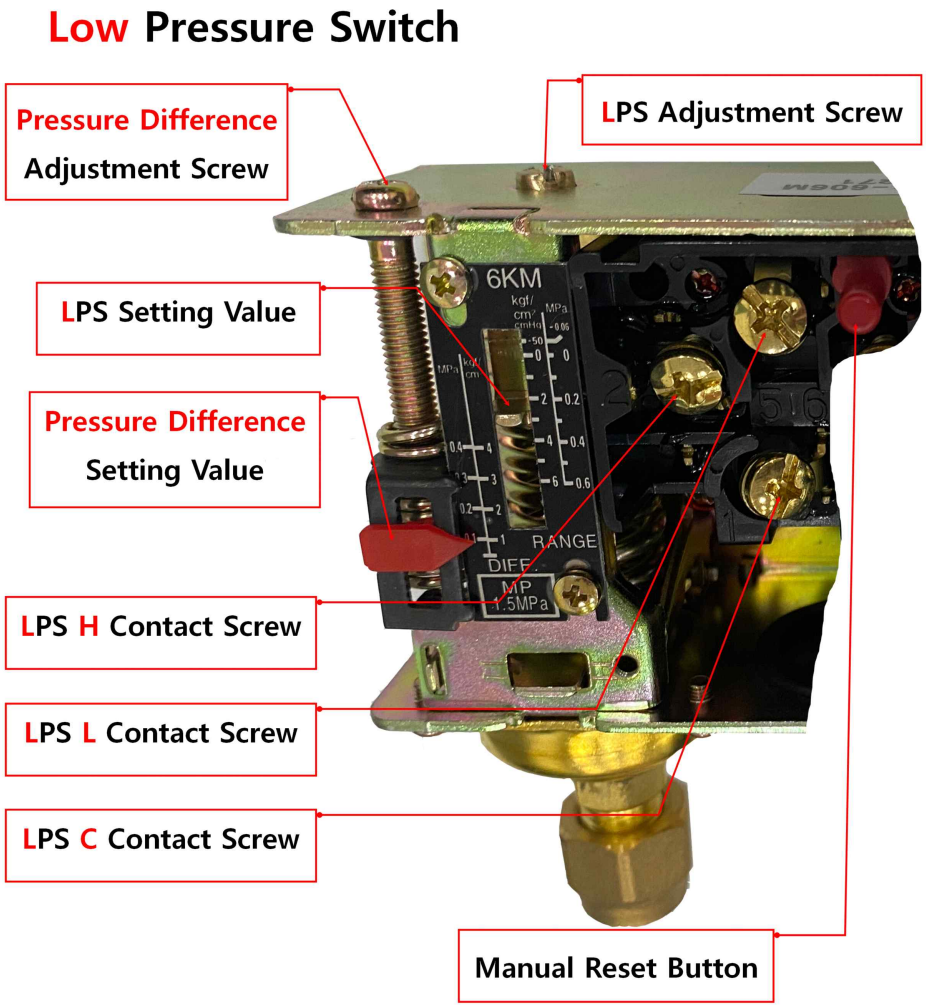
DPS is a multi purpose switch which contains both low-high pressure swtiches.
DPS consist of lever, contact adjust screw and run/stop compressor upon refrigerant pressure.

1) Structure

Referring the figure above, LPS is located below cover of DPS and High Pressure Switch (HPS) is located next to itself. There are 3 contacts each which is ' C' below the LPS, ' A' above, ' H' , and ' L' (B contact) on the upper side.
LPS contains pressure up/down adjust screw and HPS has manual return structure which lack of down pressure switch.

High/low pressure switch protects the equipment by opening/closing L,H contact upon high/low pressure configuration during equipment operation.

1) L.P.S. method



Right gradation: Low pressure (RANGE)

Left gradation: offset(DIFF)

① Adjust low pressure by turning the screw clockwise/anti-clockwise with screw driver(+)

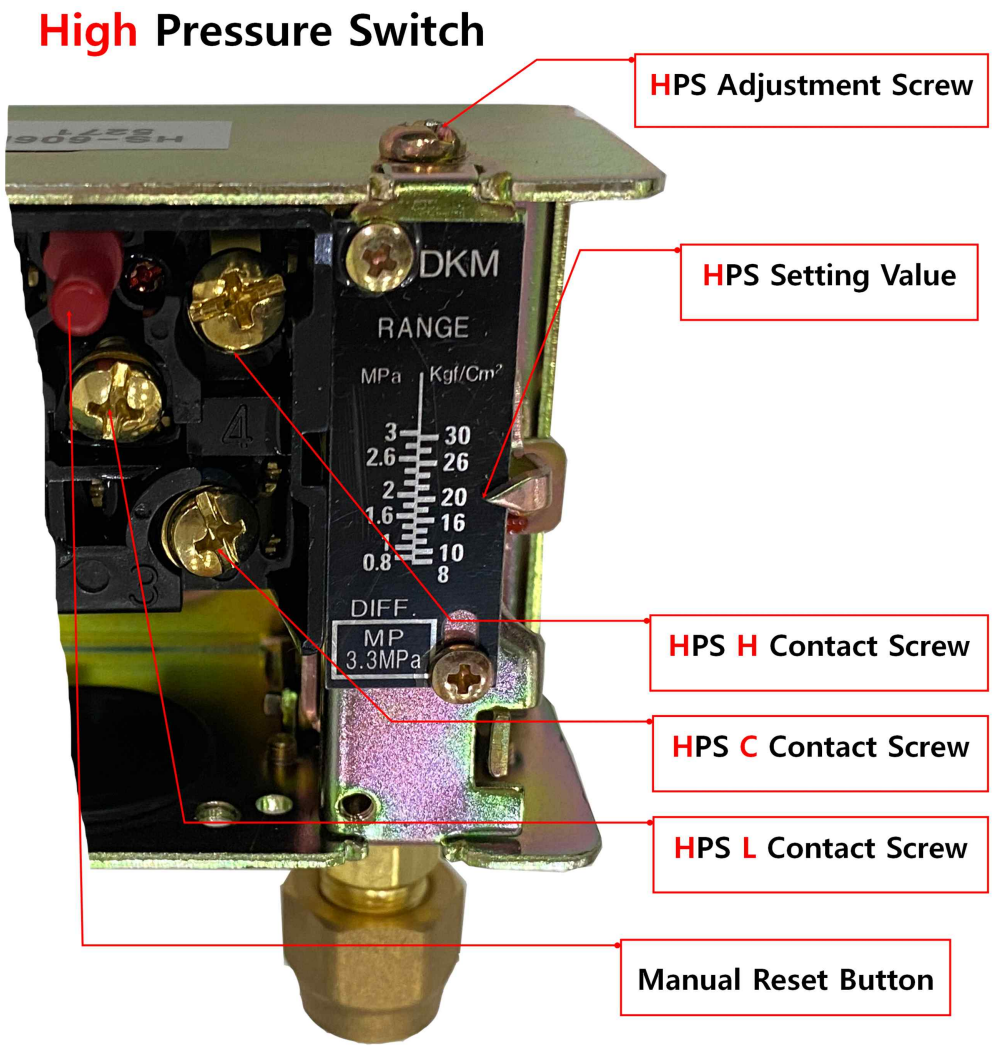
② Also adjust offset by turning the screw clockwise/anti-clockwise with screw driver(+)

③ Apply (+) power on com port and connect to certain port upon configuration (L or H) then connect other side of the cable to Comp (red port) next to DC power input.

④ LPS-L Line OUT (connect to COM -> L line port when pressure drops below configuration pressure)

⑤ LPS-H Line OUT (connect to COM -> H line port when pressure reaches up to configuration pressure)

2) H.P.S. method

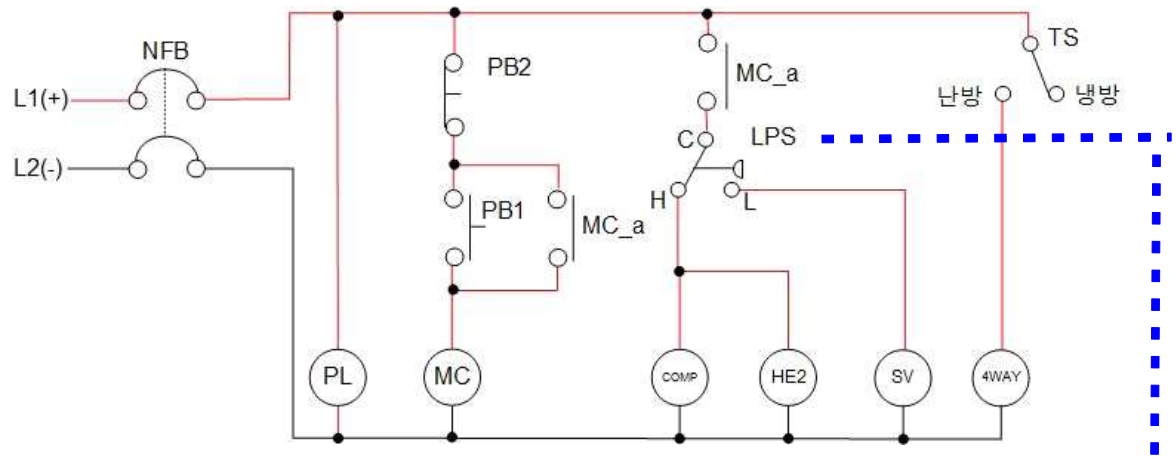


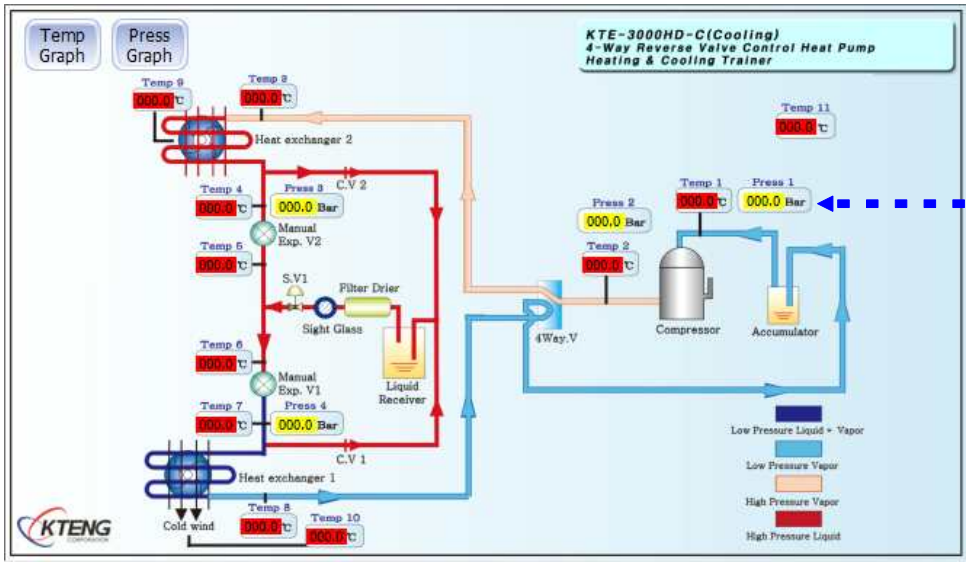
⑥ Adjust high pressure by turning the screw clockwise/anti-clockwise with screw driver(+)

⑦ HPS-L Line OUT (connect to COM -> L line port when pressure drops below configuration pressure)

⑧ HPS-H Line OUT (connect to COM -> H line port when pressure reaches up to configuration pressure, manual return by reset)

Experiment name	6. Practicing pressure configuration of pressure switch	Class time(hr)
		8





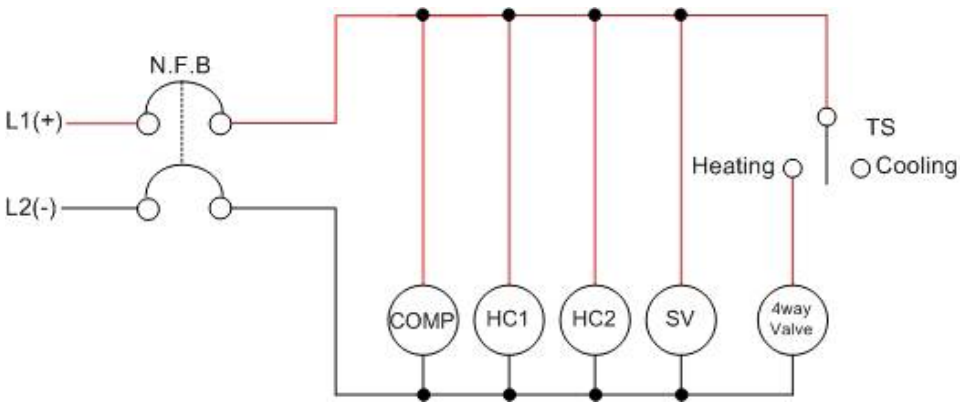
Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark
	Work (Point 70))	Circuit configuration using banana jack	20		
		Circuit configuration using real wire	20		
		Configuration state	10		
		Understand and description for circuit	20		
	Task (Point 10)	Task attitude 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 circuit reversing refrigerant flow direction for "heat pump refrigeration system" and operation.	Class time(hr)
		8
The object of experiment	① To understand the principal of reversing refrigerant flow direction using 4-way V/V. ② To configurate manual control circuit of the system. ③ To understand the principal of cooling operation and heating operation of the system and operate reversing each system.	

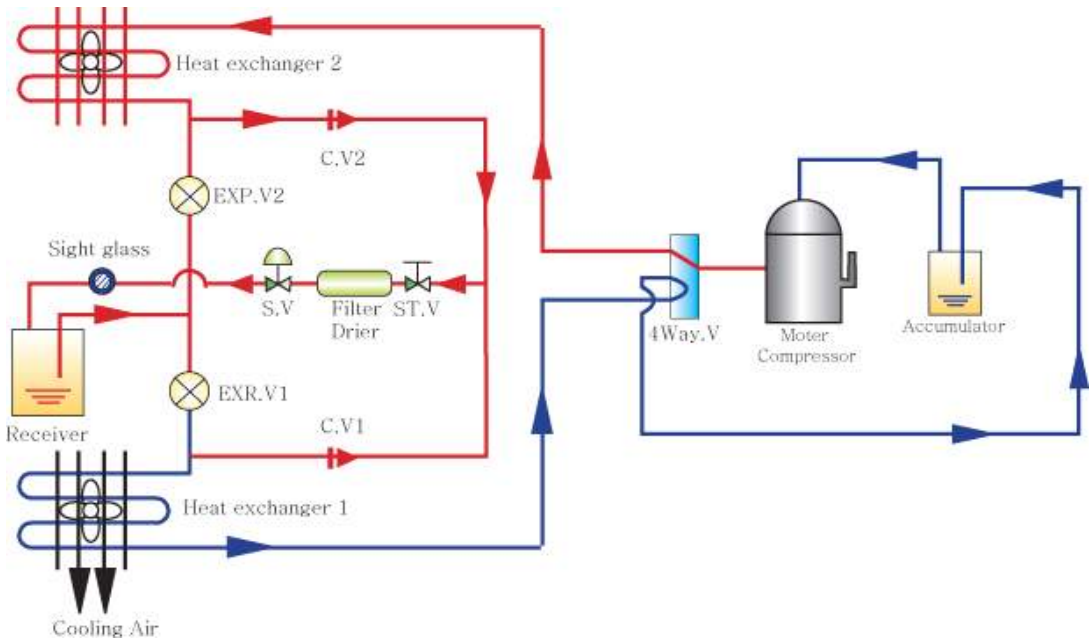
Experiment equipments	Tool & material	Spec of tools	Q'nty
· 4-ways reverse V/V heat pump trainer(KTE-3000HD)	· Driver · Nipper · Wire Stripper · Hook meter	· #2× 6 × 175mm · 150mm · 0.5~6mm^2 · 300A 600V	1 1 1 1/Group

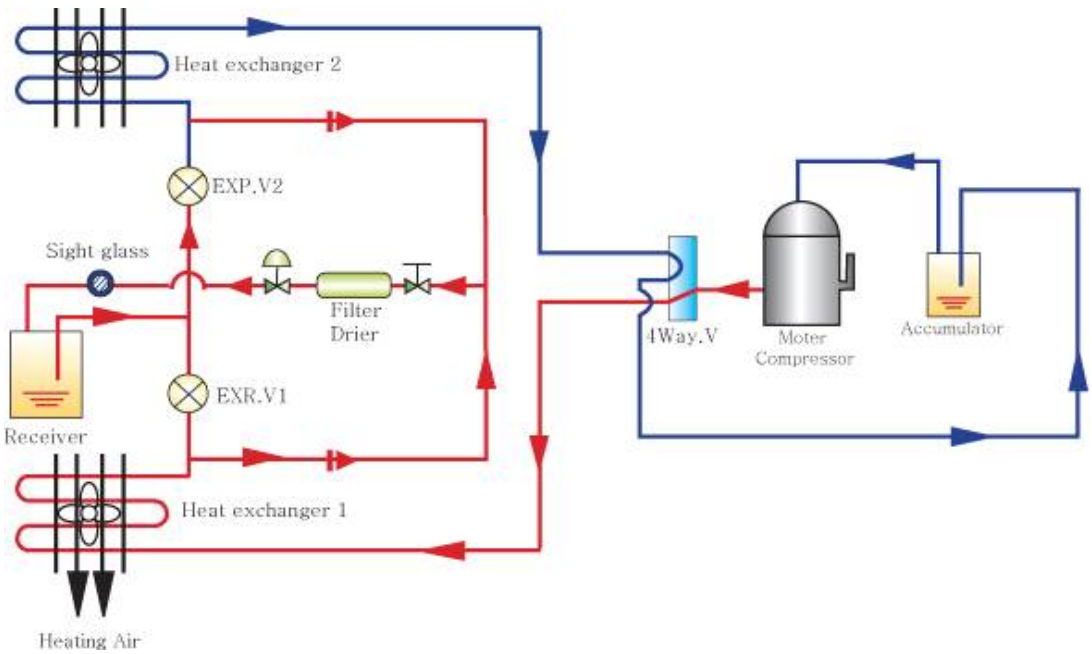
Control Circuit



L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
HC1 : 1 Heat Exchanger Fan Motor
HC2 : 2 Heat Exchanger Fan Motor
SV : Solenoid V/V
4way valve : Reversing V/V
TS : Toggle S/W
COMP : Compressor Motor

[Related Theory]





COMP : Compressor Motor
HC1 : Heat Exchanger1
HC2 : Heat Exchanger2
S.V : Solenoid Valve
4-Way.V : 4-Way Reversing Valve

· Check Point

1. Set a heat pump using 4-ways reversing V/V cooling, heating refrigeration trainer, and check electric state and refrigerant charging state.
2. Understand the function of operating circuit.
   ① Explain the progress that refrigerator starts when NFB is on.
   ② Explain the principal of heating cycle comparing with cooling cycle when TS(Toggle S/W) reverses.
   ③ Explain the principal of cooling cycle comparing with heating cycle when TS(Toggle S/W) reverses.
3. Explain the function of 4-ways reversing V/V.
4. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
5. Configurate circuit using real wires(KTE-4000SQ) and operate using banana jacks with experiment equipments, tools and materials.

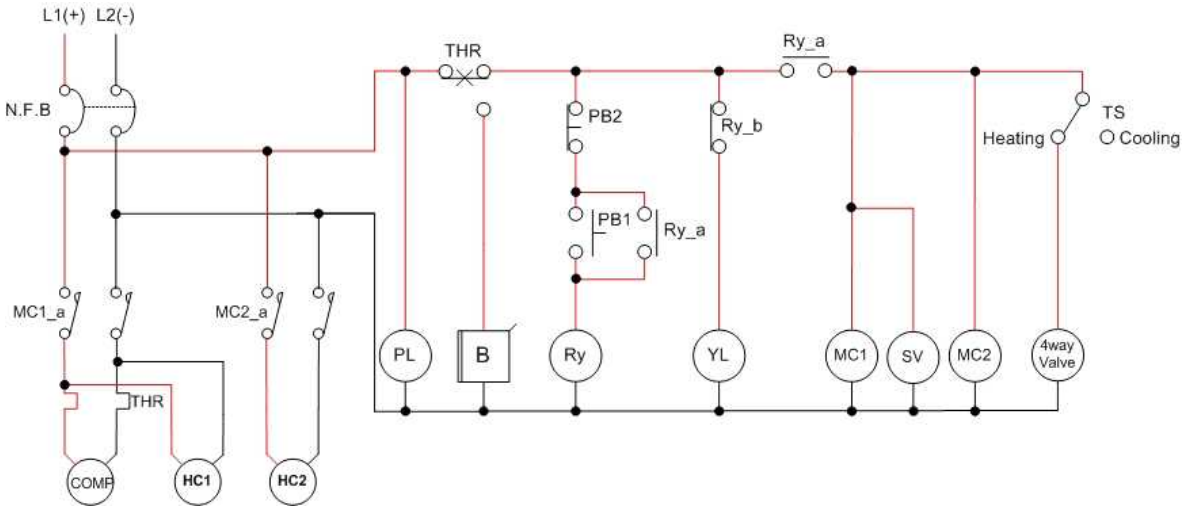
Relationship between technical description rating items and task	Appraisal		Allot	Point	Remark			
	Work (Point 70))	Circuit configuration using banana jack	20					
		Circuit configuration using real wire	20					
		Configuration state	10					
		Understand and description for circuit	20					
	Task (Point 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 manual control circuit for "cooling and heating heat pump refrigeration system" and operation.	Class time(hr)
		8

The object of experiment	① To explain and understand the motion of manual control circuit for "cooling and heating heat pump refrigeration system". ② To configurate self-holding circuit for "cooling and heating heat pump refrigeration system using 4-ways reversing V/V". ③ To make wiring self-holding circuit for "cooling and heating heat pump refrigeration syste musing 4-ways reversing V/V".

Experiment equipments	Tool & material	Spec of tools	Q'nty
· 4-ways reverse V/V heat pump trainer(KTE-3000HD)	· 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-a : MC "a" contact
THR : Thermal Relay
COMP : Compressor Motor
YL : Yellow Lamp

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
TS : Toggle S/W
4way valve : reversing V/V
HC1 : 1 Heat Exchanger Fan Motor
HC2 : 3 Heat Exchanger Fan Motor
PL : Power Lamp

・Check Point

1. Set a heat pump using 4-ways reversing V/V cooling, heating refrigeration trainer, and check electric state and refrigerant charging state.
2. Understand the function of operating circuit.
   ① Explain the progress when PB1 is pushed.
   ② Explain the process of heating operation when TS is reversed to heating operation during the system running.
   ③ Explain the process of cooling operation when TS is reversed to cooling operation during the system running.
   ④ Explain the progress that refrigerator starts when PB_2 is pushed.
3. Configurate circuit using banana jacks and operate using banana jacks with experiment equipments, tools and materials.
4. Configurate circuit using real wires(KTE-4000SQ) and operate using banana jacks with experiment equipments, tools and materials.

<table>
<tr><td rowspan="7">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="5"></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>

4. Experimental

4-1. Install and how to use KTE-DA100

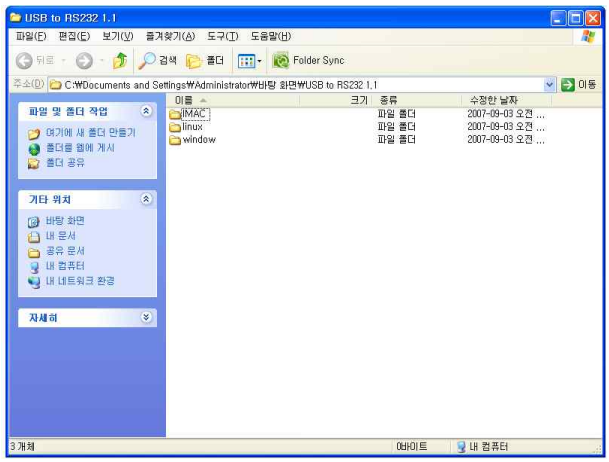
(1) INSTALL USB TO SERIAL

- Communication method is using cmputer and RS232 protocol for communication
- If you got a desktop which is connected with Serial Port back, you don't have to install USB TO Serial.
- If you got a desktop which doesn't have notebook or Serial Port, you need to install progress for collecting data using USB Port.

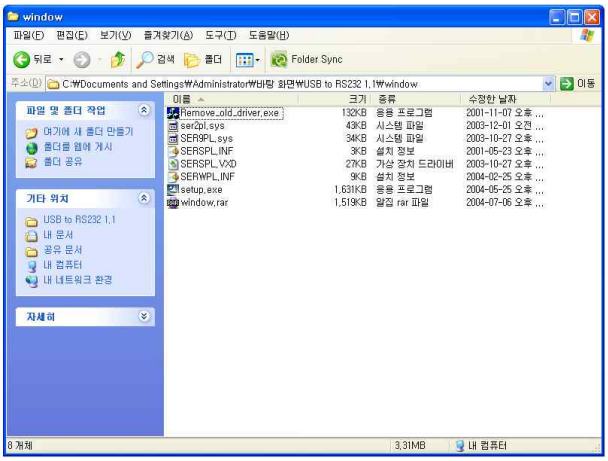
① Put Install CD into CD-ROM.

② After reading "CD-ROM DIRECTORY", Following screen is indicated.

③ Double click window folder in this screen.



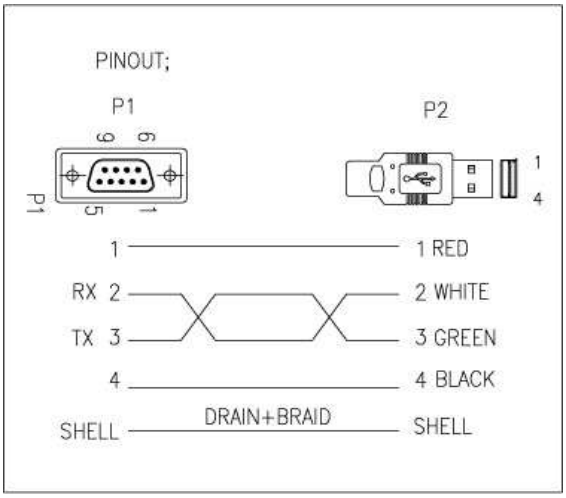
④ Go into window folder following file is indicated, In here, operate Setup.exe whici is installation file.



⑤ Click "Next" then it goes to install.

⑥ After installing, next screen is indicated.

⑦ USB TO SERIAL PORT wiring diagram.

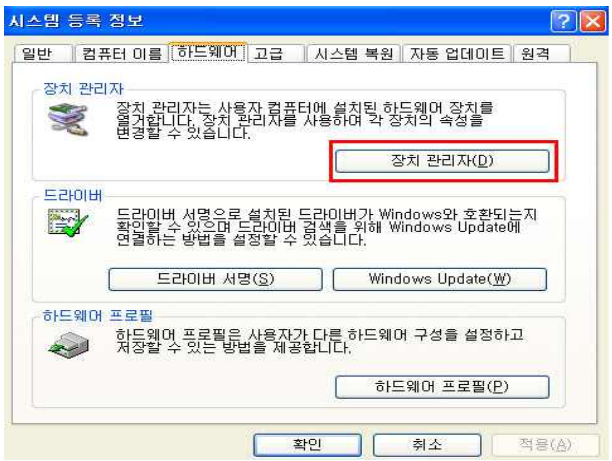


⑧ Method to set Communication Port

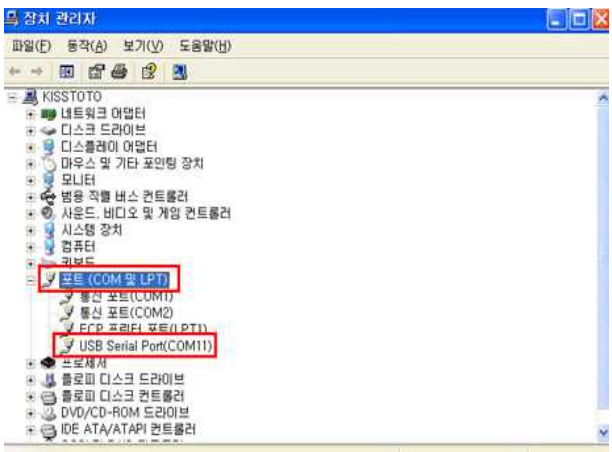
Click "Strat"// Option// into Control Panel.

Double click "System" in Control Panel.

⑨ Click "Hardware tap".

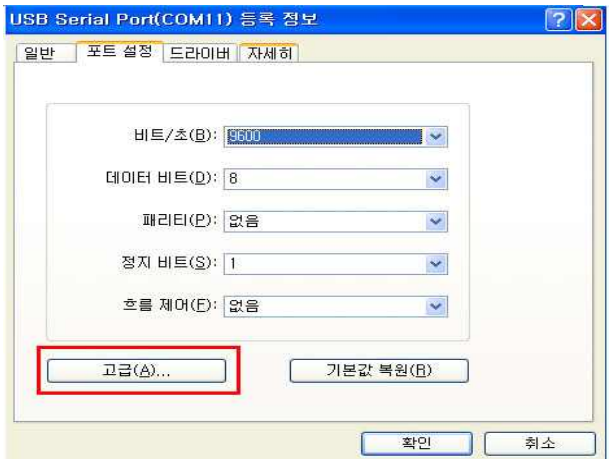


⑩ Click "Device Administrator".



⑪ When you click like picture, emege USB SERIAL PORT. After Mouse right click "USB SERIAL PORT" and click "Attribute".

⑫ Click "Port option".

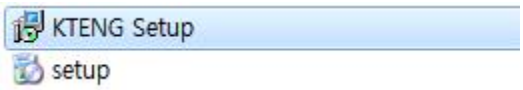


⑬ Click "High rank".

⑭ After setting appropriately to port for user equipment, Click OK.

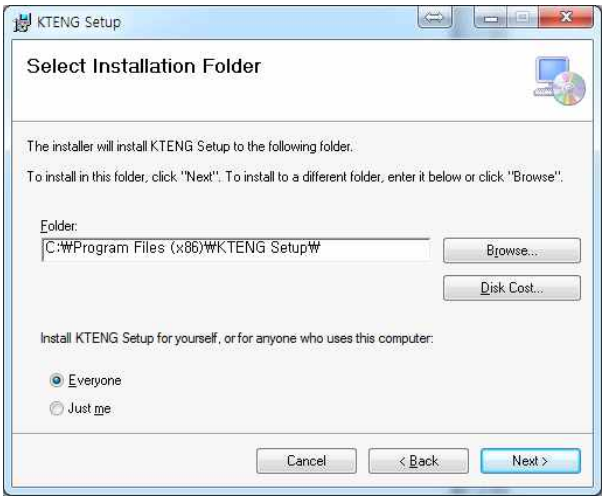
(2) KTE-DA100 Installation and Operating

1) KTE-DA100 Installation

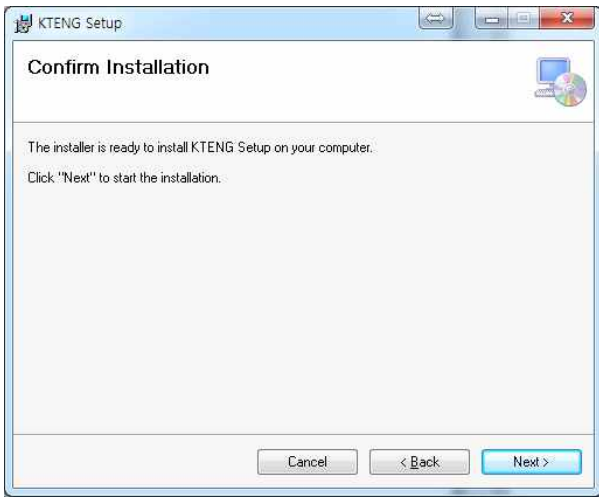


① You can see a installation files that in CD or USB for installation then double click 'KTENG Setup' file to start installation. If the program cannot be installed using 'KTENG Setup', try to 'setup'file.

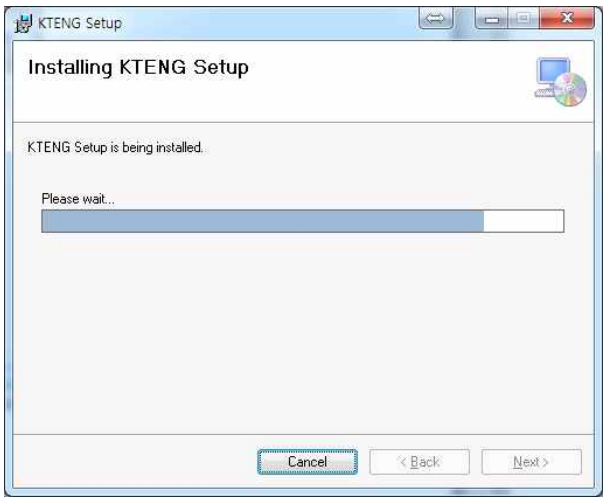
② If you can see a 'Setup Wizard' screen, click the 'Next>'.



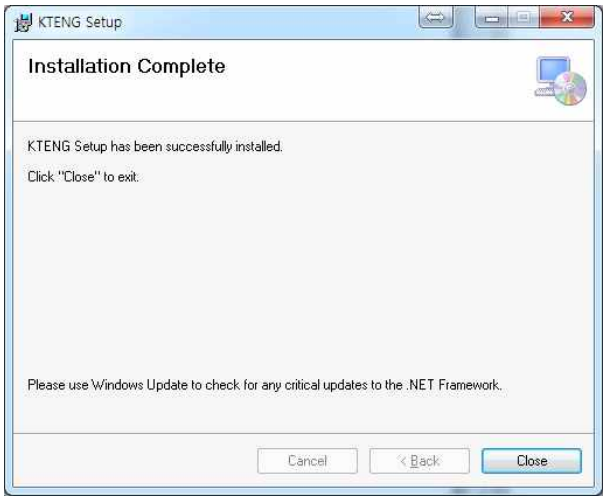
③ You can change a installation route. If you want to change a installation route, click the 'Browse..' and find a new route then click the 'Next>'.



④ It require to confirm installation intention. Please click the‘Next>’.

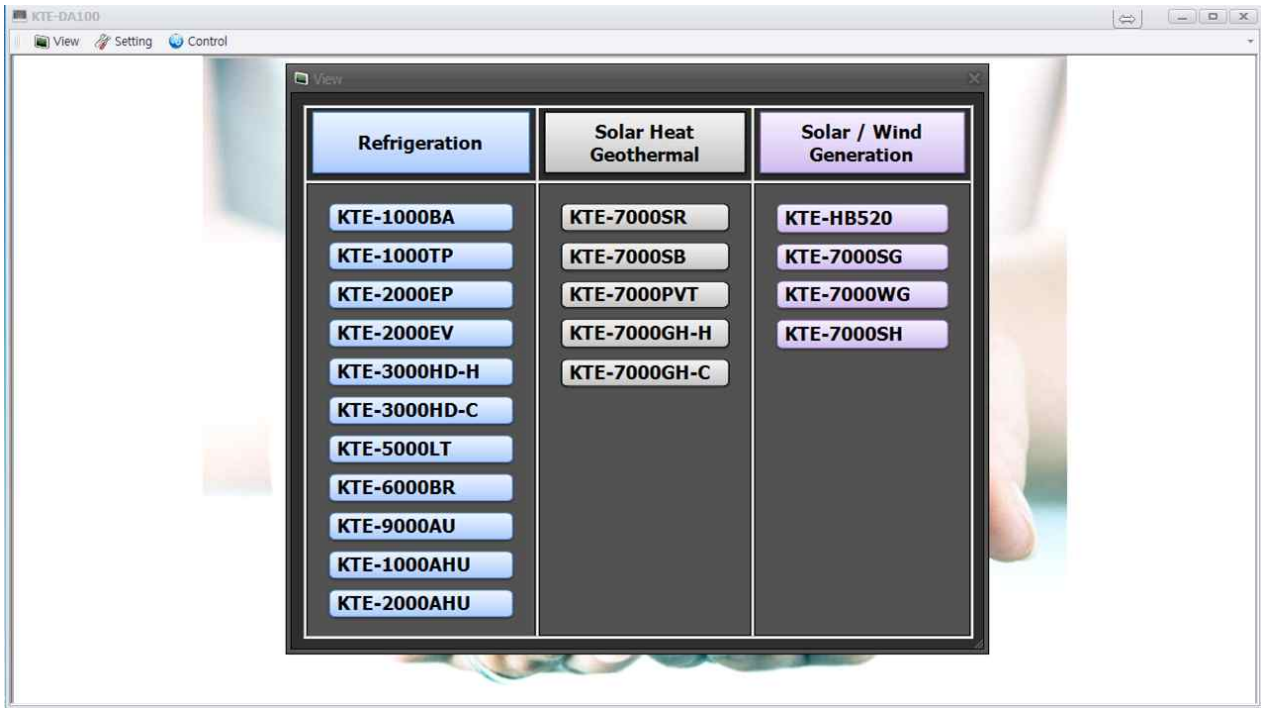


⑤ Installing a program.



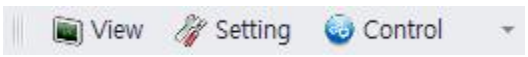
⑥ Please click the ‘Close’ and complete a installation.

⑤ Start program by using icon in wallpaper or routing folder then the main page of program come up.

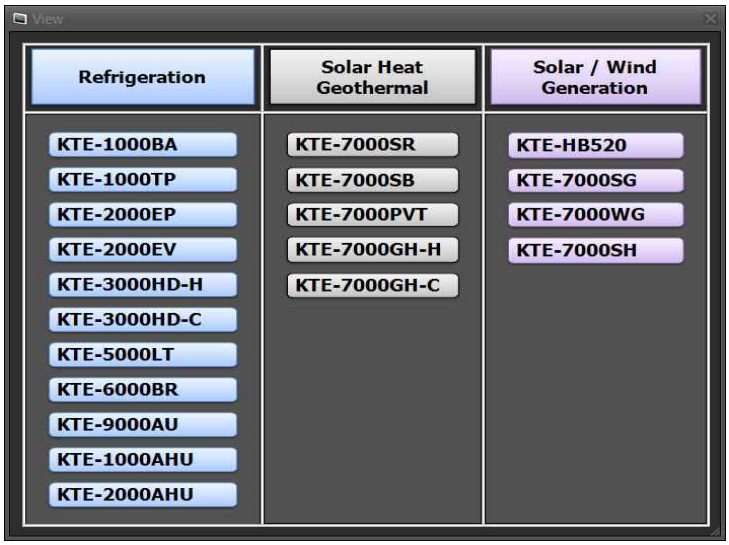


KTE-1000BA	Standard Refrigeration Experimental Equipment	KTE-7000SR	Solar Radiation Energy Experimental Equipment
KTE-2000EP	Evaporation Pressure Parallel Control Experimental Equipment	KTE-7000SB	Solar Heating Hot Water Boiler Experimental Equipment
KTE-2000EV	Refrigerant Parallel Expansion Valve Experimental Equipment	KTE-7000PVT	PVT Performance Measuring Equipment
KTE-3000HD-H	4-Way Reverse Valve Control Heat Pump Experimental Equipment (Heating Mode)	KTE-7000GH-H	Geothermal Heat Pump Experimenatl Equipment (Heating Mode)
KTE-3000HD-C	4-Way Reverse Valve Control Heat Pump Experimental Equipment (Cooling Mode)	KTE-7000GH-C	Geothermal Heat Pump Experimenatl Equipment (Cooling Mode)
KTE-5000LT	Binary Refrigeration Experimental Equipment	KTE-HB520	Hybrid Power Conversion Experimental Equipment
KTE-6000BR	Brine Refrigeration Experimental Equipment	KTE-7000SG	Solar Power Generation Experimental Equipment
KTE-9000AU	Car Air-Conditioner Experimental Equipment	KTE-7000WG	Wind Power Generation Experimental Equipment
KTE-1000AHU	Air-Conditioning Unit Automatic Control Equipment	KTE-7000SH	Solar-hydrogen Fuel Cell Experimental Equipment
KTE-2000AHU	Air Handing Unit Lab-view Programing Equipment		

2) Main Menu Composition

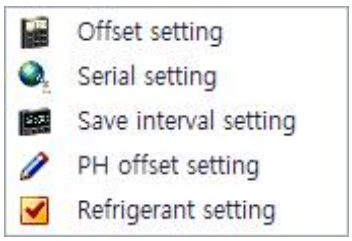


① View

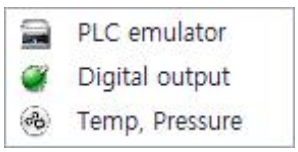


(Refrigeration 11 species, Solar-Geothermal 5 species, Solar-Wind energy 4 species)

② Setting



③ Control



(2) Setting

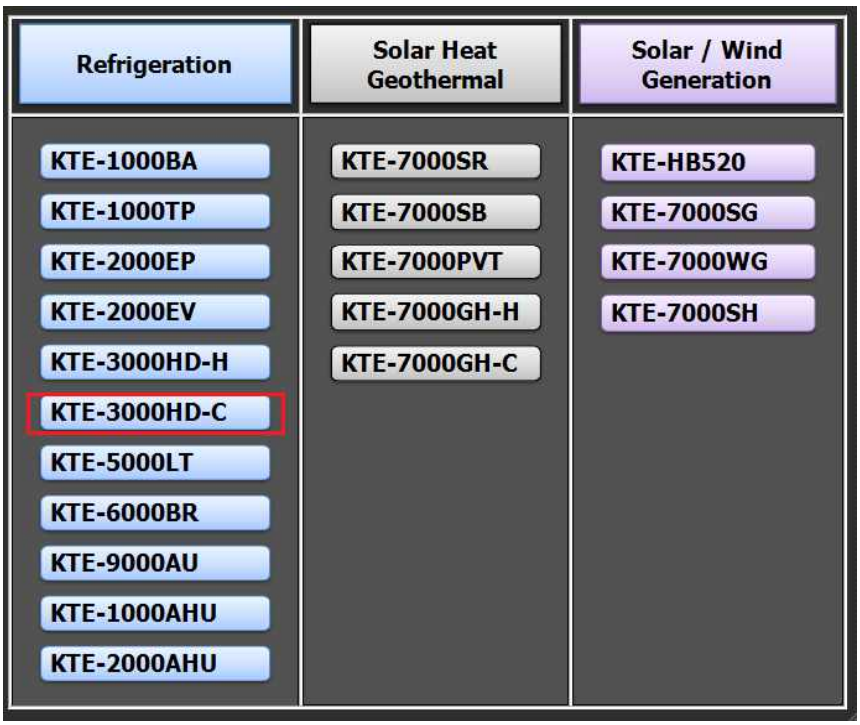
Menu	Explain
Offset Setting	Setting initial pressure, temperature
Serial Setting	Communicating port setting
Save Interval Setting	Setting data acquisition time interval
PH Offset Setting	Setting range of axis at p-h chart
Refrigerant Setting	Select refrigerants

(3) Control

Menu	Explain
PLC emulator	Using PLC control
Digital output	Control a Hardware
Temp, pressure	Control a temperature, pressure

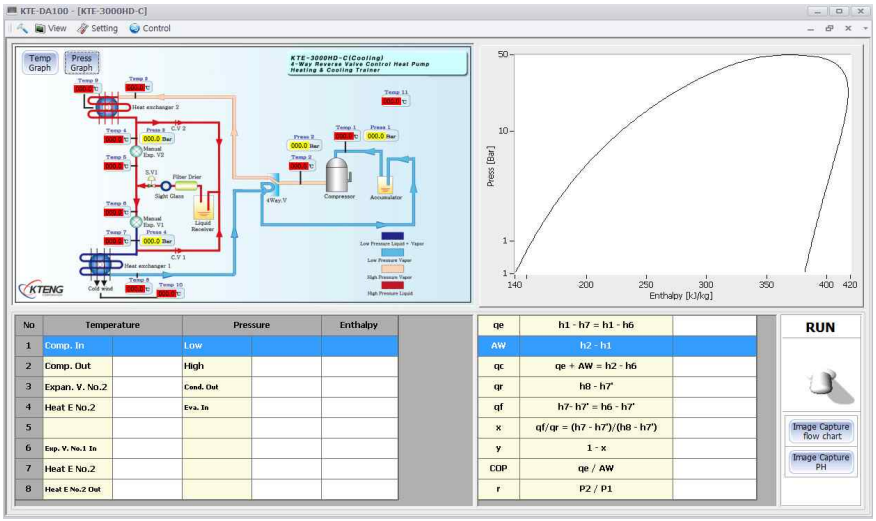
(4) Application of data acquisition equipment(Model : KTE-DA100)

1) Selection of Model



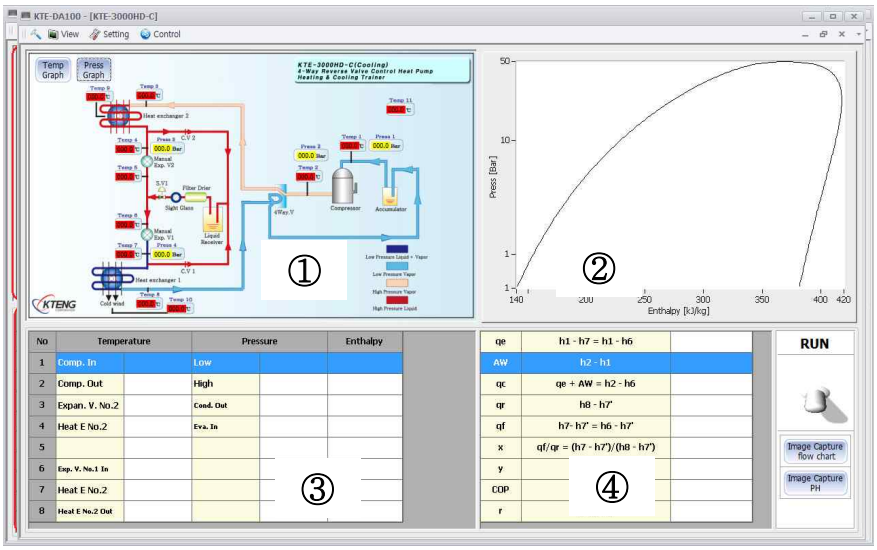
① When program started, 'View' screen is activated.

② Select a model what you want.
(Click the KTE-3000HD-C)



③ Main user interface of KTE-3000HD
(4-Way Reverse Valve Control Heat Pump Heating & Cooling Training Equipment) is activated.

i) Composition of main user interface



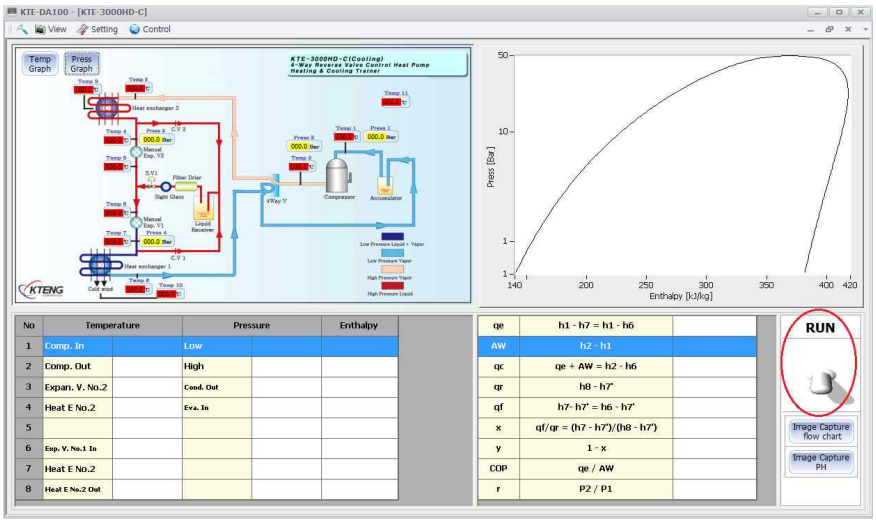
① Schematic diagram of system show temp., press., (in realtime.)

② p-h chart.

③ Data table of temp., press. and enthalpy.

④ Calculation value of COP, cooling capacity, heat capacity in HX.

ii) Operating and saving data

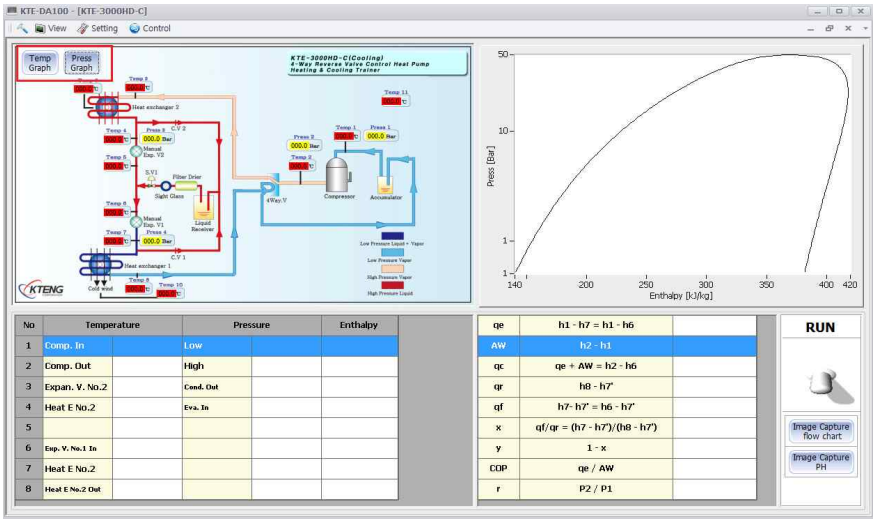


① Click a toggle switch to run program to save data.

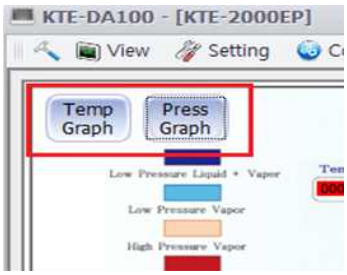
② Write a title and save a file by excel.

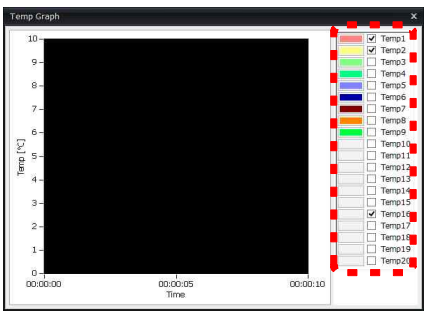
※ The reason of writing title first is that can save data even though unavoidable situation happened.

iii) Find a graph

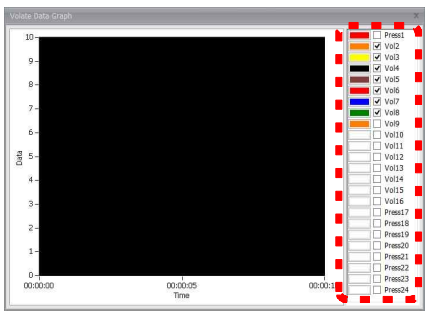


① If you want to see a temp., and press, graphically, please click a icon in red box below.



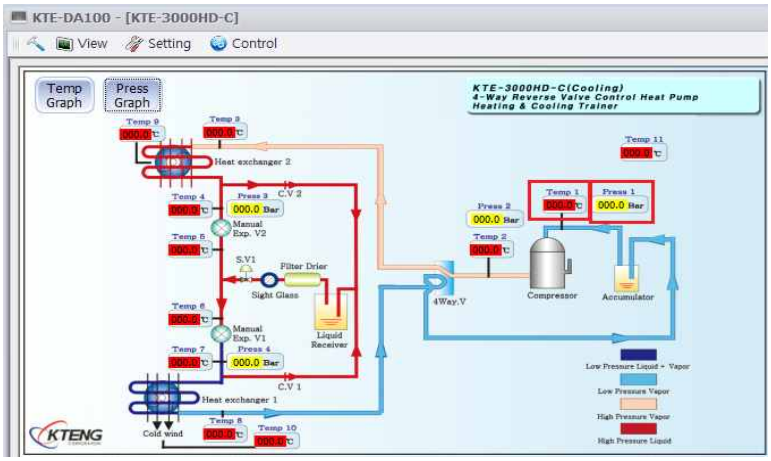


Temperature Realtime Graph

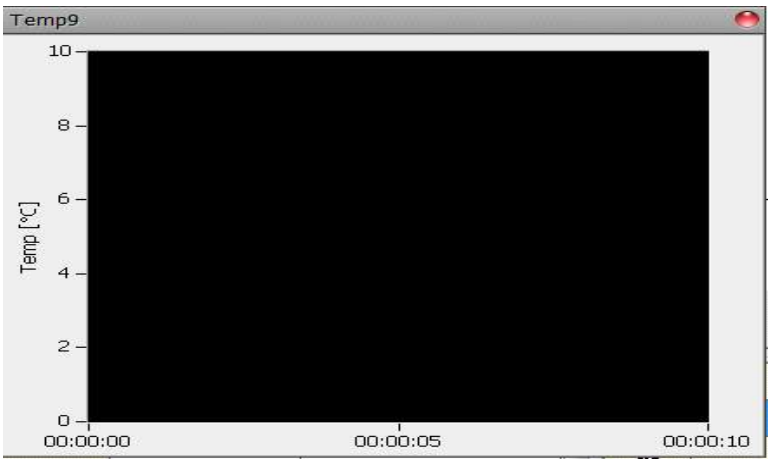


Pressure Realtime Graph

② You can always see the graph for location and figure through checking temperature, pressure

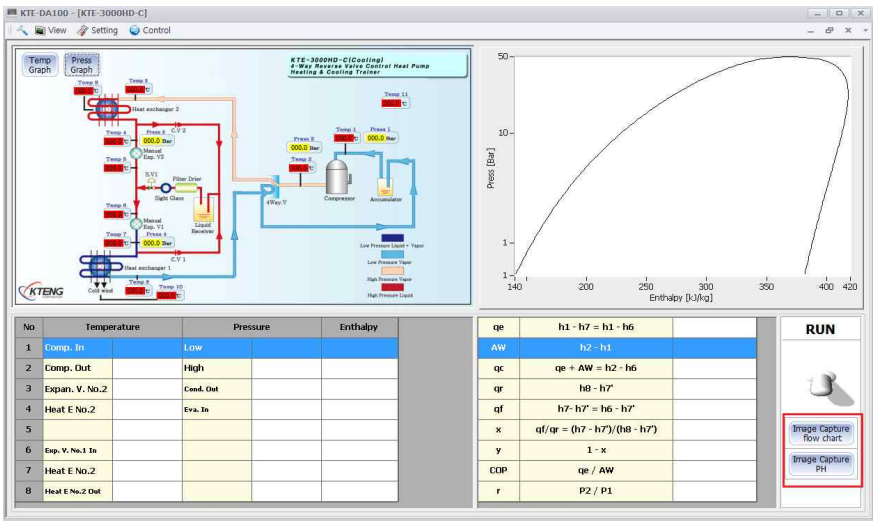


③ Seeing the graph for individual temperature and pressure is that double click display of monitor then indicate the graph window as below



④ You can always check the temperature in real time.

iv) Function for capture



① The bottom of the right side, click Image Capture flow chart and Image Capture PH then it is saved to JPG files

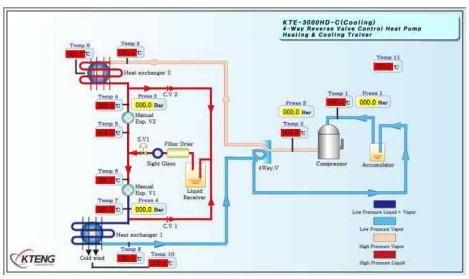
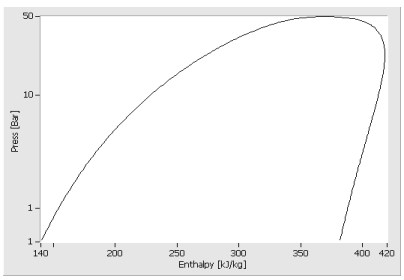


Diagram capture(Flow Chart)

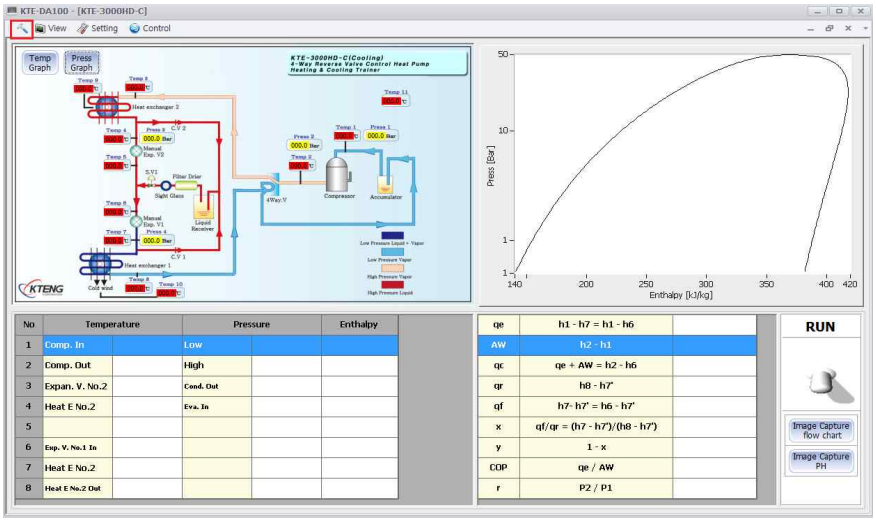


Ph graph capture

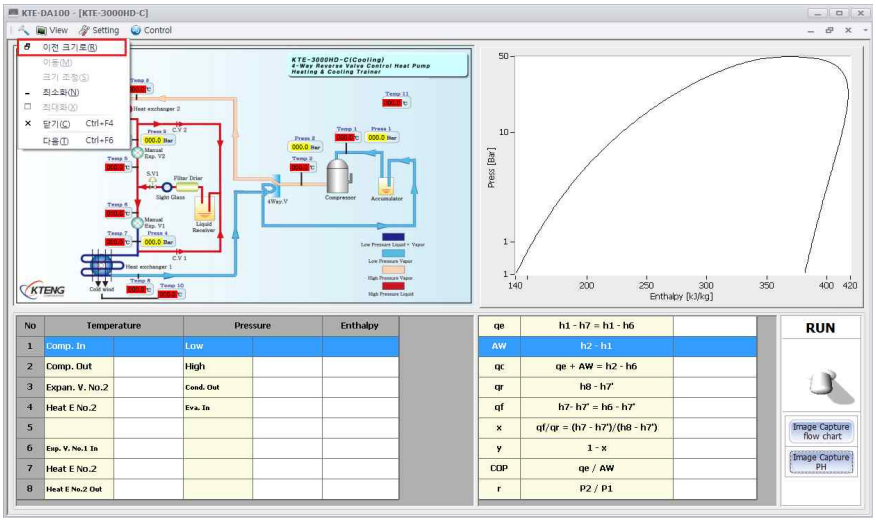
② Monitor when choosing -Diagram(FlowChart) capture - Ph graph capture

2) Function for collecting data tools

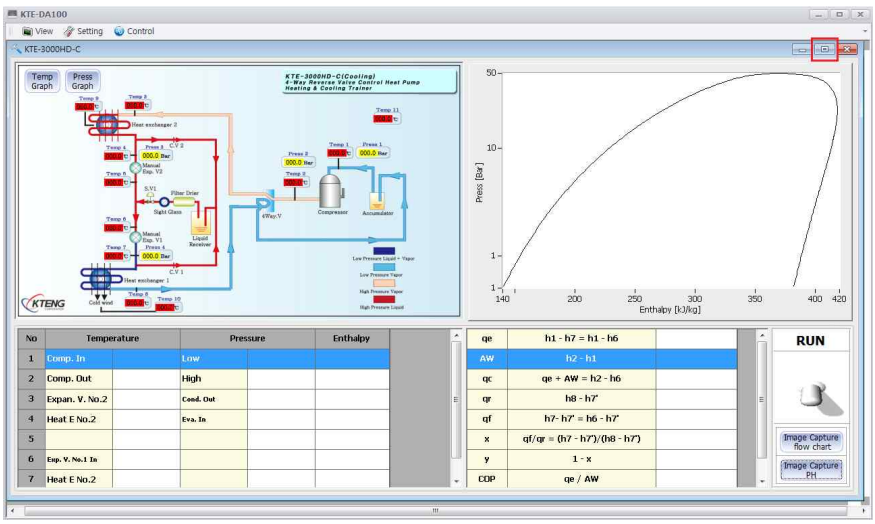
i) Tools



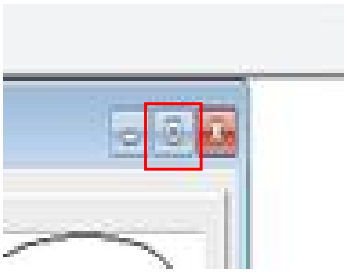
① Click  in Tools

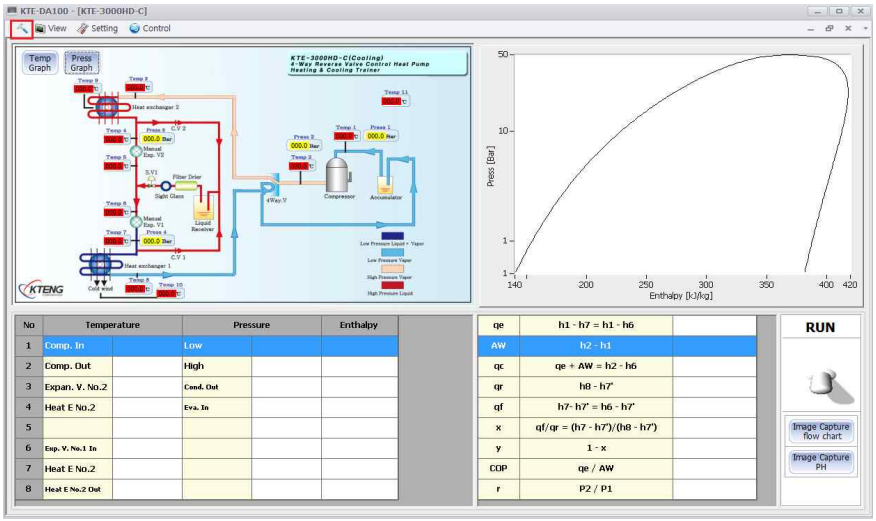


② When you click (R) for before size, the window is activated for moving

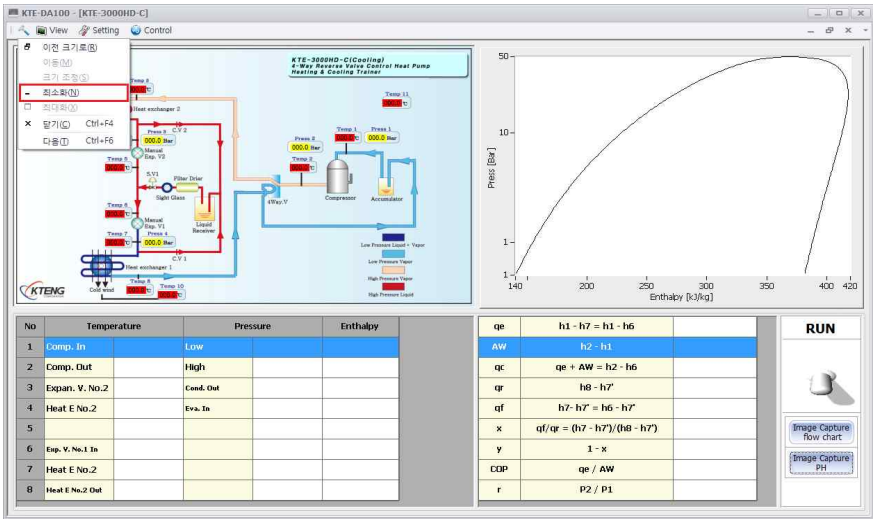


③ Click that button, the window is bigger.

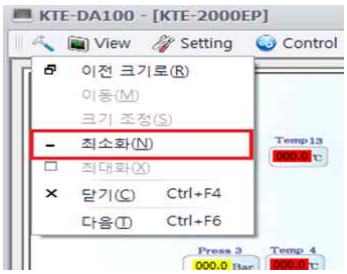




④ Click 

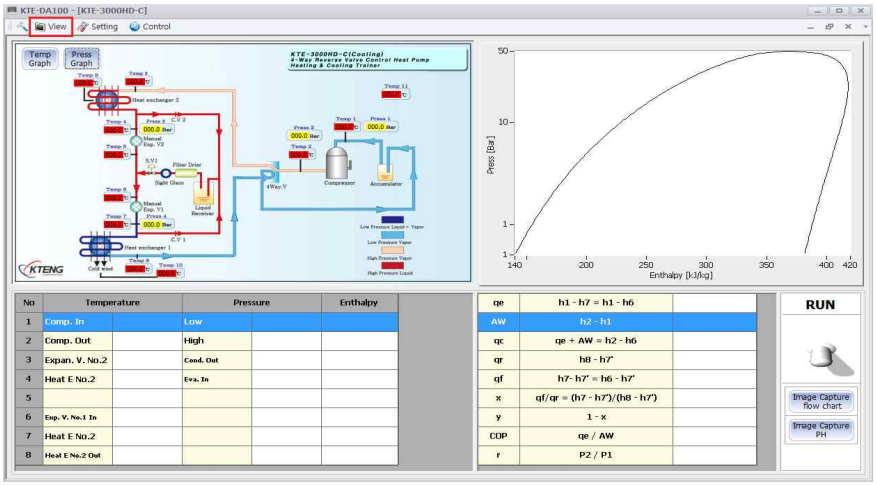


⑤ When click the minimum(N), indicate bottom of the left side.

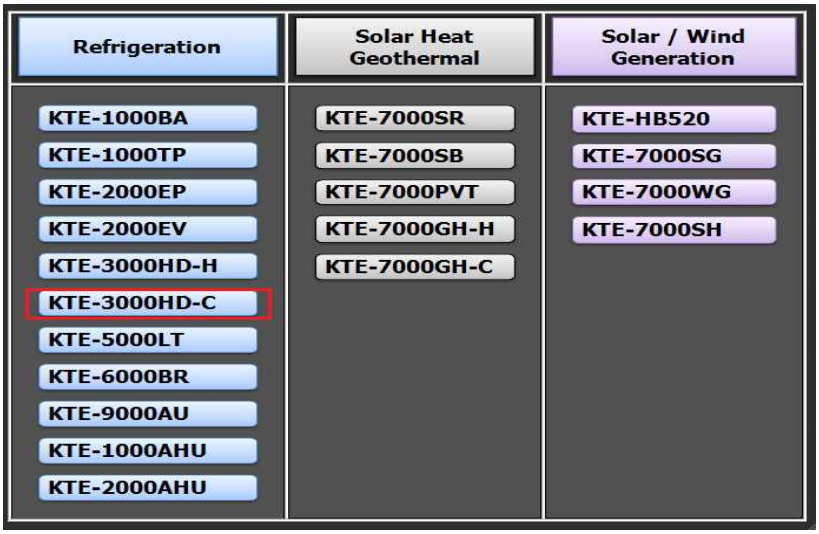


⑥ When click whole monitor, it is returned.

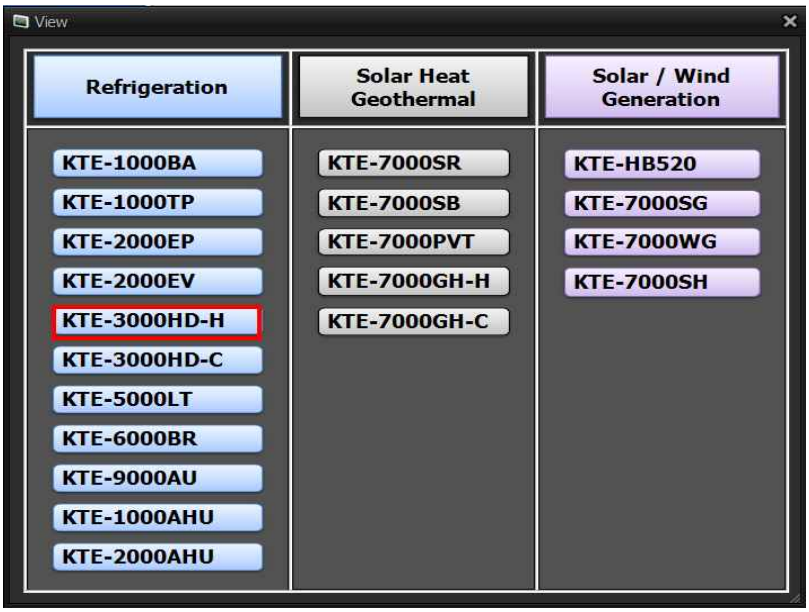
ii) View



① Click the view in Tools



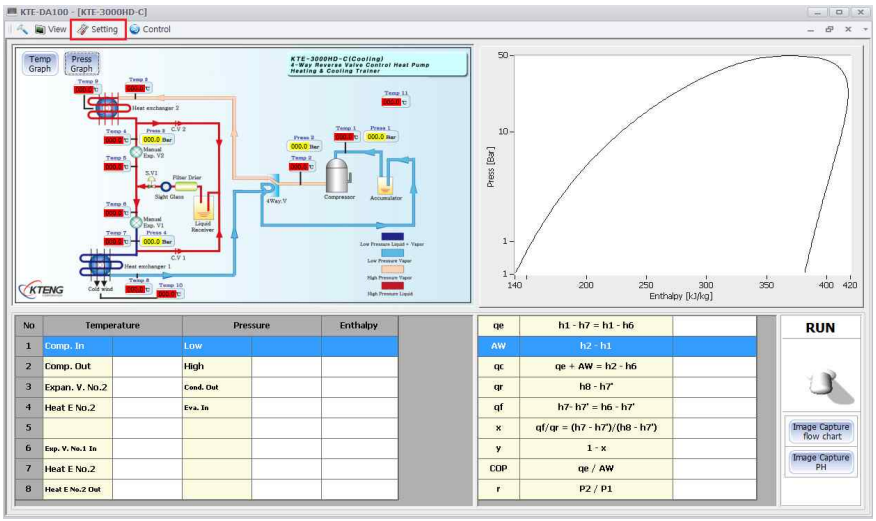
② When you click the view and click Model name then it goes to main sreen and it indicates program screen which is connected with real equipments



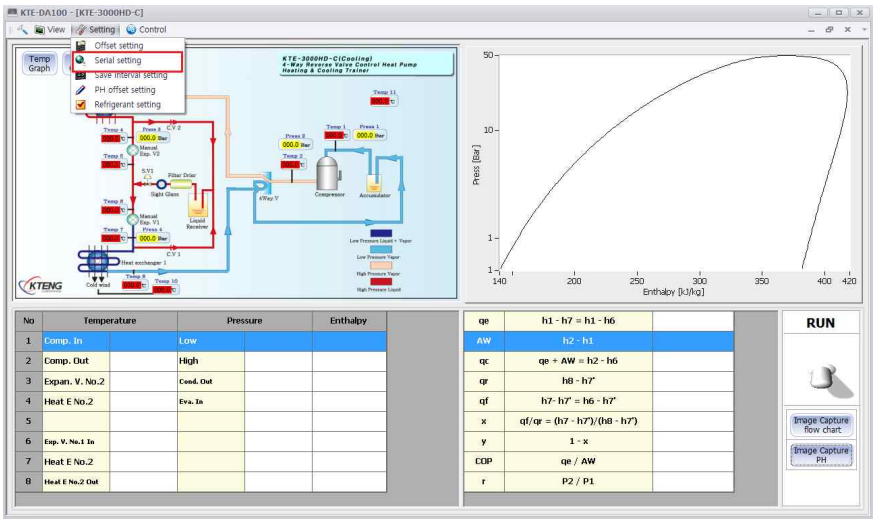
※ Operate to same way a Heating Mode (KTE-3000HD-H.

iii) Setting

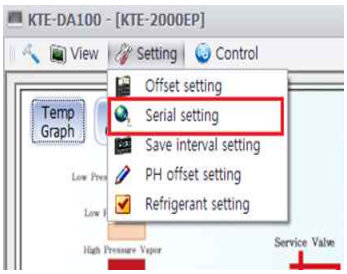
a) Serial setting



① Click Setting



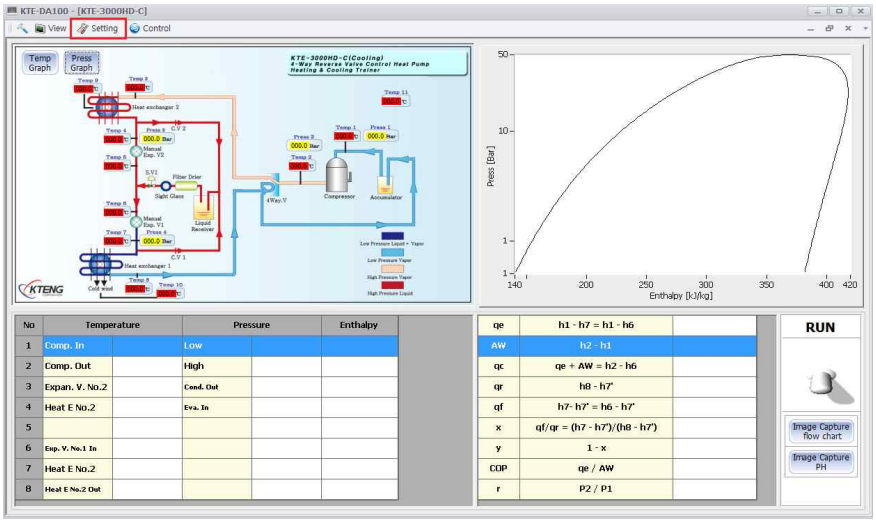
② Click Serial setting



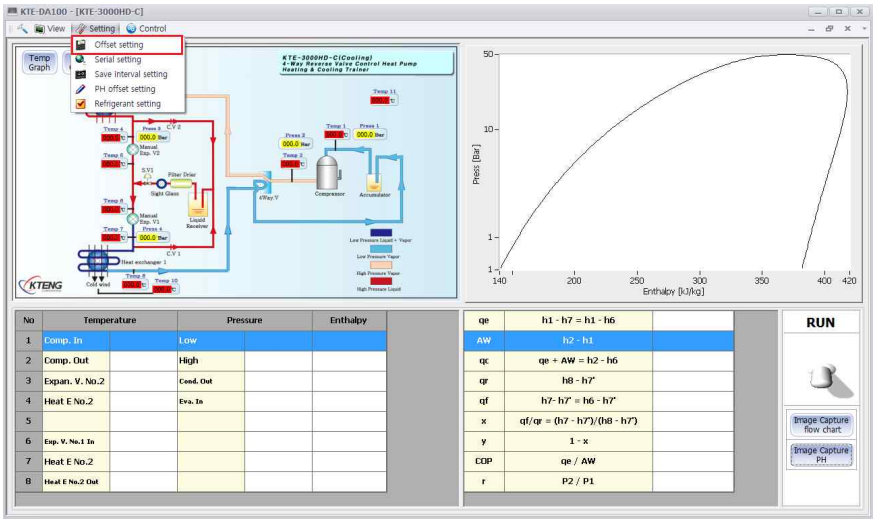
③ COM No is changed depend on port location. choose COM No and Click OK

※Chcking port No is on Page_1-1 use to serial installation

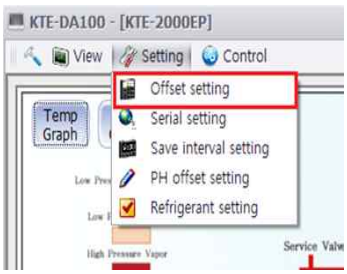
b) Offset setting

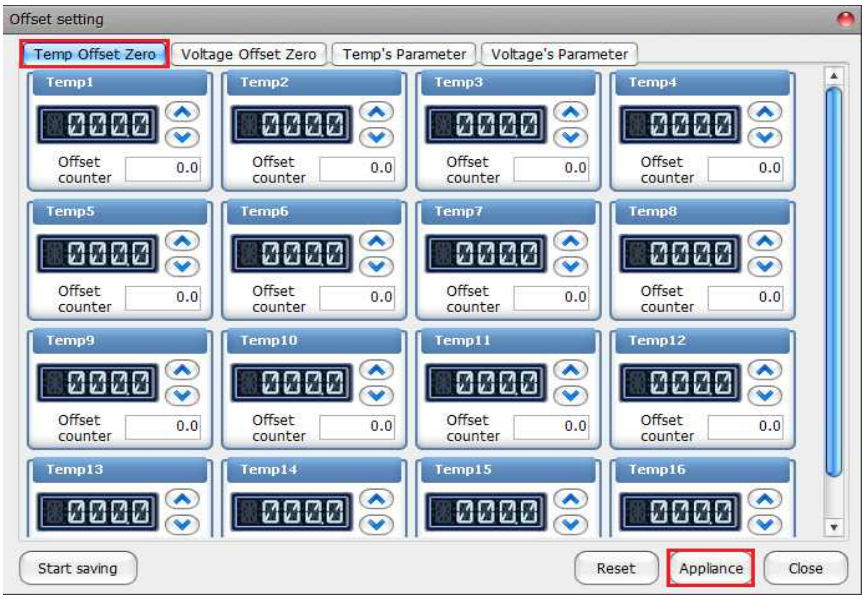


① Click Setting in Tools



② When you click Offset setting, below screen is indicated





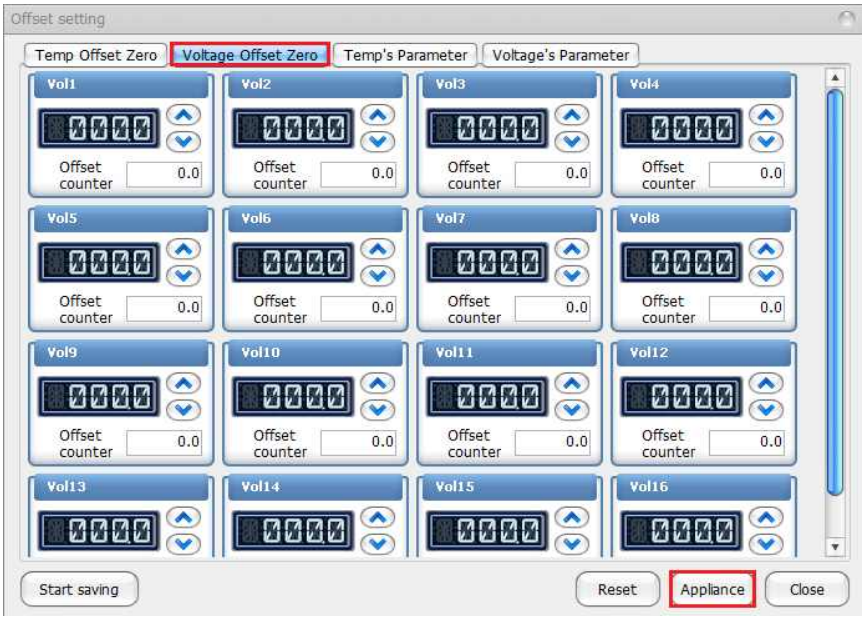
③ Temp Offset Zero is that can control temperature

: You can control using direction key

Offset counter 0.0 : It is indication for temperature figure

Click the application then click the Close for applying the figure

*Refer : Temp No has twenty section which is separated as a sensor.



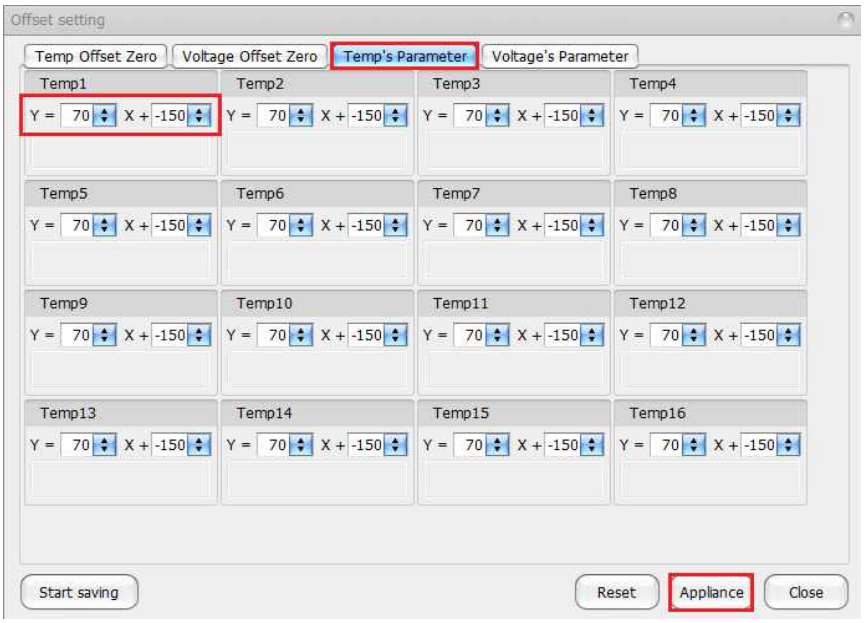
④ Voltage Offset

Zero is a part of can control voltage

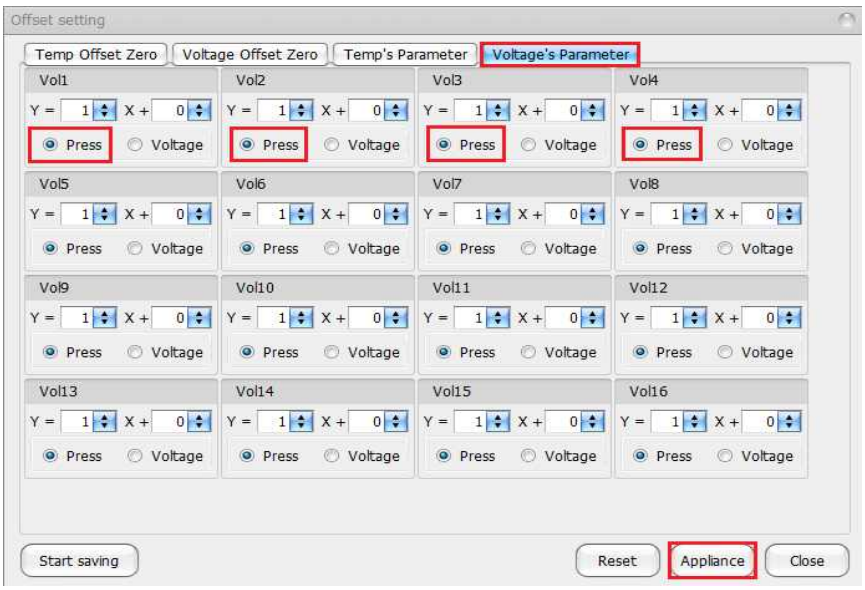
: You can control using direction key

: It is indication for voltage figure

Click the application then click the Close for applying the figure

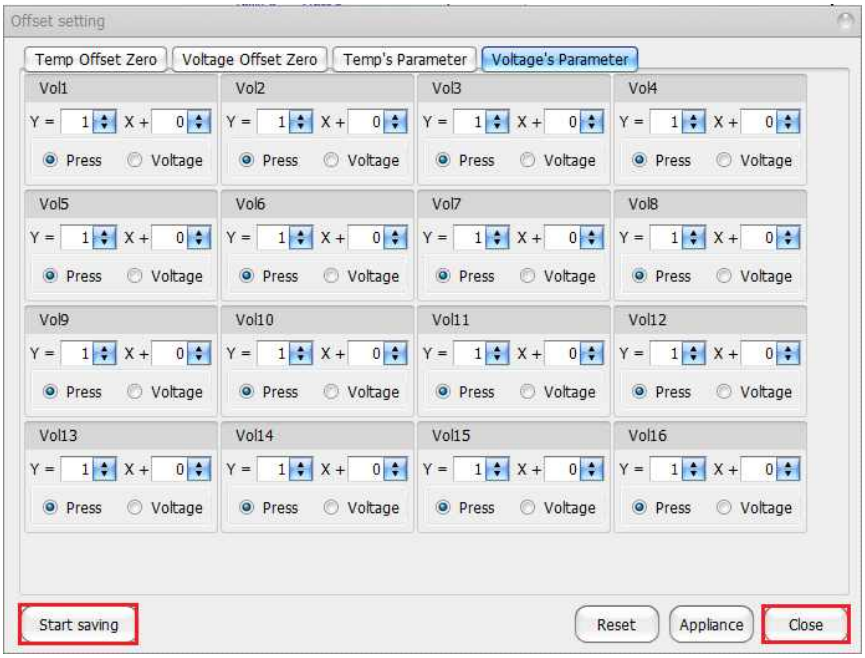


⑤ Temp's Parameter must enter a value of Y = 70X-150 on all of the items is a place to enter a formula that converts the output signal of the thermometer with temperature. click the "Application" and click "Close" for Application



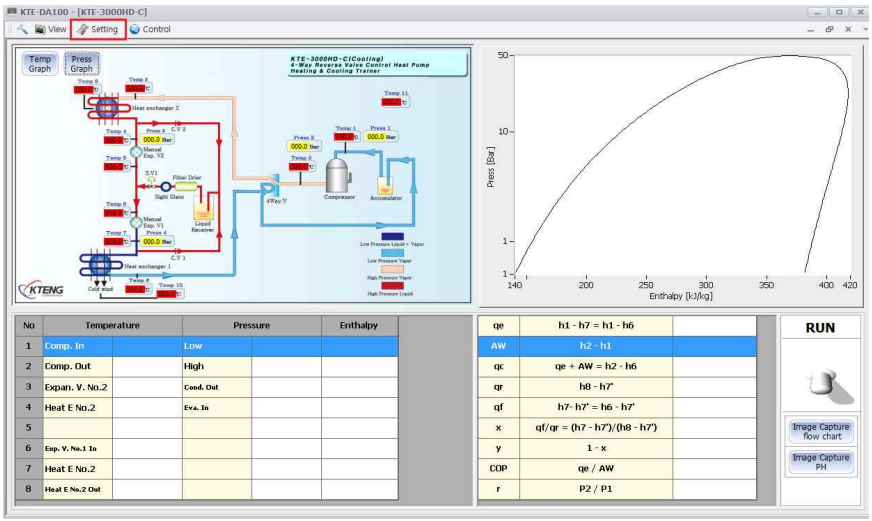
⑥ Voltage`s Parameter has a function which can input the figure for changing input figure, You can set as choosing Pressure, Voltage.

Click “Application" and click "Close" for Application.

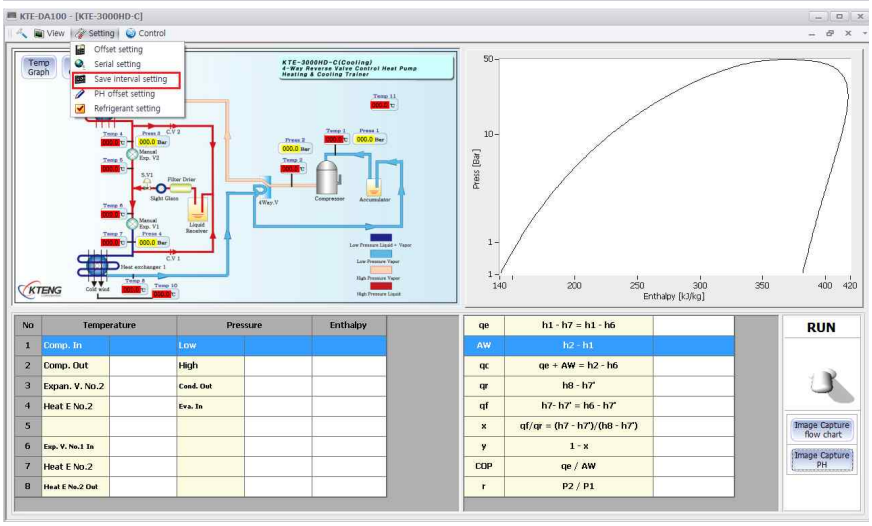


⑦ Start saving set figure and Click "Close" on the left screen

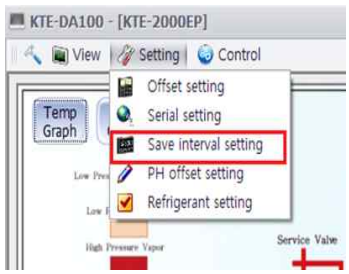
c) Save interval setting

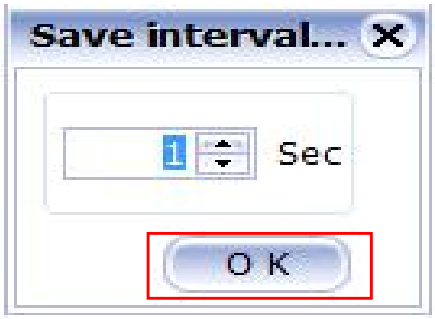


① Click Setting



② Click Save interval setting

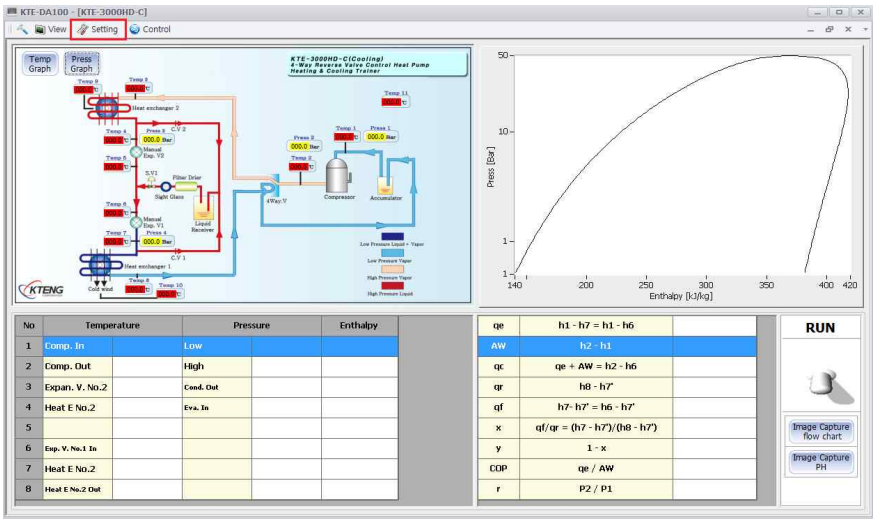




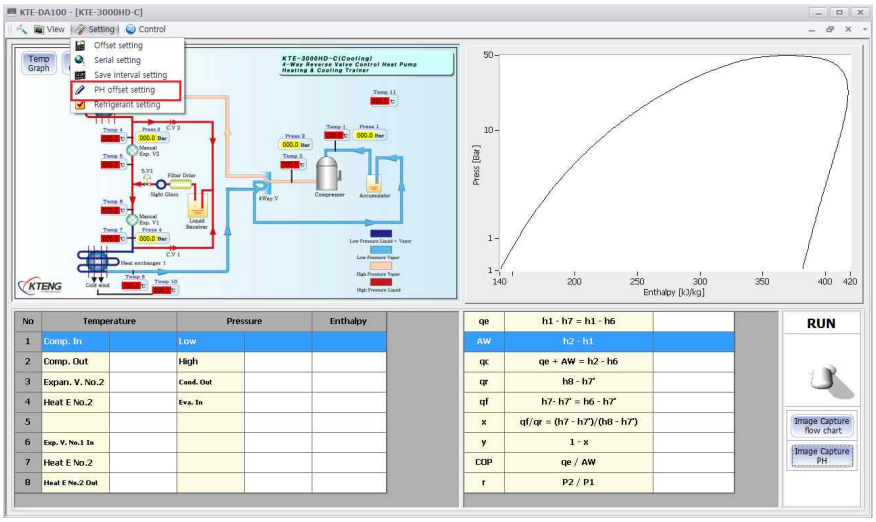
③ Save interval setting

A function for setting a data storage time interval The time interval as an Excel file Can be stored in line.(However, the number of seconds (Sec) because When set to one minute is Set to 60Sec)

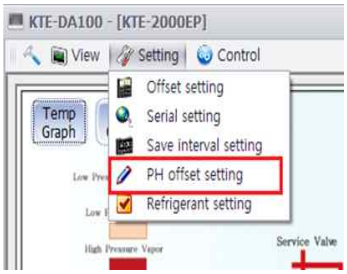
d) PH offset setting

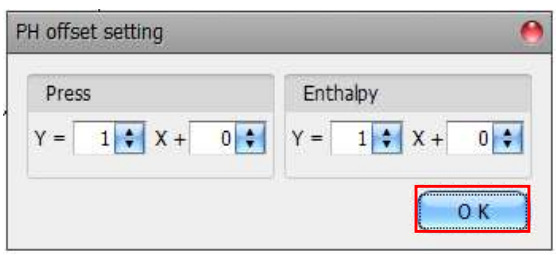


① Click Setting



② Click PH offset setting

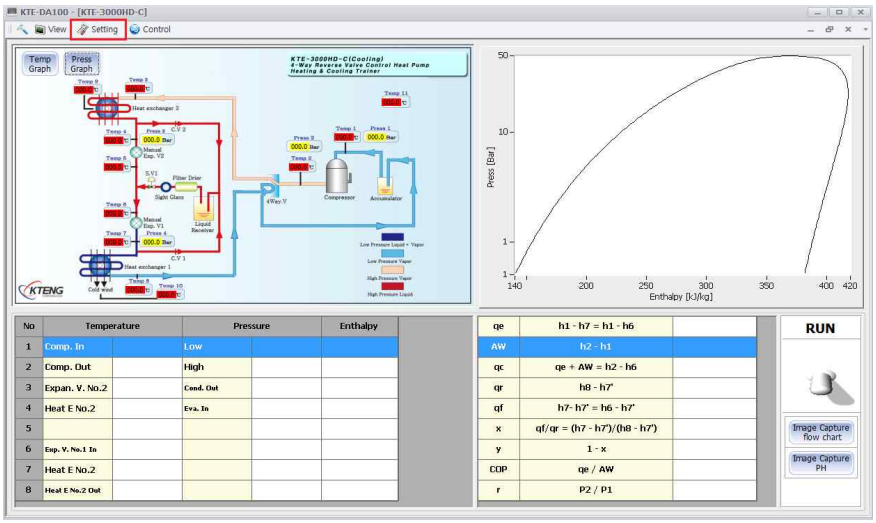




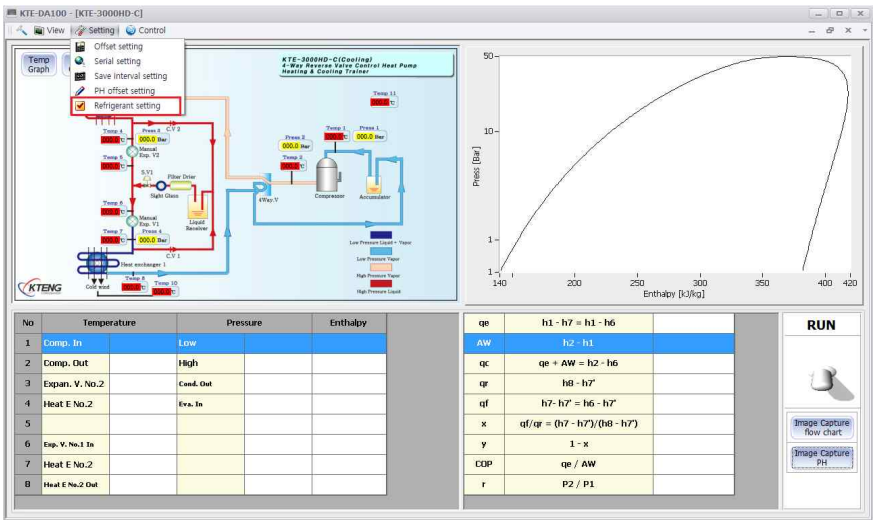
③ On the main screen

The PH seondopyo Press, The axis values of the Enthalpy Adjustment function

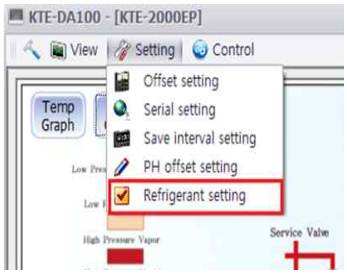
e) Refrigerant setting

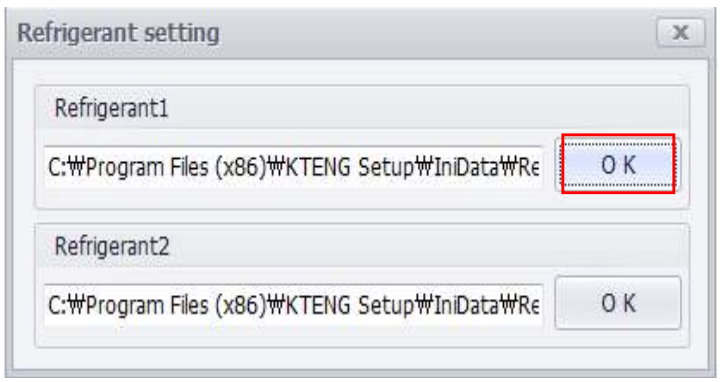


① Click Setting



② Click Refrigerant setting





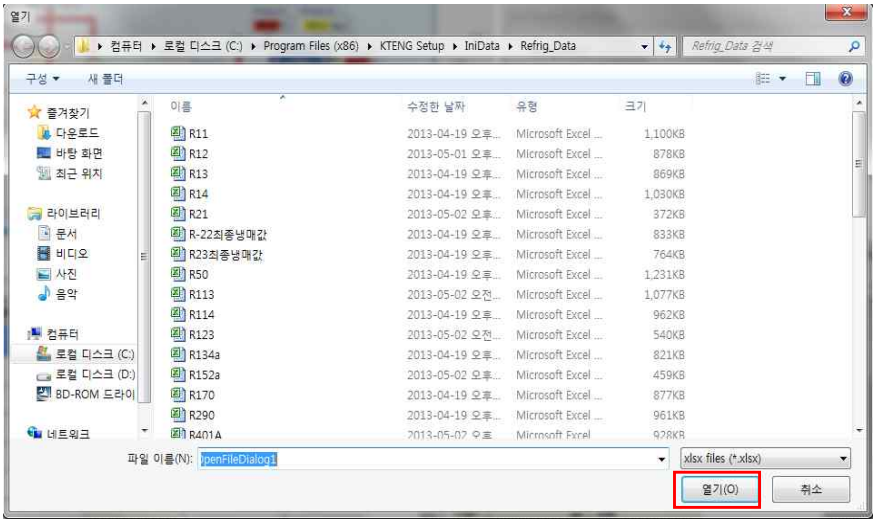
③ Refrigerant setting

Isafunctionfor selectingthe refrigerant

-1won refrigerationcycle Refrigerantten thousand

-2won refrigeration cycle is selected for the selection of the Refrigerant 2Refrigerant1 and canbe appliedto the program.

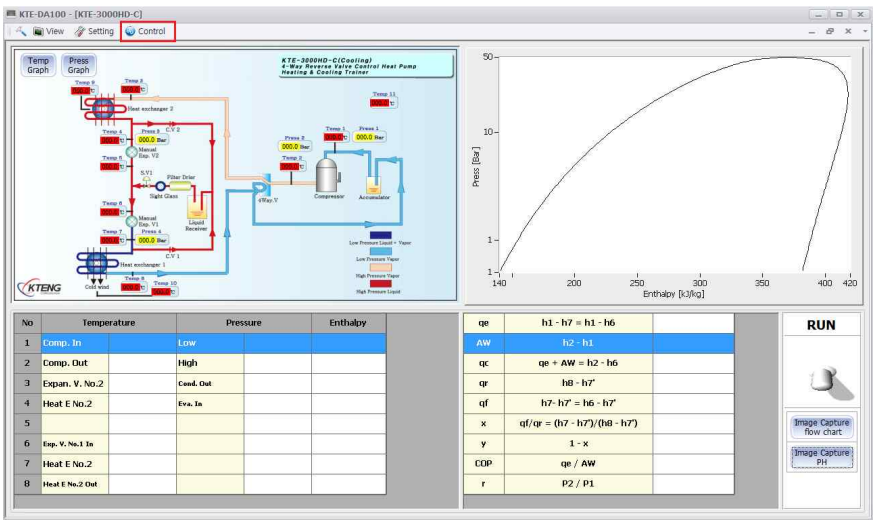
Click " OK "



④ Click ‘run’

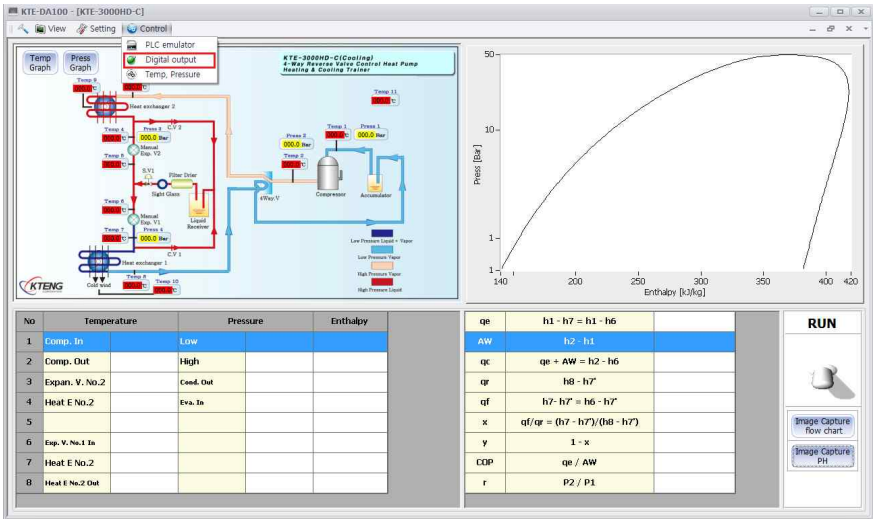
iv) Control

a) Digital output

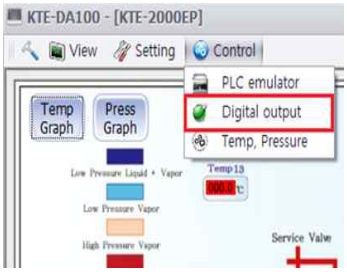


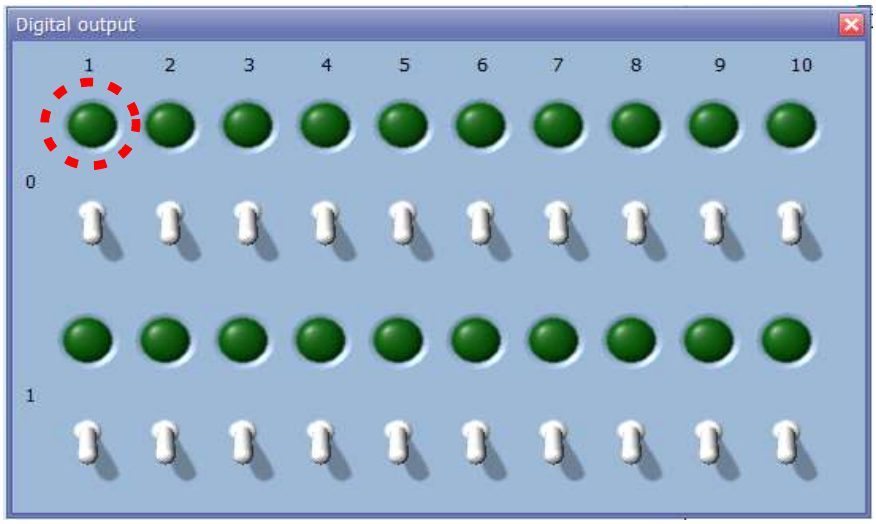
① Click

" Control " in Tools



② Click"Digital output"





③ Digital output is the second comp by number And to the switch ON / OFF

When you work with equipment to

Operating the stand relay and

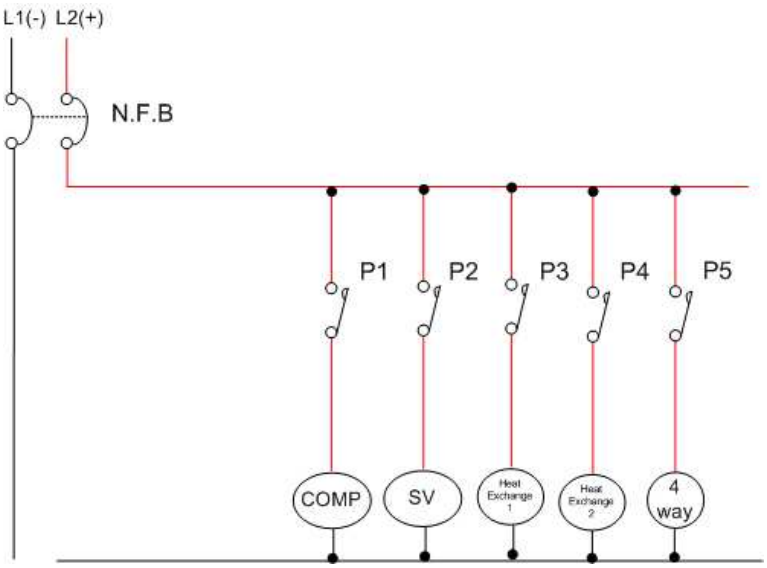
The operation or without through the lamp

Function to determine

④ Green circle (comp) top

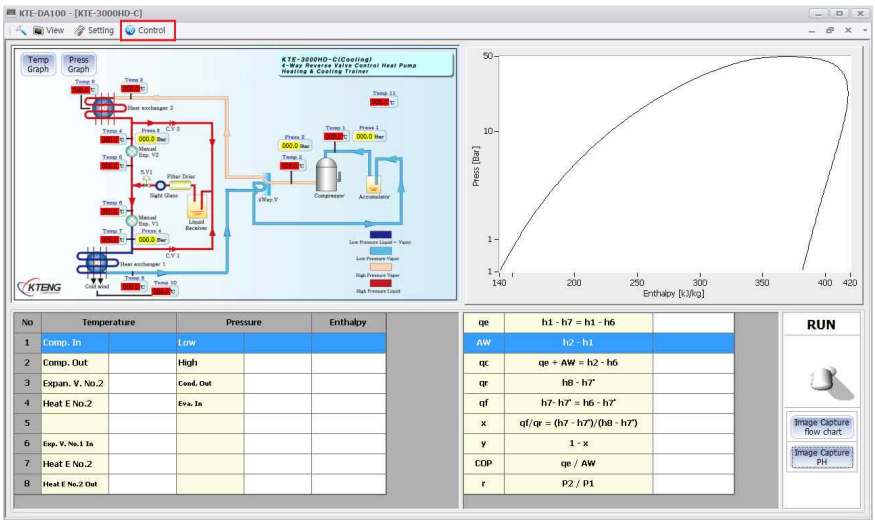
Numbers are located on the control panel

Comp 1 from above

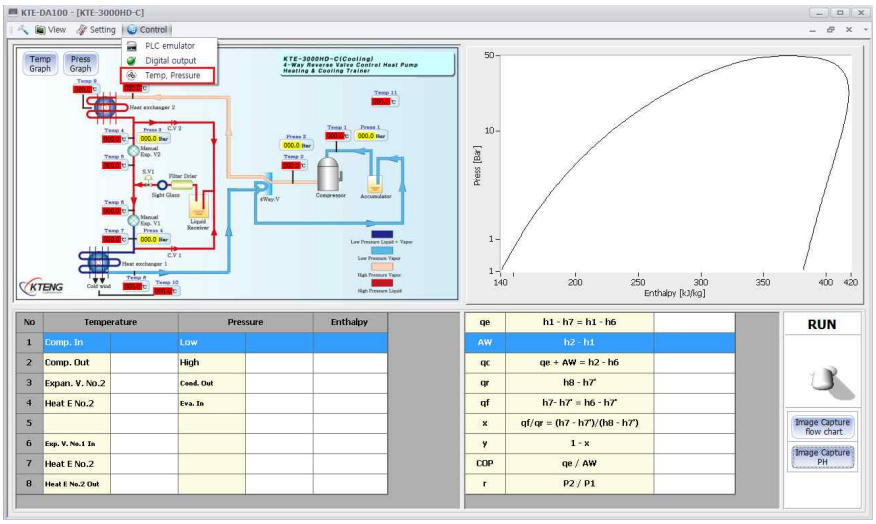


⑤ Side picture is circuit diagram of Digital output

b) Temp, Pressure

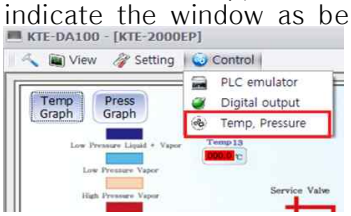


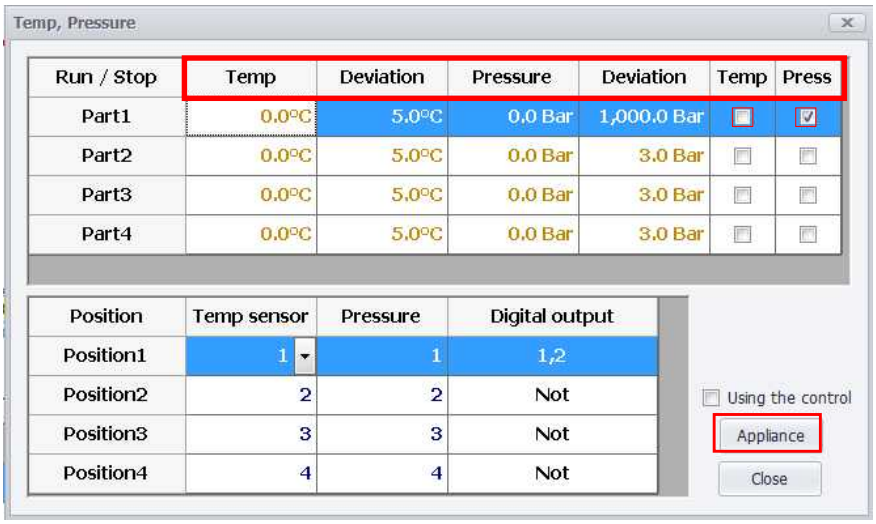
① Click "Control"



② Temp, Pressure has a function which is interlocked with temperature and pressure

When click “Temp, Pressure", indicate the window as below





③ Temp(settemperature), Deviation, Pressure(set pressure)

Deviation is indicated deviation and it can be saving the figure you want and it can choose both Temp and Pressure

Temp sensor : Selection for pressure sensor location

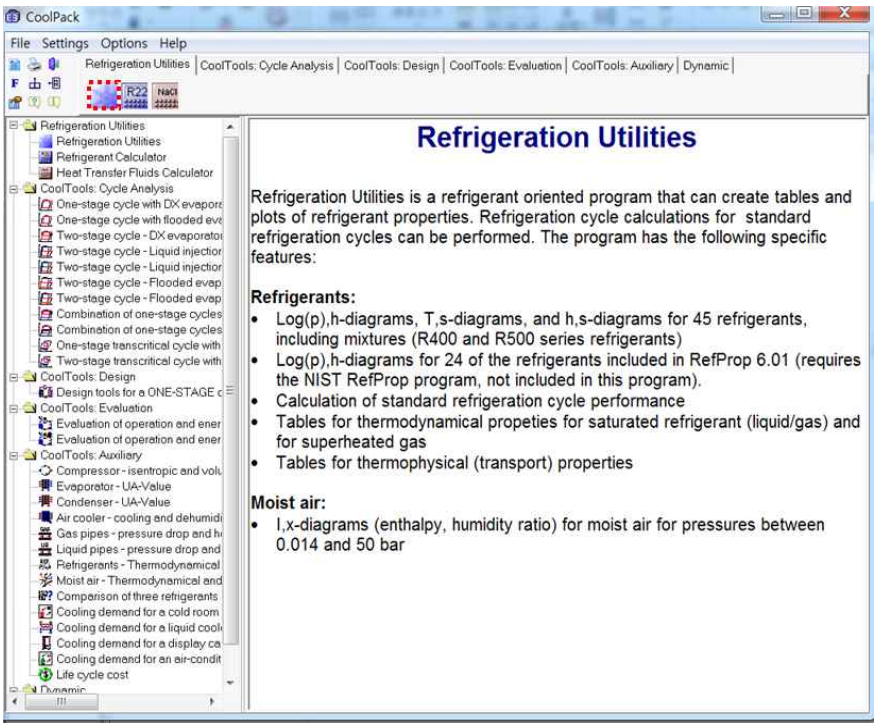
Digital output : Selection output port what you want to control

After setting, Click “Appliance” and “Close"

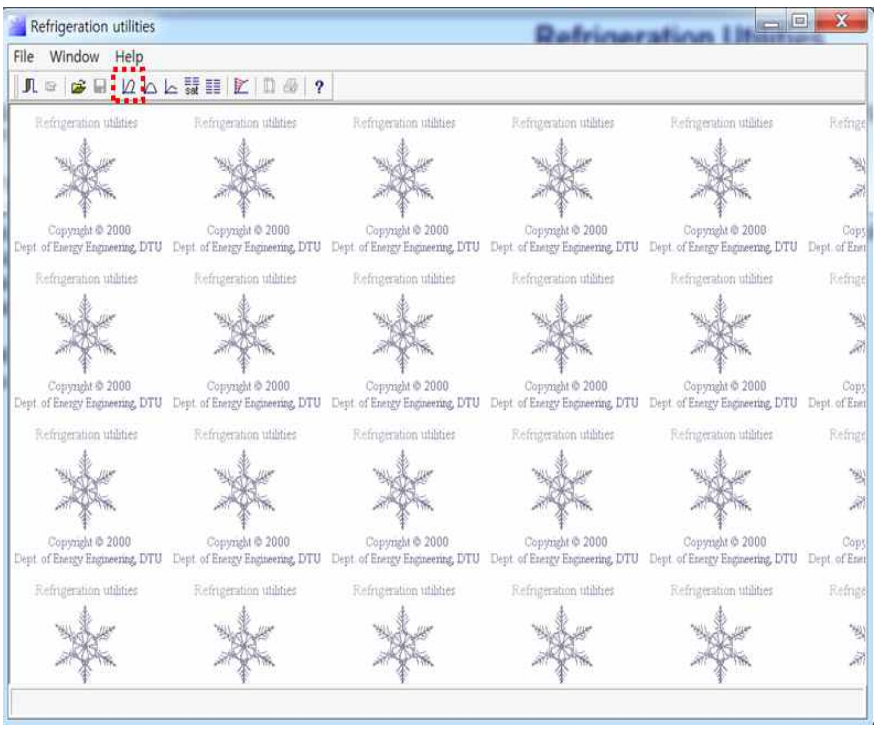
4-2. Drawing a P-h diagram (Coolpack)

1. Refrigerant Utilities

① Click “Refrigeration Unitilties”

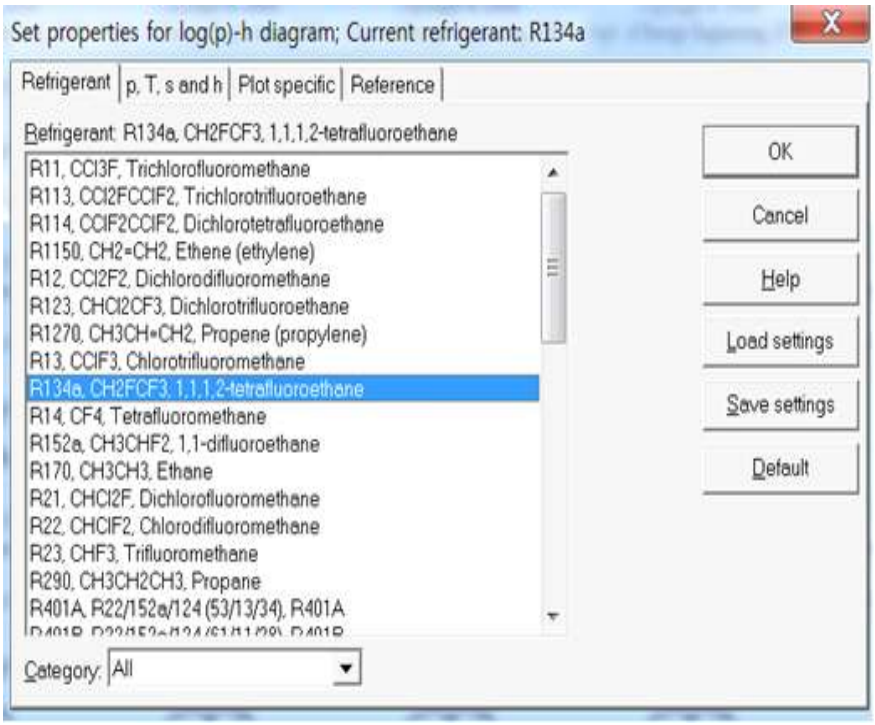


② Click a P-h diagram



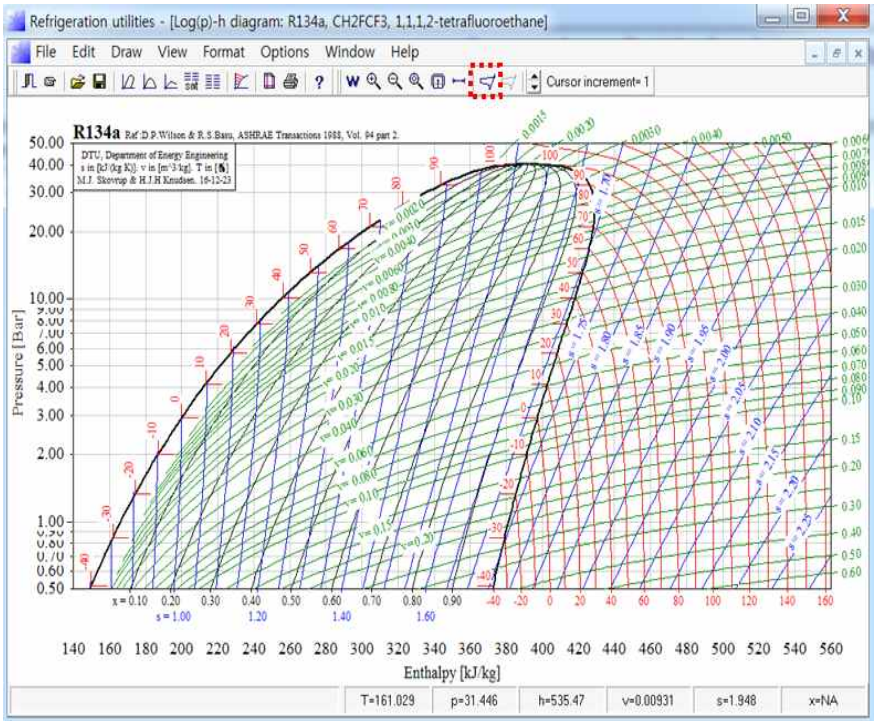
③ Click a Refrigerent

- KTE-3000HD : R-134a

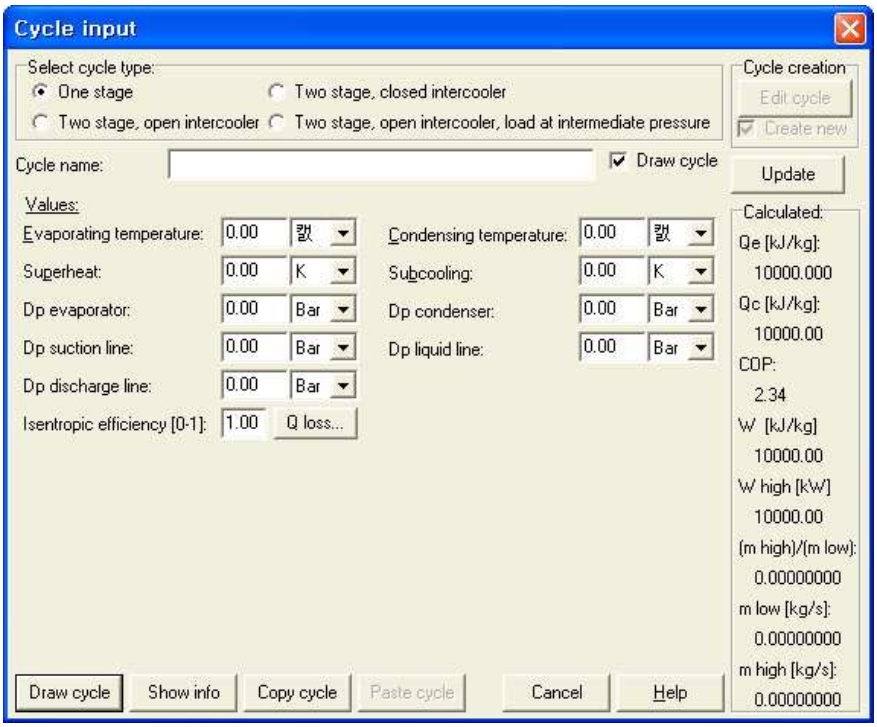


④ Click a "R-134a"

- Click "Cycle"



⑤ Cycle input



2. 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.

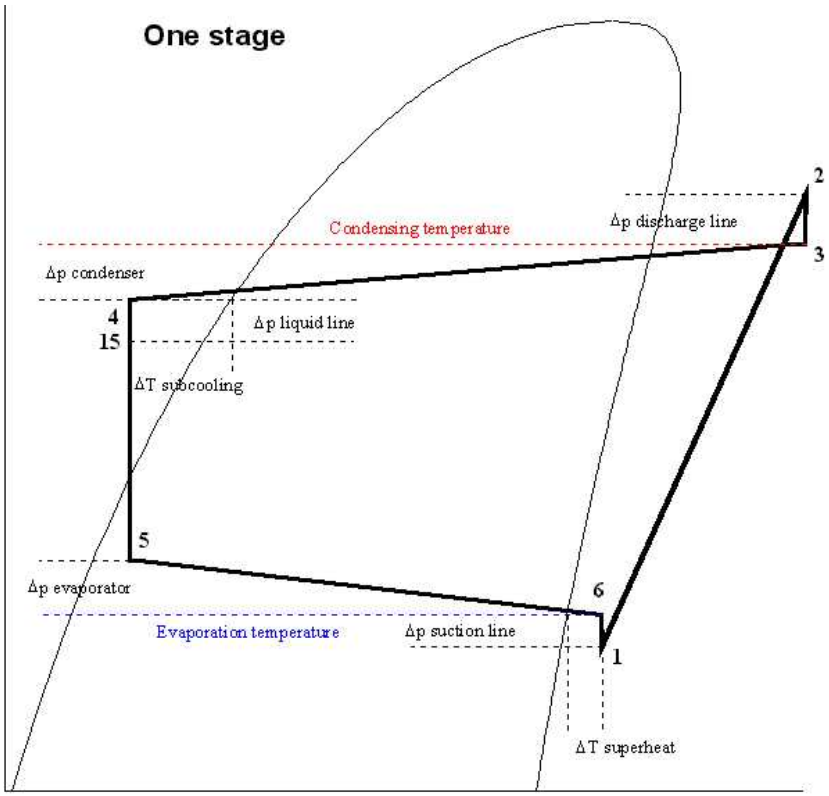
(7) DP Condenser : Temperature (or pressure) Difference between inlet of condenser and inlet of expansion valve.

(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.

(11) P-h Diagram


One stage
2
Condensing temperature
Δp discharge line
3
Δp condenser
4
15
Δp liquid line
ΔT subcooling
5
Δp evaporator
6
Evaporation temperature
Δp suction line
1
ΔT superheat

3. Refrigeration cycle and P-h diagram

(1) Refrigeration cycle

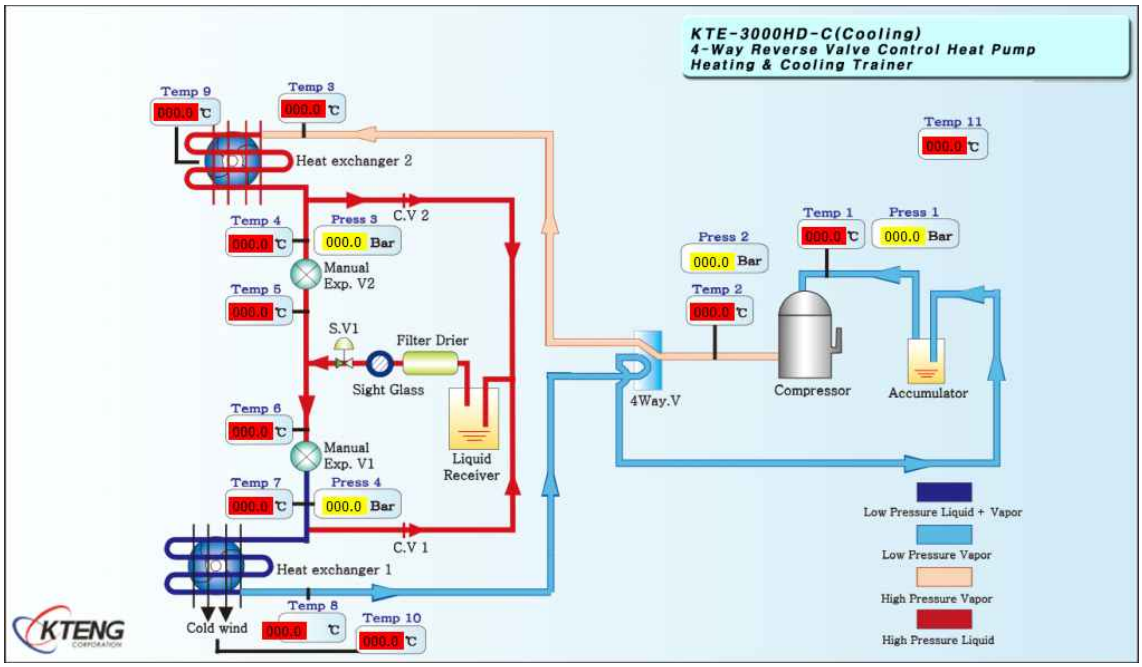


Fig. 4-1. KTE-3000HD Diagram (Cooling Mode)

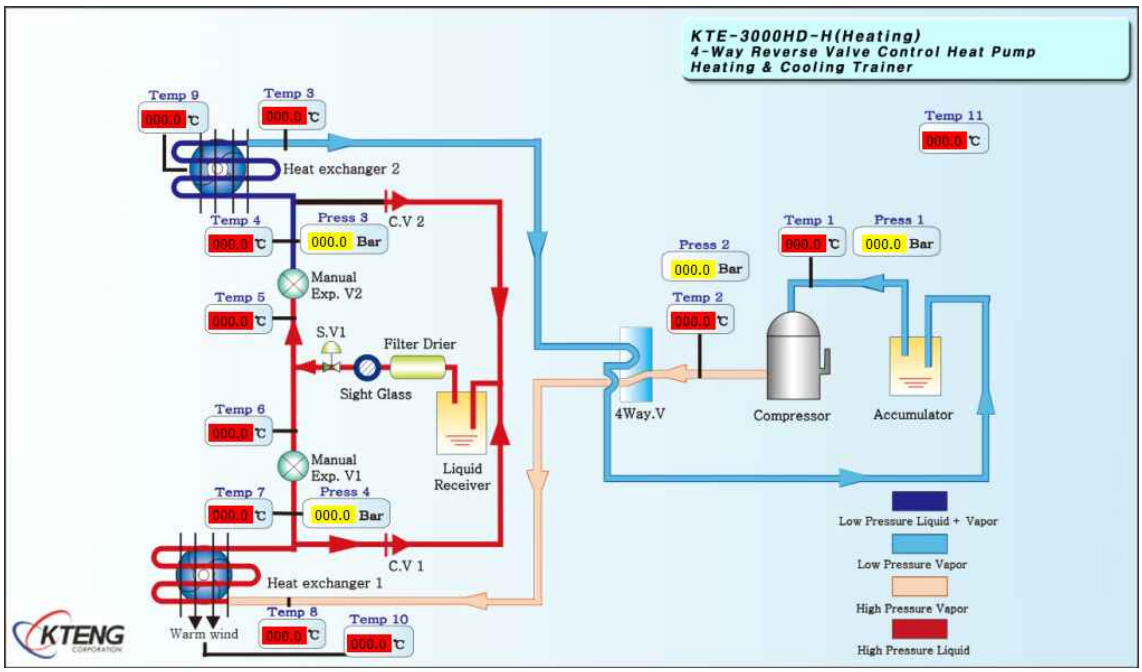


Fig. 4-2. KTE-3000HD Diagram (Heating Mode)

(2) P-h diagram

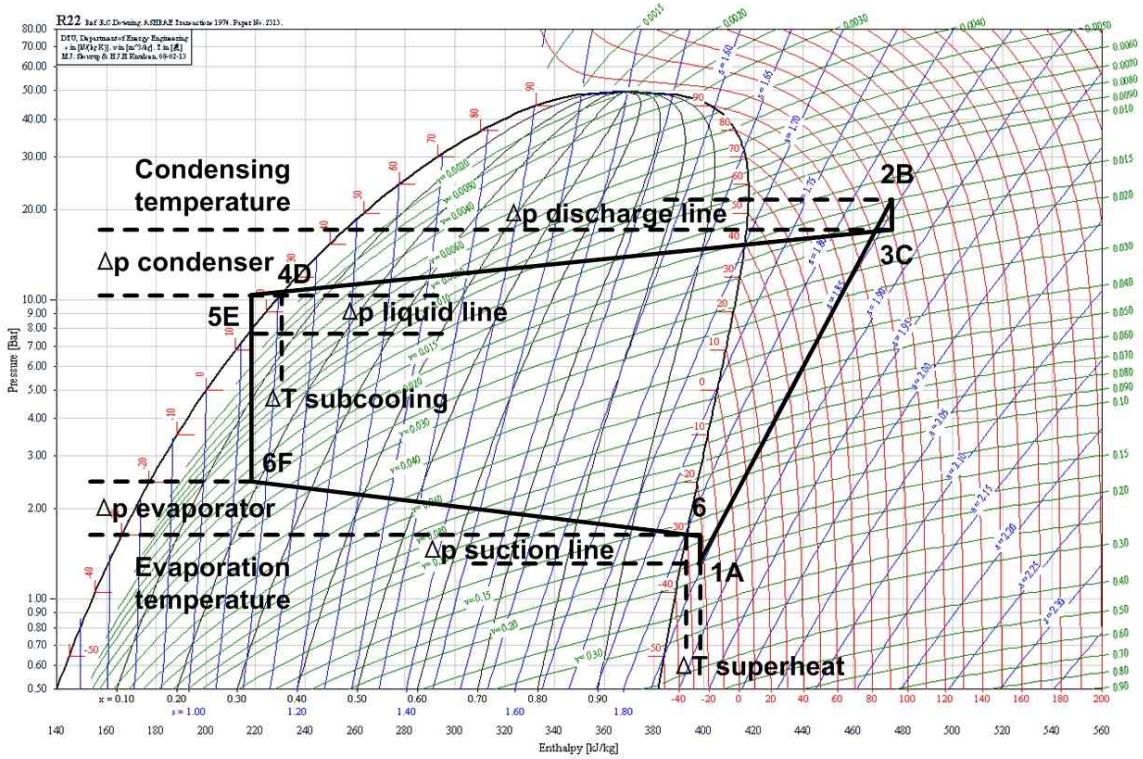


Fig. 4-2. P-h Diagram

(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							

4. Example drawing a P-h diagram

(1) Data measuring_Variable evaporation Temp

Table 4-3. Data measurement

Data point	Table1	Table2	Table3	Remark
Evaporation Temp	-15℃	-10℃	-5℃	
Condensing Temp	40 ℃	40 ℃	40 ℃	
Isentropic efficiency	1	1	1	
Qe [kJ/kg]	132.157	135.161	138.124	
Qc [kJ/kg]	169.933	168.734	167.675	
COP	3.5	4.03	4.67	
W [kJ/kg]	37.775	33.573	29.551	
Pressure Ratio	6.193	5.063	4.176	

(2) Data measuring_Variable Condensing Temp

Table 4-4. Data measurement

Data point	Table1	Table2	Table3	Remark
Evaporation Temp	-15℃	-15℃	-15℃	
Condensing Temp	40 ℃	30 ℃	20 ℃	
Isentropic efficiency	1	1	1	
Qe [kJ/kg]	132.157	146.855	161.083	
Qc [kJ/kg]	169.933	178.744	186.662	
COP	3.5	4.61	6.30	
W [kJ/kg]	37.775	31.889	25.578	
Pressure Ratio	6.193	4.692	3.483	

(3) Drawing solution P-h diagram

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

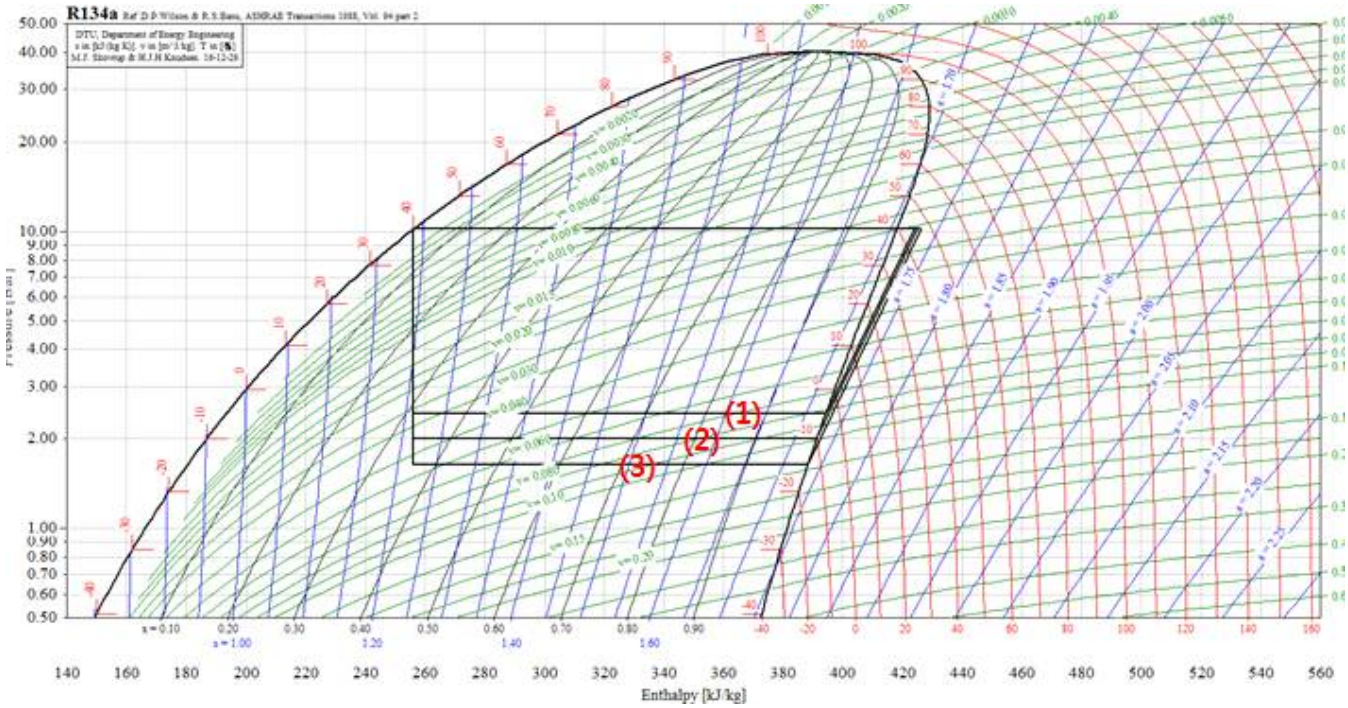


Fig. 4-3. Solution about No.1 on Table 4-3

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

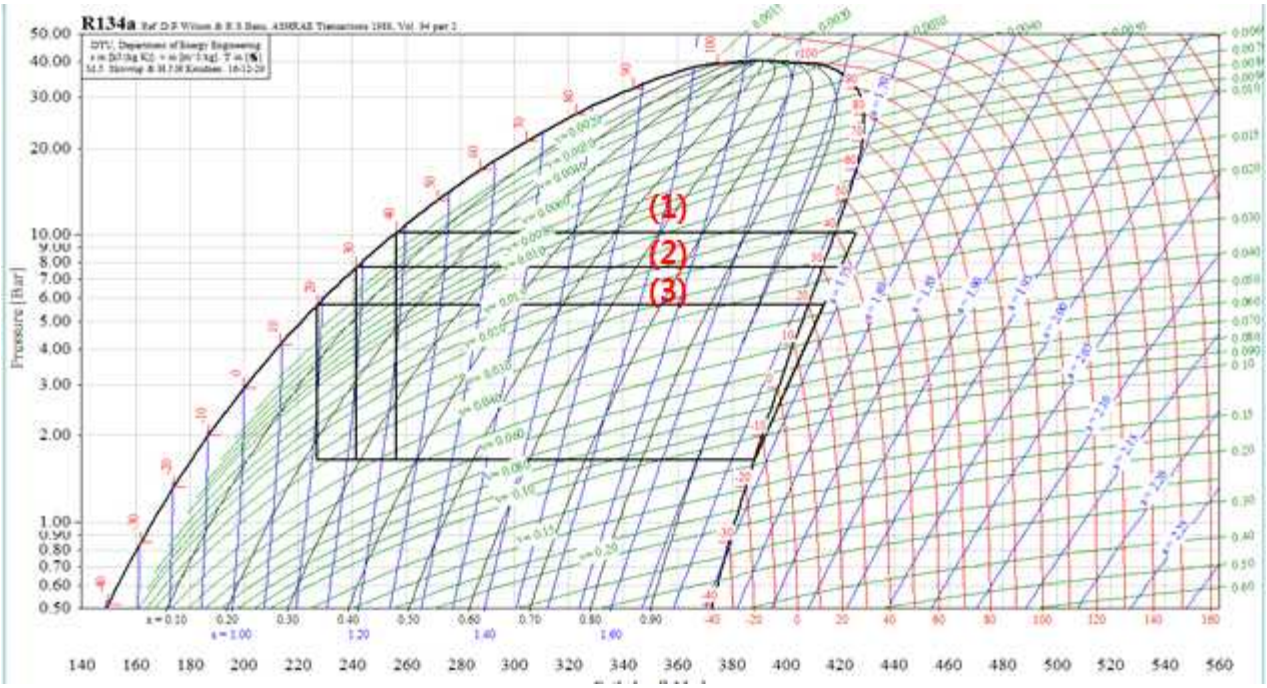


Fig. 4-4. Solution about No.1 on Table 4-4

3) Note a performance test result

Table 4-5. 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							

3) 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 4-6. 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

Chapter 5. Notice and Guarantee

1. Mechanical trouble and measures

1-1. When the Power lamp does not connect

(1) If the power lamp do not work when the N.F.B turn on. Please check inserts a power cord in the reverse side of N.F.B or installation in power input.

Check the AC LAMP is turn on

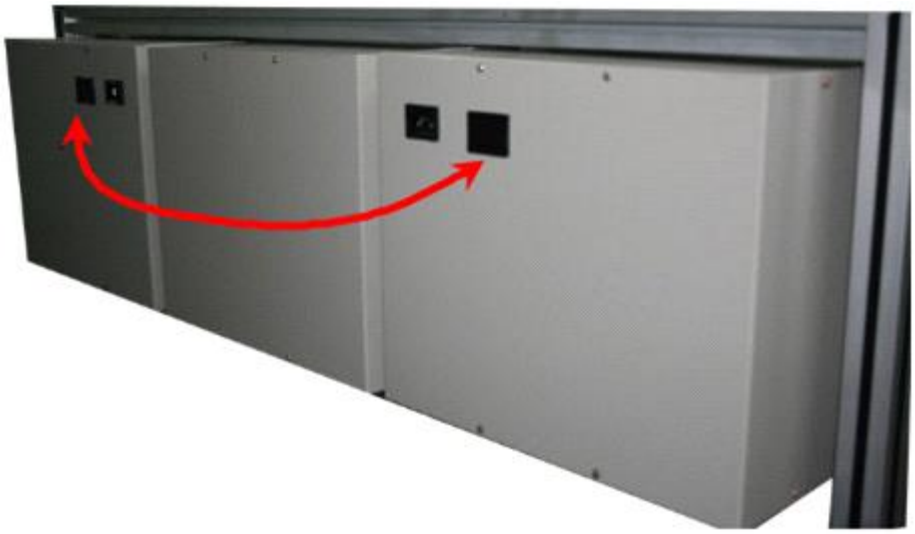
Installed the N.F.B on reverse side of control panel

① Check the power cord is put in on reverse side.

② Check the power cord is plug in.

1-2. When the temperature module is power off

※ If temperature module power is OFF like above



Reverse side of temp module panel

Installing the N.F.B on back side of control panel

① Check the power cord is put in on reverse side.

② Check extension connected the power cord through extension cable.

1-3. When trouble of the other parts

(1) Contact us when Operation of other parts is strange or out of work. Then we will handle rapidly.

2. Caution Notice on operation

2-1. Power Supply

(1) Main power of this equipment is use a single phase AC 220V.

(2) After equipment action order turns on N.F.B and watches circuit diagram and finishes wiring by RCA cable in proposition that power cord was counted, DC toggle switch does on.

(3) Use RCA cable and power supply at equipment operate secures because use DC 24V, but should observe to +, - mixing use of monad as operating power is DC.

(4) Also, base and control panel of equipment is all aluminum quality of the material when interlink red + terminal, should take care not to reach in aluminum base.

2-2. Machine Equipment

(1) When using a charging nipple installed at low pressure and high pressure side of, notice refrigerant not to leak.

(2) Use after making sure how to use well exactly operating a manual expansion valve .

(3) When going out of factory, super heating and sub cooling are set up 5±2℃, but as your continue using the setting value will be changed.

(4) Notice fragile arcrylic duct of evaporator for visual inside. Be careful not to break it.

(5) If you separate any component of product by yourself, the system gets damage and you never get A/S from us.

2-3. Data Acquisition device and Software

(1) After set up circuit of electric panel on the main equipment, connect Data Acquisition device and computer. Check if the cable is connected correct, turn on the switch on panel.(* Please follow step by step as manual book.)

2-4. Else

(1) After reading the manual book, operate the system.

(2) If you have any question, call us.

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

3E EDUCATION
ENGINEERING
ENVIRONMENT

KTENG Co., Ltd.
TEL: 82-31-749-5373 | FAX: 82-31-749-5376
overseas@kteng.com | http://www.kteng.com
11, Meorusut-gil, Opo-eup, Gwangju-si,
Gyeonggi-do, 12771, South Korea