# Model : KTE-7000GH

# GEOTHERMAL HEAT PUMP EQUIPMENT

# USAGE MANUAL

Korea Technology Institute of Energy Convergence

Korea Technology Engineering Co.,Ltd.

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## 5. Failure and Correction



## 6. The Equipment Usage Notification

# 1. Geothermal Heat Pump Experimental Equipment

## 1-1. Summary

Geothermal heat pump system is a device that collects and pump heat from or to the ground. Underground temperatures are more stable than air temperatures through the year. The heat from underground is used to evaporate and condense a refrigerant that circulates in a system such as in refrigeration system.

The geothermal heat pump experimental equipment consist of steam pressure mode standard freezing cycle, and lets the tester experience the performance of convertible action of warming and cooling through the operation of 4-way valve as well as the experiment and practice of auto control drive of each basic refrigerator and the configuration practices of the freezing system.

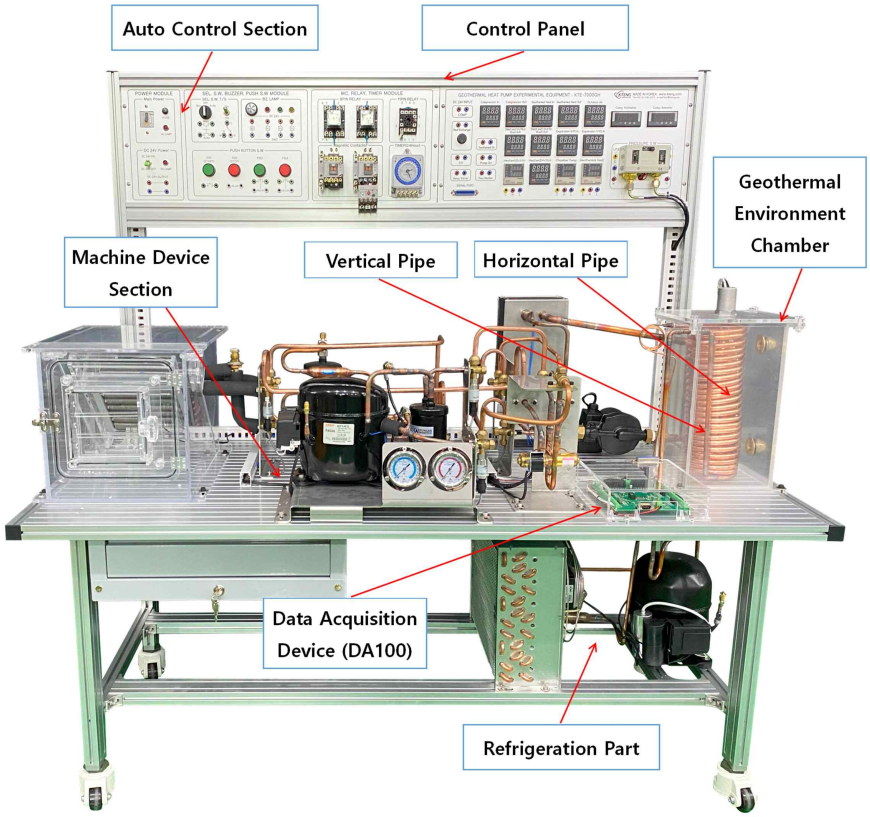
Especially, the expander attaches and controls manual expansion valve and can arbitrarily change the evaporation pressure randomly while you drive. Therefore, on the basis of theoretic freeze cycle which concentrates on textbook(theoretic education), we let you verify, compare and analyze the performance to the actual standard freeze cycle while driving with various variables such as condense temperature variable (condense pressure variable), evaporate temperature variable (evaporation pressure variable), overheat compression, moist compression, dry saturation compression and supercooling, etc.

We can also draw P-h line using the program and hands about various changes (variables) while we drive the standard freeze cycle. The performance of standard freeze cycle change all the time according to the quantity of the coolant, open air temperature, driving time, evaporation pressure and condense pressure, and the evaporate pressure change might affect much to the performance variable with the control of opening of the manual expansion valve.

Auto control device lets us experience the needed business in performance and control task of the basic practice of each controlling task that we must learn at the science and engineering field with the heat and freezing system. Also, we let you prepare business ability and understand the auto control circuit of the heat and freezing system, which is complicated, by experiencing the forming and driving experiment and practice of the basic circuit composition and applied circuit needed at the standard freezing cycle driving, using each control device with the banana jack directly and quickly.

Moreover, it is a device that simulates an adapting power for geothermal heat pump to help students to understand the operation principles of geothermal heat pump through driving and performance measurement with the equipment in laboratory scale with the geothermal system which is recognized as one of important energy source.

## 1-2. Composition of geothermal heat pump experimental equipment




Geothermal heat pump experimental equipment

(1) Automatic control: Timer, Relay, NFB, toggle switch, ampere-voltage meter, buzzer, lamp 9red, green, orange), high pressure switch, low pressure switch, Magnetic Contactor (MC), power input, thermal switch, push button and so on. It controls the operation of heat pump mechanism.

(2) Machine parts: Compressor, plate heat exchanger, receiver, filter dryer, sight glass, solenoid valve, expansion valve, evaporator with fan, high pressure gauge, low pressure gauge, electric immerse heater and so on. They will be run according circuit configuration on the control panel.

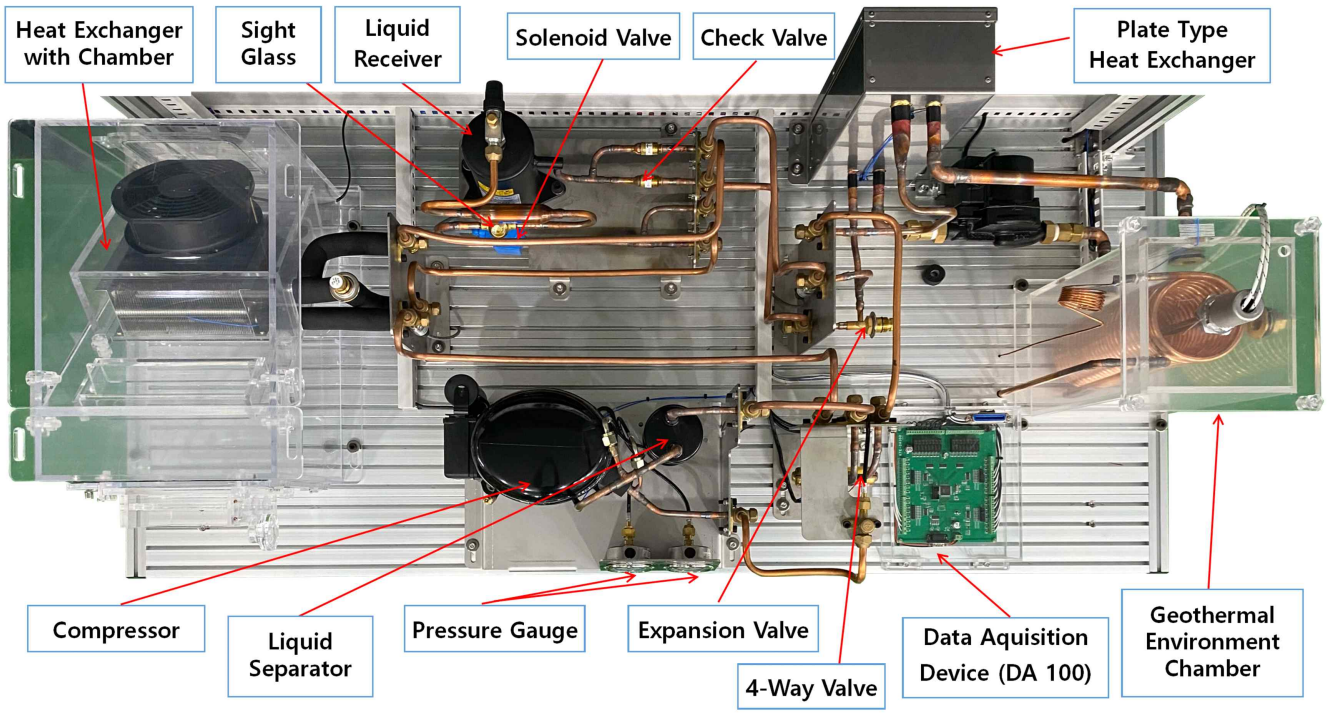
(3) Geothermal section: geothermal environment chamber, water tank consisting of chiller and electric immerse heater, vertical and horizontal circular pipe, water flowmeter, solenoid valve, pump, temperature controller to maintain temperature inside geothermal chamber and so on.

(4) Software: KTE-DA100 records each part's temperature, pressure, enthalpy, heat amount, COP of the cycle every unit time and save the data in excel file. Thus can be analyze with graphics.

(5) Hardware: KTE-DA100 composed of SMPS, T type thermocouple, pressure sensor and computer interface (minimum specification pentium 4, windows 98, memory 256 MB, hardisk space 100MB).

## 2. Detail Equipment Components

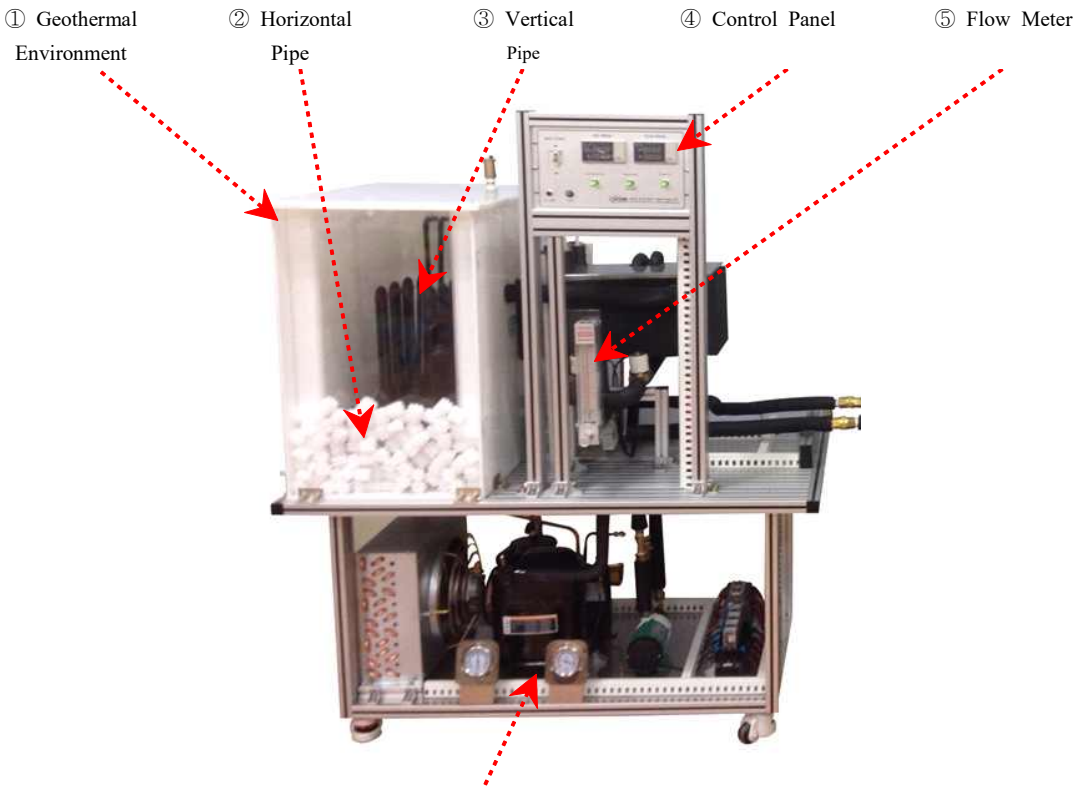
### 2-1. Heat pump machinery device section




Machine parts of geothermal heat pump experimental equipment

① Plate heat exchanger
② Check valve
③ Liquid receiver
④ 4-way valve
⑤ Liquid separator
⑥ Heat exchanger with Chamber
⑦ Solenoid valve
⑧ Expansion valve
⑨ KTE-DA100
⑩ Sight glass
⑪ Low pressure gauge
⑫ High pressure gauge
⑬ Compressor

## 2-2. Geothermal environment section (Compact)




Geothermal environment of geothermal heat pump experimental equipment

① Geothermal Environment Chamber
② Horizontal Pipe
③ Vertical Pipe
④ Control Panel
⑤ Flow meter
⑥ Refrigeration & Heating Part

※ Specification

(1) Artificial geothermal system

- Heat Unit Electrical Heater : 0.5 kW * 5 EA, Total Heat Capacity 2.5 kW
- Cooling system capacity

① Compressor : 3/4 HP, R-404a
② Condenser : 1 HP, Air cooling type

## 2-3. Heat pump parts description

### (1) Compressor

Compressor

※ Specification

- Model : P-12TN(ACC)
- 1/3 HP
- Application scope: medium and high temperature
- Range of evaporating temperature: -25℃~10℃
- Motor Type: CSR
- Cooling quantity: 1,588kcal/h
- Refrigerant: R-134a
- Single-phase 220V
- Controller included

This Compressor (gas compressor) is mechanical device common use in a standard refrigeration system. It is designed to operate, and be cooled by, the refrigerant being compressed. the compressor increases the pressure and temperature on a refrigerant (in gas state) and transport the refrigerant through a pipe in refrigeration cycle.

In other words, it plays role of sending a heat from evaporator (lower heat source) to condenser in form of high pressure and temperature gas and it circulates refrigerant in the system.

### (2) Fill nipple

Fill Nipple

Fill nipple is a necessary device used with manifold gauge when transferring a refrigerant, testing the air-tightness, testing under vacuum status, refrigerant charging of the standard refrigeration device by attaching it to the compressor discharge and suction side.

(3) Heat exchanger

Heat exchanger 1

Condenser is a device that condenses a high pressure and temperature refrigerant discharged from compressor into liquid by extracting heat of the refrigerant to outside air or cooling fluid e.g. cold water. The reason we make it into liquid phase is to utilize the potential heat when the phase changes. In order to absorb the heat from evaporator, the best performance comes out when using potential heat, that is, when it changes from liquid phase to gas phase.

(4) Liquid receiver

Liquid receiver

Liquid receiver is the vessel which stored temporarily a condensed refrigerant from condenser before deliver it to the expansion valve. The quantity of the condensed refrigerant of the receiver vary the amount of refrigerant in the evaporator, remaining in the liquid state of refrigerant in the receiver and able to smooth the drive of the device. Also, it plays a role in the pump down operation when the equipment will be stop in a long time and need repairing.

(5) Filter drier

Filter Drier

Filter drier is used to remove moisture acid and other contaminant, to providing reliable, long-lasting system protection. So in order to this, we install it in the liquid duct between the expansion valve and the liquid receiver.

(6) Solenoid valve

Solenoid valve

The solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically. So it controls the flow of the coolant. When driving the pump-down, it is connected in series with the temperature switch and the solenoid valve for main piping is opened and closed according to the closure and opening of the contact point of the temperature switch, letting pump-down process operate.

(7) Expansion valve

Expansion valve

Manual expansion valve is used for reducing pressure and temperature of liquid refrigerant from condenser. The liquid state of the refrigerant will be changed to a liquid-gas state, as the liquid refrigerant after through the expansion valve. In addition, it controls proper amount of heat absorb from the evaporator.

(8) Plate-type heat rxchanger

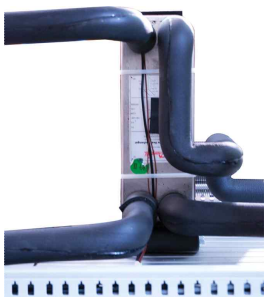
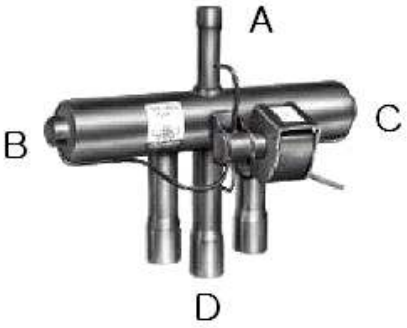


Plate-type Heat Exchanger

Heat exchanger is used in a heat transfer process from one media to another. Plate-type heat exchanger uses plate type wall as separator between cold and hot fluid so that they will never mix. It is designed for the heat of the hot media to be transmitted to the cold media by passing a hot media at one side and cold media at the other side between the adjacent plates.

(9) 4-Way valve

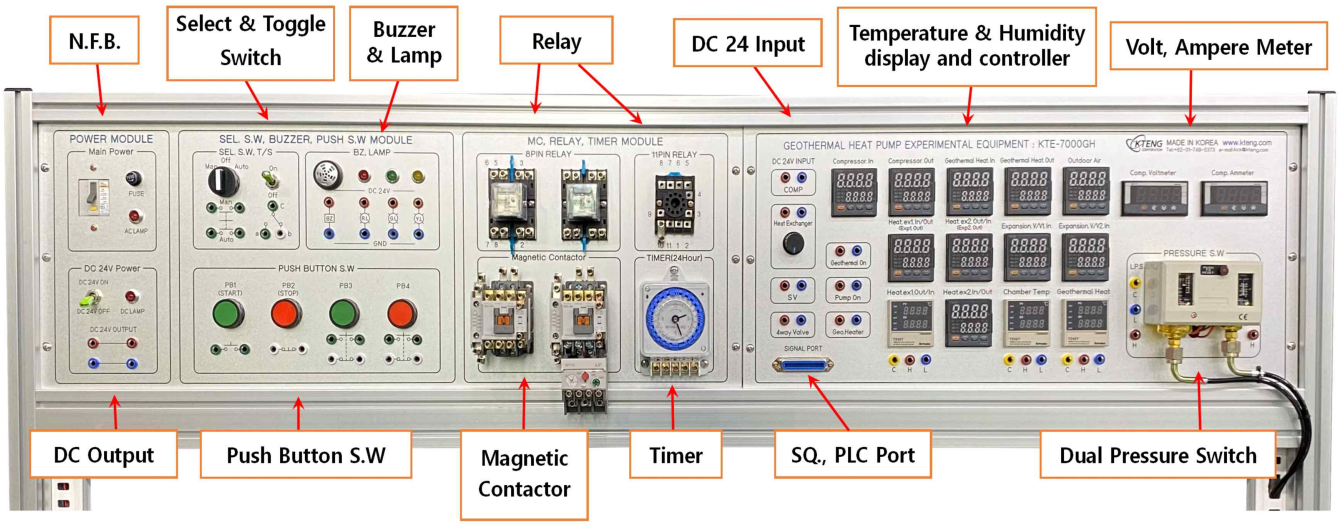



4-Way valve

4 way valve basically doesn't operate at a status where high and low pressure is not authorized. Of course, the solenoid valve that controls the direction operates according to the sign, but there is no direction change inside the actual 4 way valve. In other words, it is designed to be operated only under the condition high and low pressure is authorized. Figure 1.1.12 shows thin pipe is connected to A, B, C and D part at the 4 way valve solenoid valve. Inside the body of 4 way valve, there is a cap of size that can connect only 1 cap at the right and left lines on the basis of D lines, and they are designed to move from left to right and vice versa.

From the 4 way valve picture, A is always high pressure and D is low compressure. Under the status where cycle operates, when the thin pipe A&B and C&D are connected by solenoid V/V, B area of the inside of the 4way valve body is authorized by high pressure and the C area by low pressure, so the cap aforementioned is adhered to C area by pressure gap. At this time, the water way within the 4way valve becomes A-B and C-D. On the contrary, if the thin pipe A&C and B&D are connected, water way becomes A-C, B-D, and they change the direction inside the cycle.

## 2-4. Heat pump control panel

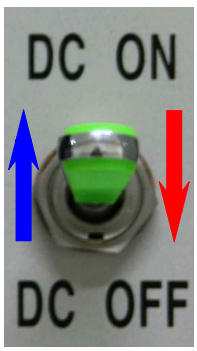



Control panel of heat pump department

① N.F.B
② Selector S/W, Toggle S/W
③ Buzzer
④ Lamp
⑤ 8 Pin Relay
⑥ 11Pin Relay
⑦ DC Input
⑧ Temp. Display
⑨ DC Power, DC Output
⑩ Push Button Switch
⑪ M.C
⑫ Timer
⑬ Signal Port
⑭ Low Pressure Switch
⑮ High Pressure Switch
⑯ Temp. Controller

(1) Main power

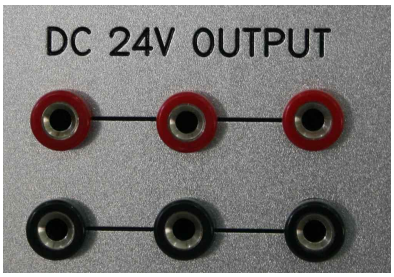

Main power section




TOGGLE Switch

Main power section is a part of control panel which has purpose alternating current (AC) electrical power supply. AC LAMP is a lamp to indicate the electricity current is flowing to the system. As you turn ON the toggle switch, direct current (DC) 24V is authorized to the system of the experimental equipment.

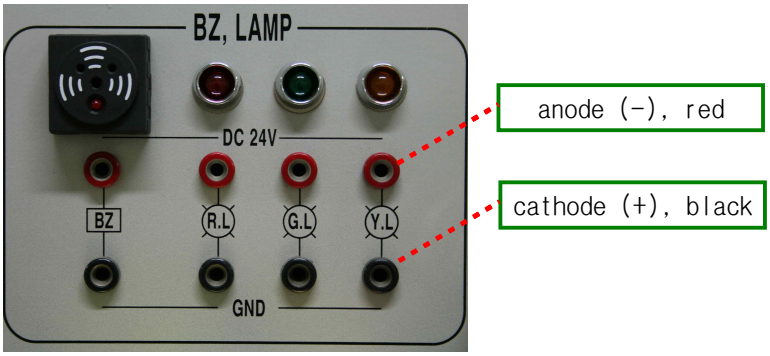
(2) Voltage and Electric current measurement




The DC 24V output section is the section for measuring voltage and electric current that use at the equipment, and it is the first section of wiring process as you star to plug **red jack wire (+)** and **black jack wire (-)**.

DC 24V Output

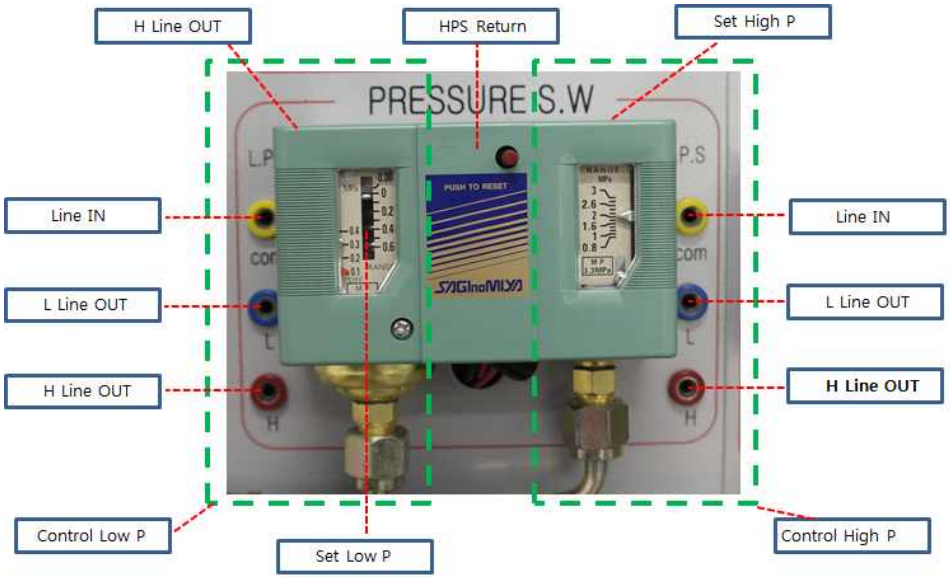
(3) Buzzer, Lamp




It is the device installed to indicate whether the equipment is operating or if there is trouble. Plug the **red jack wire (+)** and **black jack wire (-)**.

Buzzer, Lamp

(4) Pressure switch




Pressure switch

It is a form of switch that makes electrical contact when a certain set pressure has been reached on its input. In this equipment, it controls the pressure in the compressor.

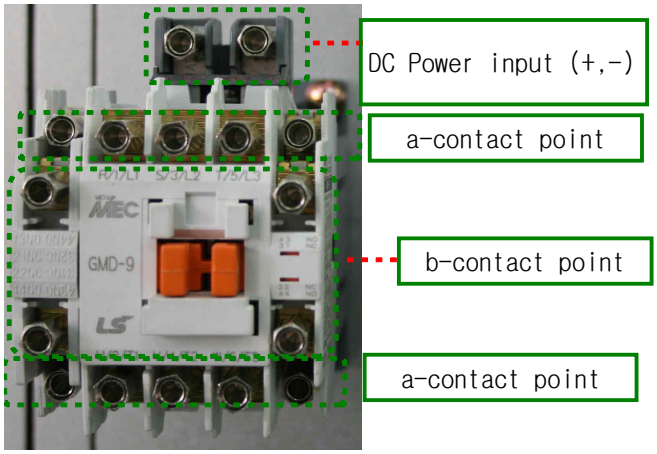
At the low pressure control (LPS) side there are RANGE and DIFF meter. RANGE is a middle value of pressure and DIFF is a deviation value of pressure to establish the minimum and maximum value of the pressure

Ⓐ To control the RANGE and DIFF values we need a screw driver (+) to rotate a screw at the

upper side of the device.

Ⓑ We plug the anode power in the com port and plug the banana jack cable in the blue (L) and/or red (H) ports according to the method of wanted control. The pressure switch is used to control the compressor.

(5) Magnetic Contactor (M/C)



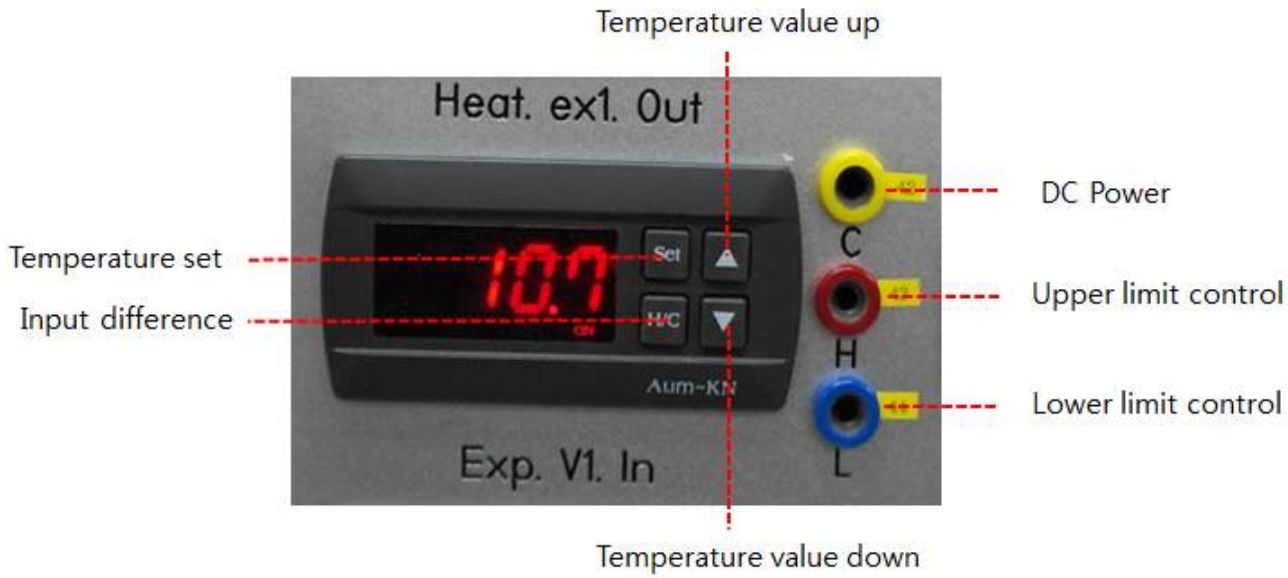

Magnetic Contactor(M/C)

It is the part that is used to switch a power circuit ON and OFF of the equipment

Ⓐ The input in the DC power input section red port is for (+) positive and black port is for negative (-).

Ⓑ A contact or normal open contact point is the contacts are separated and the switch is nonconducting, and B contact or normal open is the contacts are touching and electricity cal flow between them.

(6) Temperature switch (OLD VERSION)




Temperature switch

It is the part that is used to control a circuit turn ON and OFF by setting the temperature of the equipment.

① Push the "set" button to the temperature main value section.

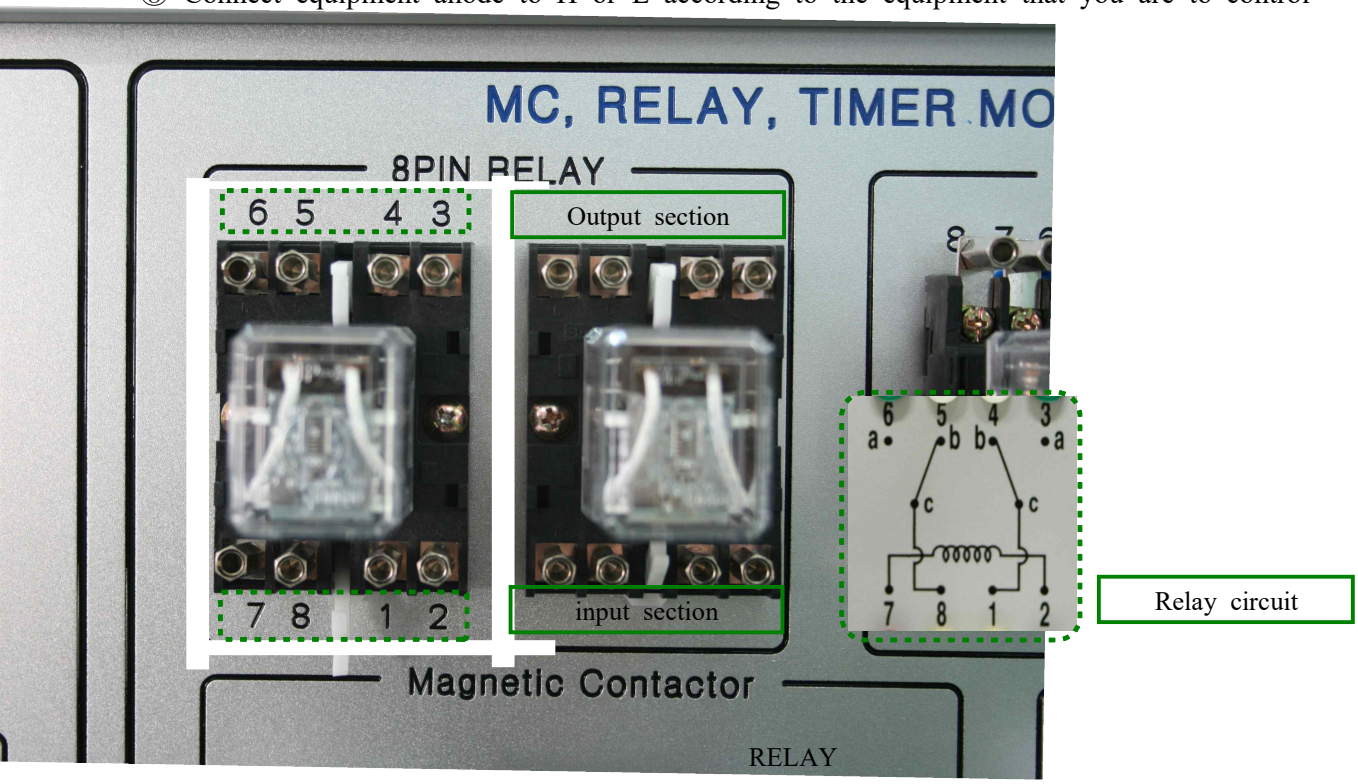
② Push the up or down arrows to set the value of main temperature.

③ Push the "H/C" button to set temperature deviation and push the up or down arows to set the

deviation value.

④ The red / positive (+) cable is connected to com

⑤ Connect equipment anode to H or L according to the equipment that you are to control




Relay is a part that is used to control the circuit by switching ON and OFF with low power signal.

Ⓐ Connect the positive (+) port with the red jack cable and negative (-) port with the black jack cable of the power input section.

Ⓑ Connect the input and output ports with the red jack cables depend on the contact type we are using to control the circuit.

(8) Button, Toggle Switch


Toggle switch

It is a switch that break an electrical circuit or diverting the current from one conductor to another by flip the buttons.

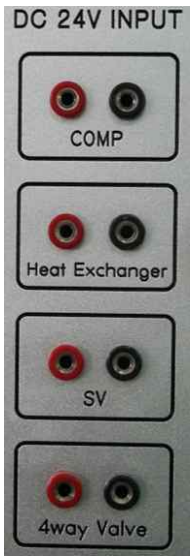
① As for the toggle switch, input + power to C and turn on or stop through a or b choice.

(9) Other temperature displays


Device that display temperature at each location.

Temperature display

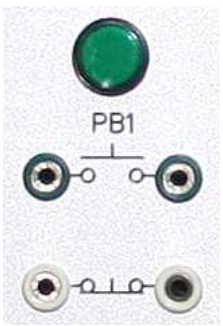
(10) Equipment power input section




Parts that inputs power to each part of equipment (Connect anode (+) to red jack cable and cathode (-) to black jack cable)

Equipment power input section

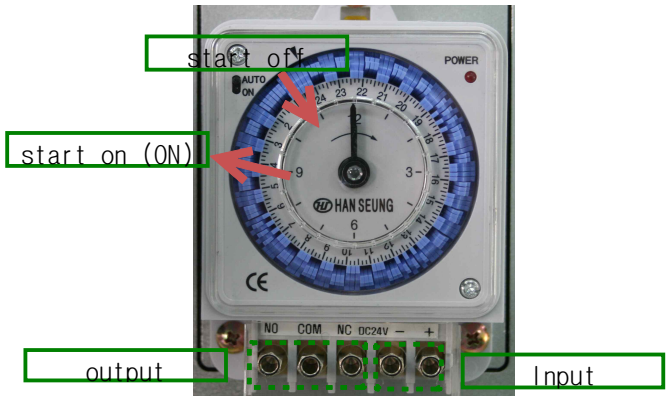
(11) Push button switch




Push button with A (normal open) and B (normal close) contacts, it switches on or off of a circuit configuration mechanism.
There is no different polarity of input and output in the system.

Push button switch

(12) Timer




Timer

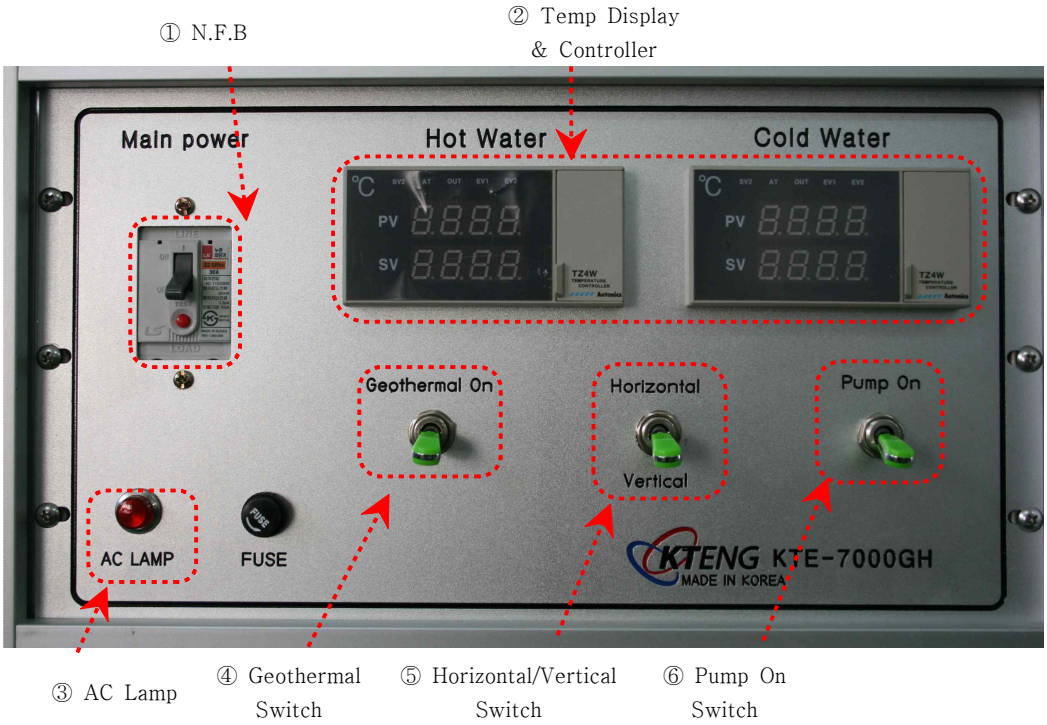
Connect DC curent to the positive (+) and negative (-) ports

AUTO: Panel adjustment to the ON and OFF position

ON: the contacts are always connect

the minimum timing range is 10 minutes and full timing range is 24 hours

## 2-5. Control panel of geothermal division




Control panel of geothermal department

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

Main power section is a part of control panel which has purpose alternating current (AC) electrical power supply. AC LAMP is a lamp to indicate the electricity current is flowing to the geothermal division system. As you turn ON the toggle switch, direct current (DC) 24V is authorized to the system of the experimental equipment.

(2) AC LAMP

When you turn on the N.F.B power, power is authorized and light is on the AC LAMP.

(3) Geo-thermal environment ON/OFF switch

When you turn ON the Geothermal switch, it operates cooling/heating mode according to the setting of temperature value.

(4) Horizontal/Vertical Convertible Switch

When we activate the switch toward horizontal, the horizontal ground heat exchanger is operating, and when we ativate the switch toward vertival, the vertical ground heat exchanger is operating.

(5) Circulation pump ON/OFF switch

the water in the ground heat exchanger will be pumped to the plate heat exchanger in the heat pump division when we switch up to the pump on.

# 3. Data Acquisition device between PC and machine

## 3-1. Data Acquisition and System Monitoring Program

### 3-1-1. 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, coefficient of performance in the abstract with temperature and pressure data which are measure in real time

(4) Being saved data all of temperature, pressure and enthalpy on every second as excel

(5) Experiment for variety of condensation temperature(Subcool) on second cycle as change of evaporation temperature on first cycle.

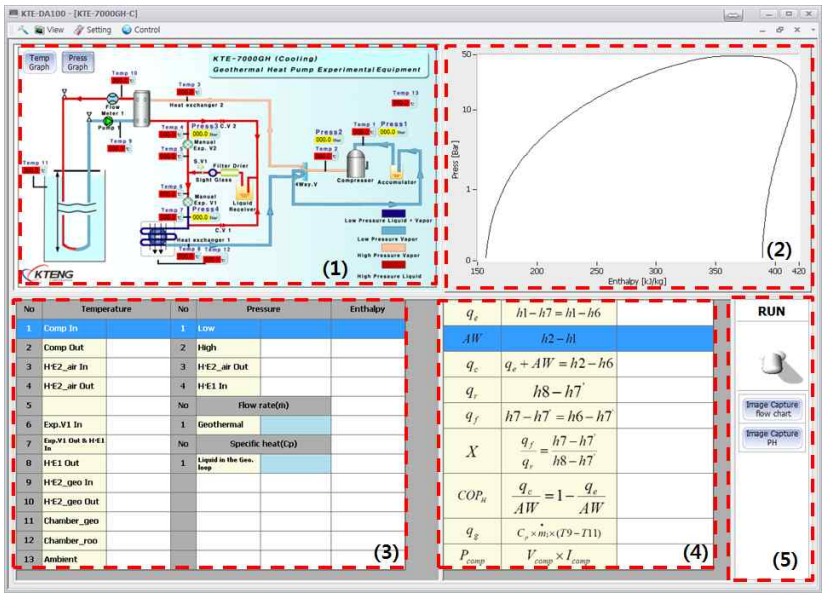
(5-1) Experiment for variety of condensation pressure on second cycle as change of evaporation temperature on first cycle.

(6) Experiment for variety of evaporation temperature(Superheat) on first cycle as change of evaporation temperature on first cycle.

(6-1) Experiment for variety of evaporation pressure on first cycle ass change of evaporation temperature on first cycle.

(7) Check the COP as change of evaporation temperature on first cycle.

### 3-1-2. Composition




(1) Schematic diagram of equipment.

(2) p-h diagram.

(3) Data table for temperature, pressure and enthalpy.

(4) Sort of Calculation value like as COP, cooling capacity and heating capacity.

(5) Start switch and capture button

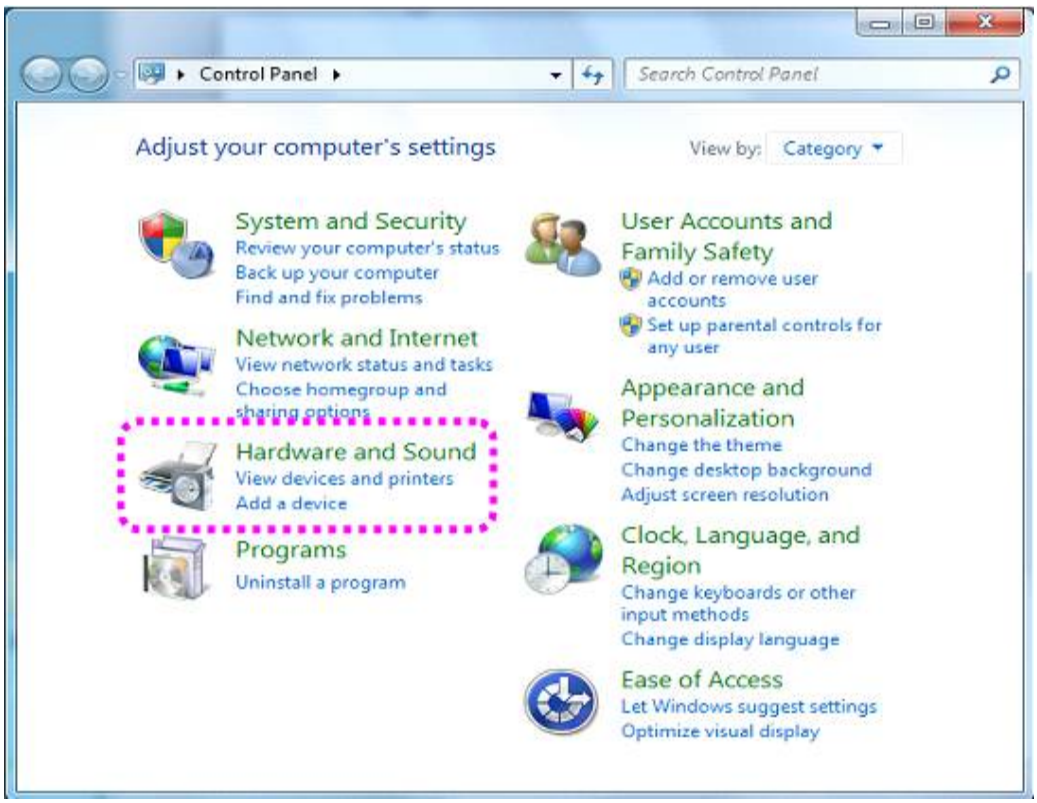
3-1-3. Being registered with KoreaSoftwareCopyrightCommittee.

## 3-2. Install and how to use KTE-DA100

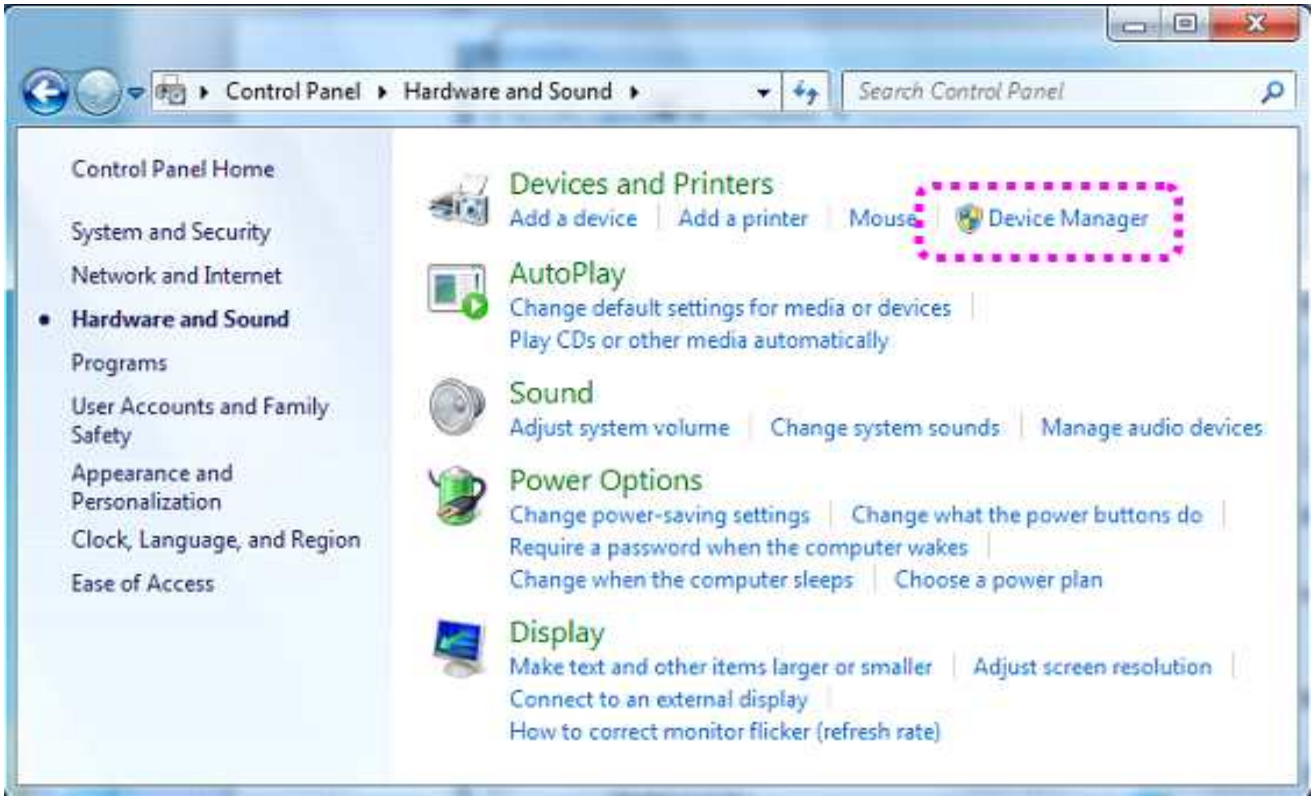
### 3-2-1. INSTALL USB TO SERIAL

- Communication method is using computer 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.

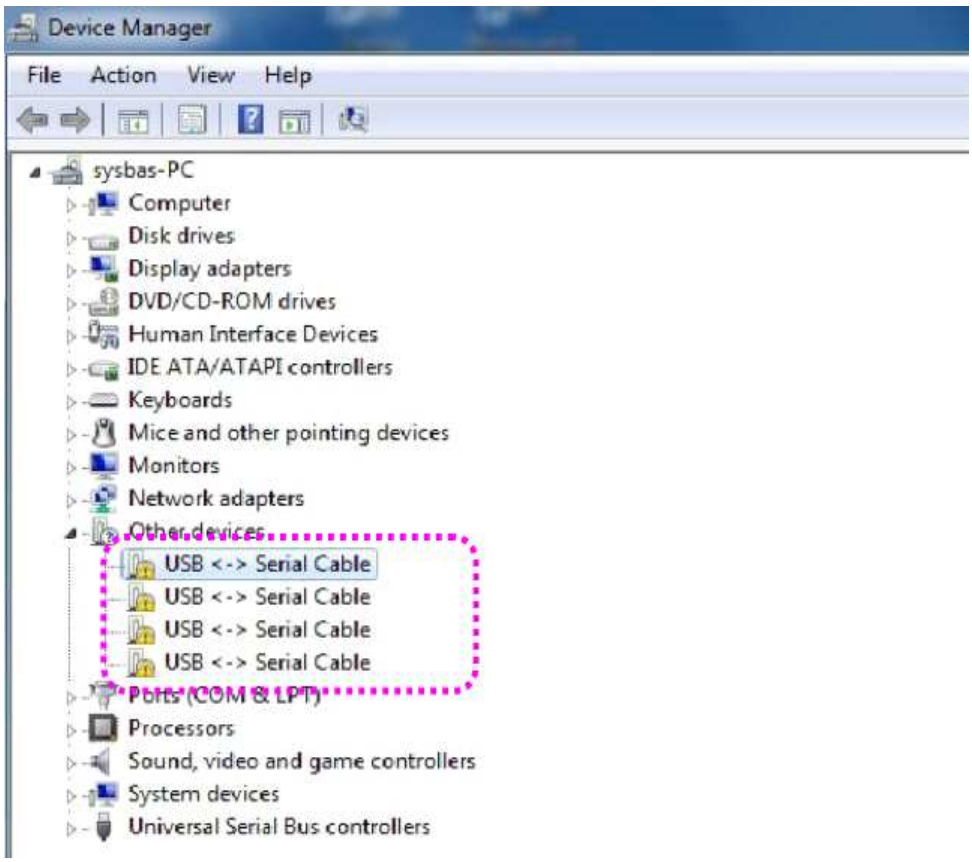
1. Run Windows 7
2. Connect USB MultiPort to your PC's USB port.
3. Inset media CD(provided with MultiPort) into the CD drive.
4. Click "Hardware and Sound" in "Control Panel"



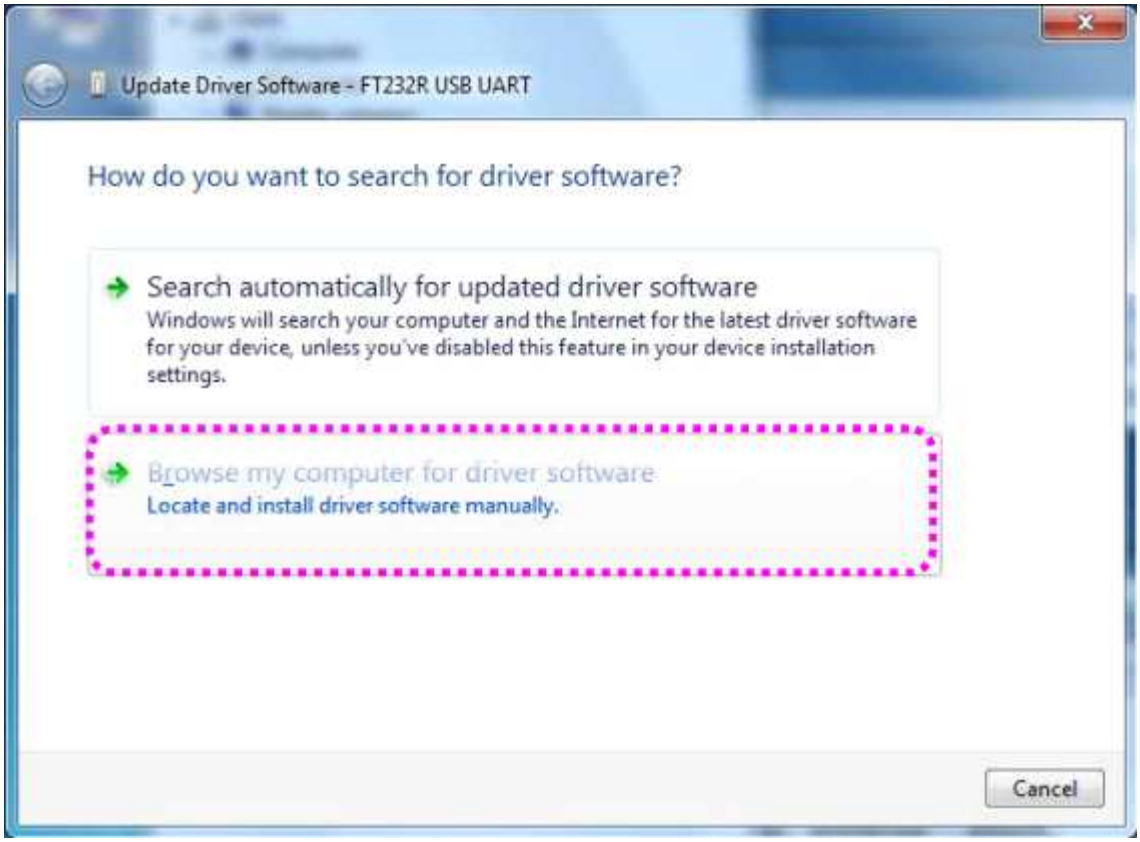
5. Following picture depicts Device Manager after carrying out step 4. Click “Device Manager”.




6. Right click “USB <-> Serial Cable” in “Device Manager”. Then choose “Update Driver Software”.

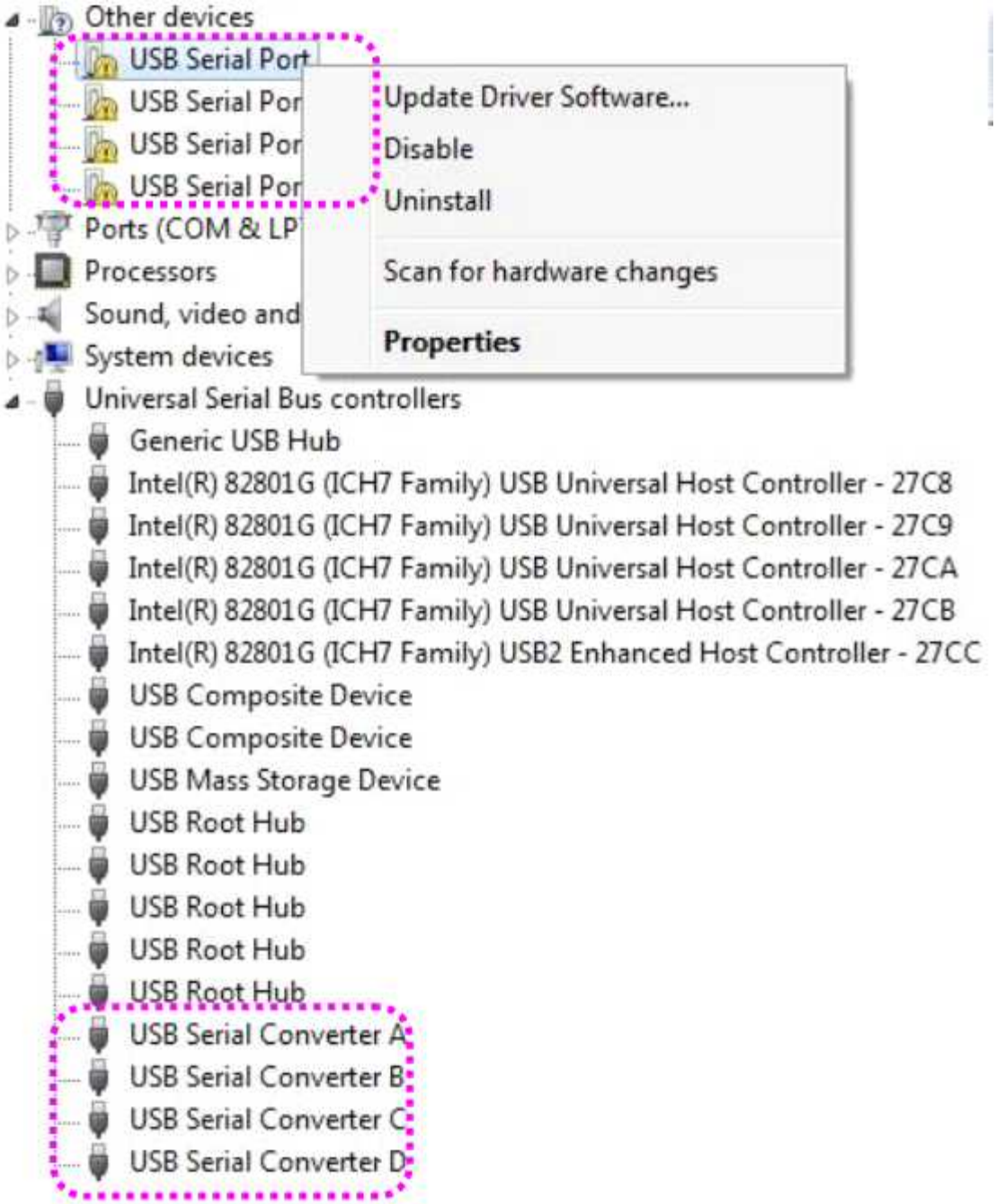


7. Click “Browse my computer for driver software”in order to install driver manually.

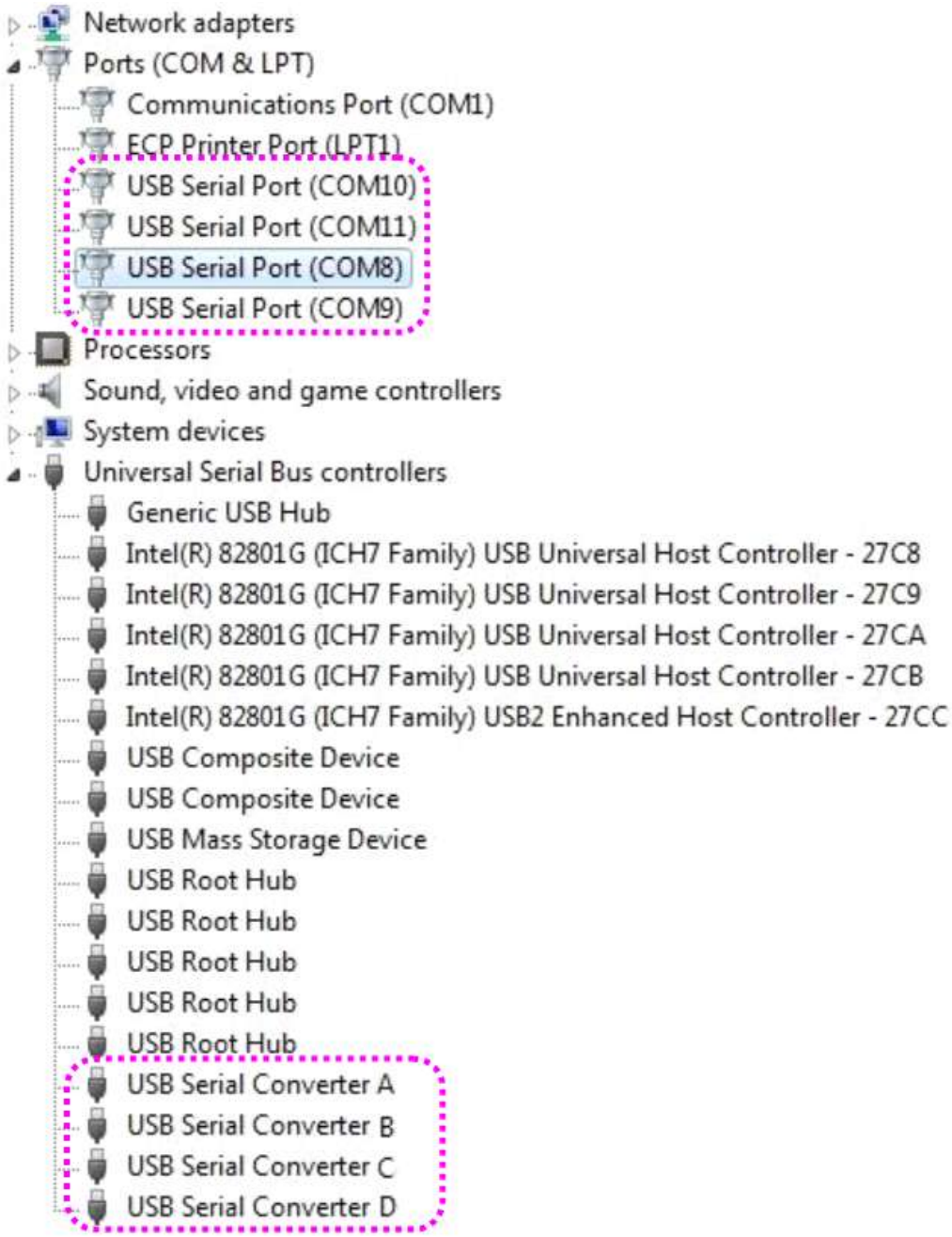



8. Click “Browse”and set driver software’s location to [CD]:\Driver\USB\Win2000\,XP,2003,Vista,2008,7”.

9. Confirm that “USB Serial Converter” is installed normally. Then, right click “USB Serial Port”and follow the same process from number 6 again.



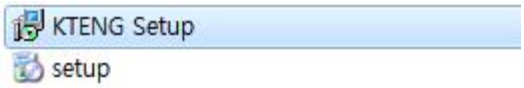
10. Following picture depicts “Device Manager”after carrying out all steps. As can be seen, all “USB Serial Converters” and“USB Serial Ports” are successfully installed.




11. “USB Multiport”installation on Window 7 is now finished.

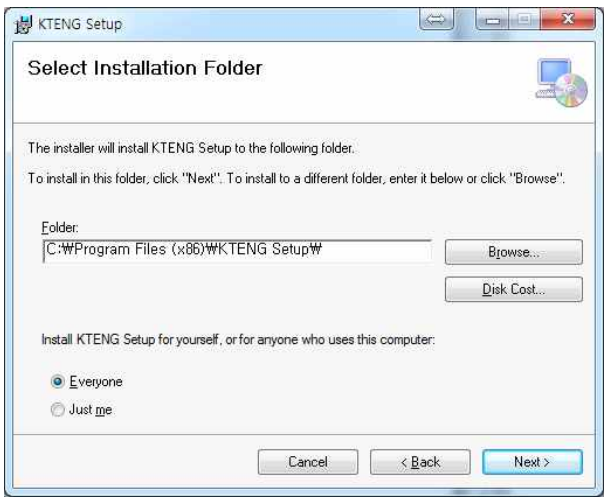
### 3-2-2. KTE-DA100 Installation and Operating

#### ① KTE-DA100 Installation

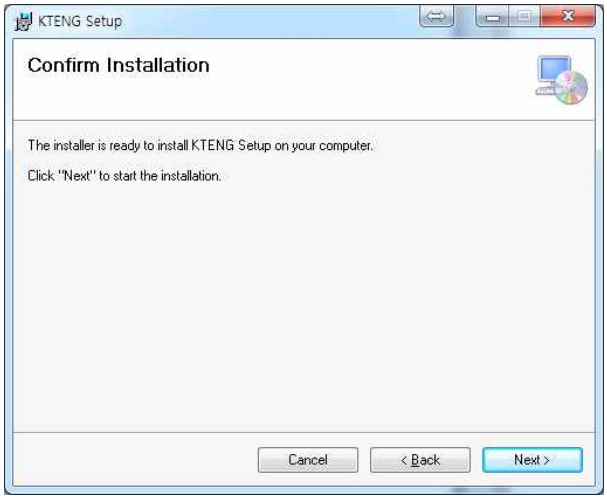



1) You can see a installation files that in CD or USB for installation then double click ‘KTENG Setup’ file to start installation. If the program cannot be installed using ‘KTENG Setup’, try to ‘setup’file.

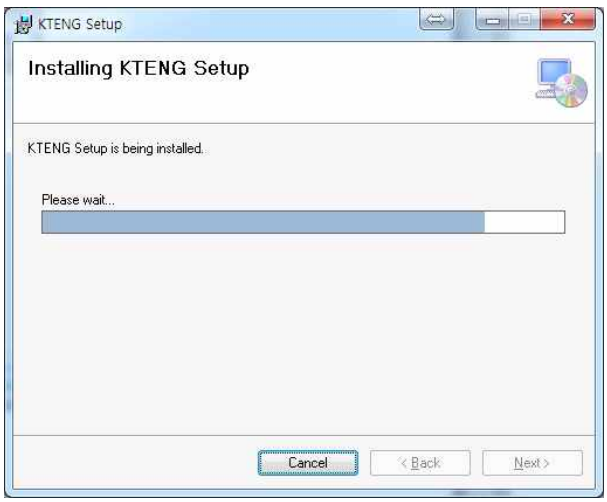

2) If you can see a ‘Setup Wizard’ screen, click the ‘Next>’.



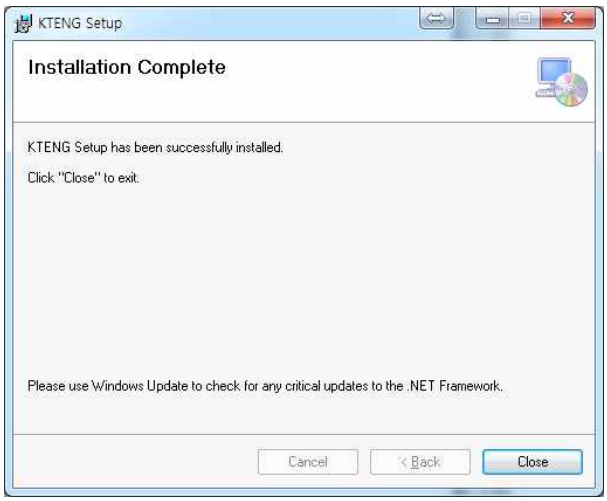

3) You can change a installation route. If you want to change a installation route, click the ‘Browse..’ and find a new route then click the ‘Next>’.




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




5) Installing a program.

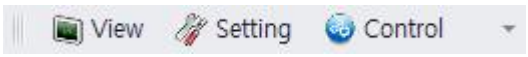



6) Please click the ‘Close’ and complete a installation.

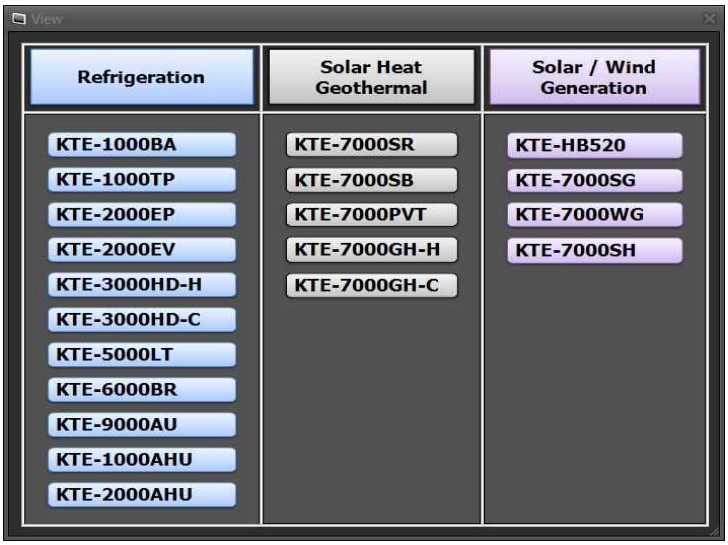
5) Start program by using icon in wallpaper or routing folder then the main page of program come up.


| | | | |
|---|---|---|---|
| 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

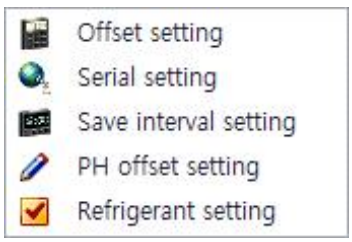




1) View

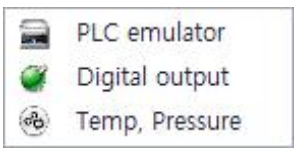



(Refrigeration 11 species, Solar-Geothermal 5 species, Solar-Wind energy 4 species)

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 |

※ Please refer to page 69 for more detail information.

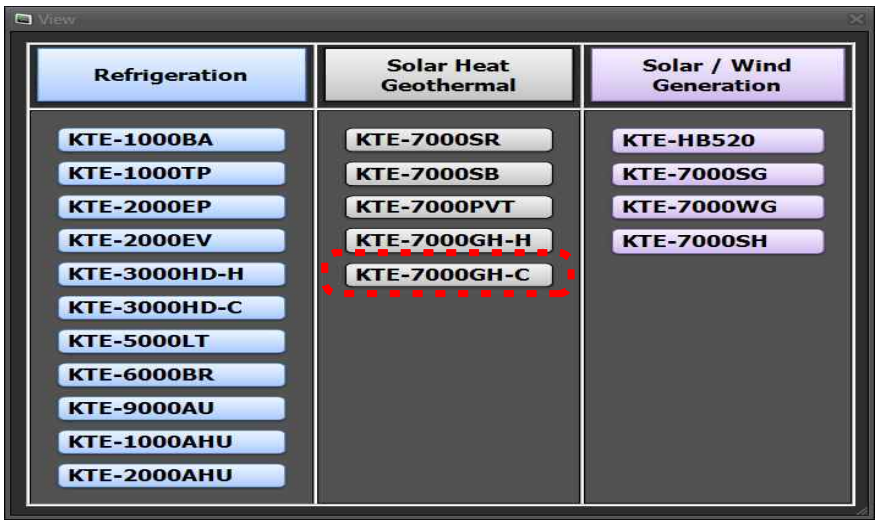
## (3) Control

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

※ Please refer to page 76 for more detail information.

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

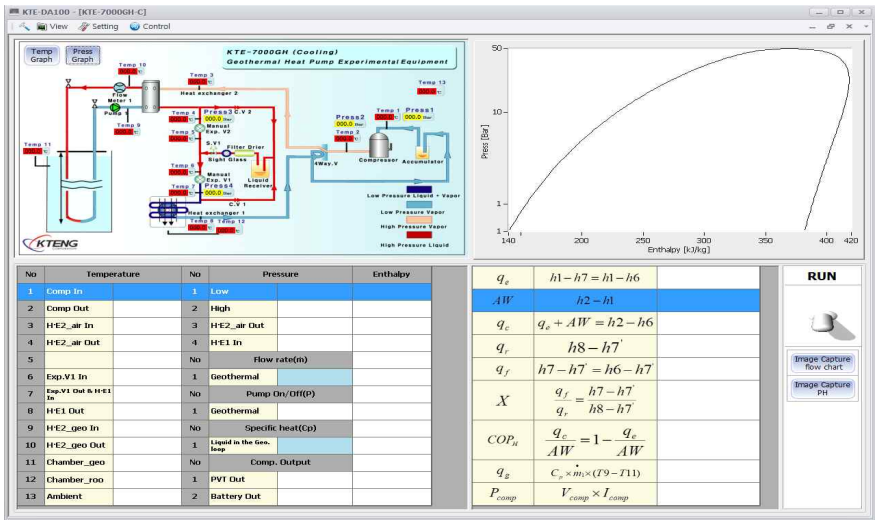
### ① Selection of Model




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

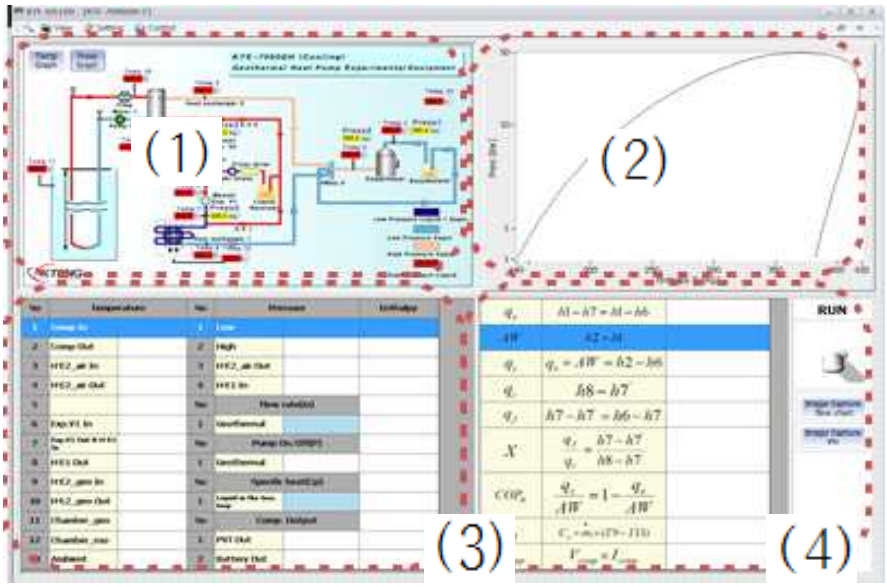
(2) Select a model what you want. (Click the KTE-7000GH-C)

※ GH-C : Cooling
GH-H : Heating mode




(3) Main user interface of KTE-7000GH-C(Geo-Thermal Heatpump Experimental Equipment) is activated.

## i) Composition of main user interface



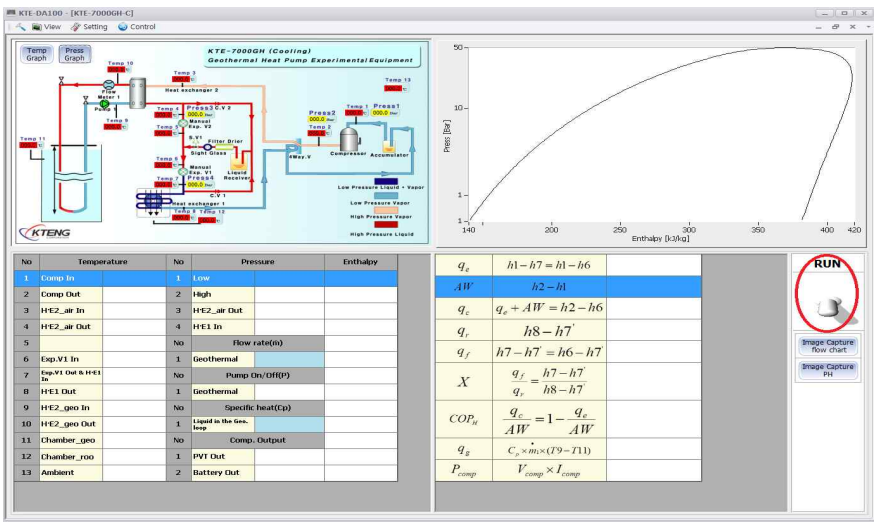

(1) Schematic diagram of system show temp, press. in realtime

(2) p-h chart.

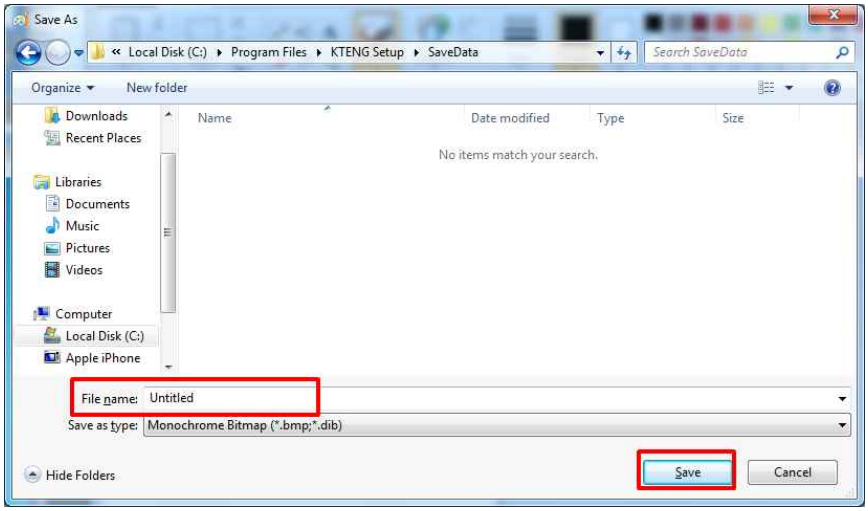
(3) Data table of temp, press, and enthalphy

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

## ii) Operating and saving data



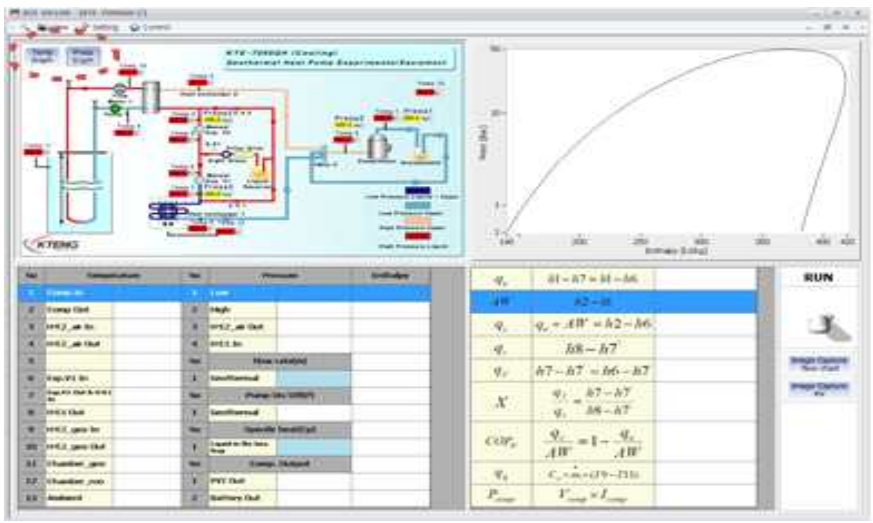

(1) Click a toggle switch to run program to save data.



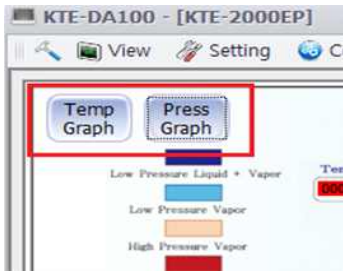

(2) Write a title and save a file by excel.

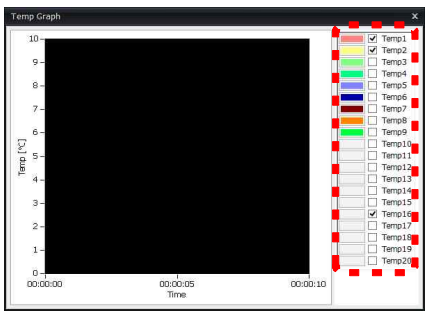
※ The reason of writing title first is that can save data even though unavoidable situation happened.

## iii) Find a graph

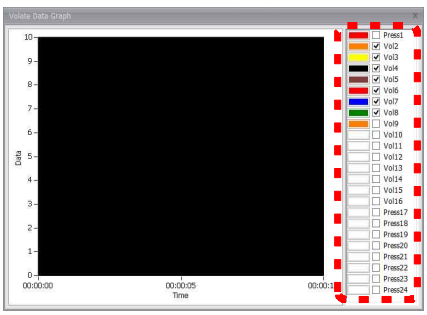


(1) If you want to see a temp., and press, graphically, please click a icon in red box below.



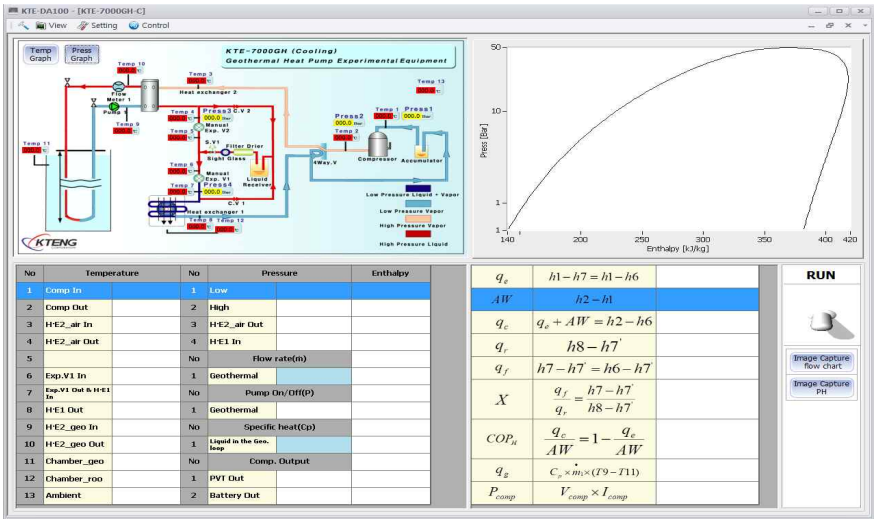




Temperature Realtime Graph




Pressure Realtime Graph

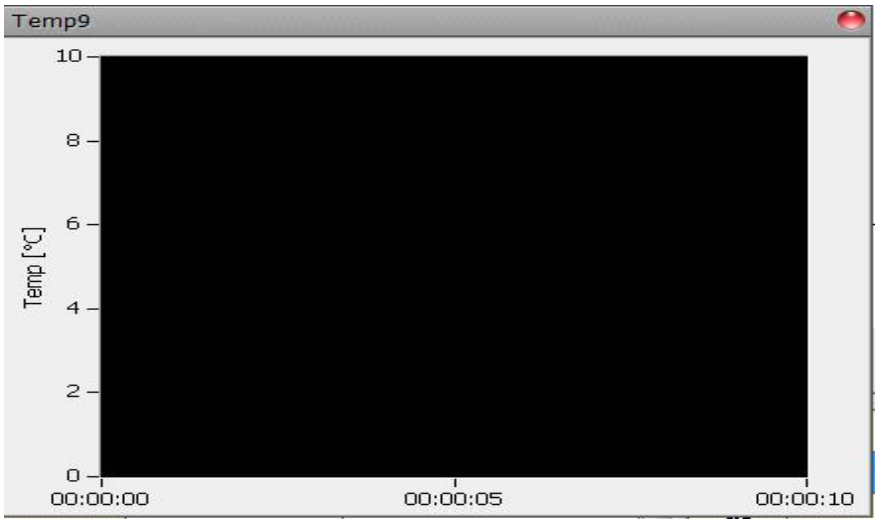
(2) You can always see the graph for location and figure through checking temperature, pressure




| No | Temperature | No | Pressure | Enthalpy |
|---|---|---|---|---|
| 1 | Comp In | 1 | Low | |
| 2 | Comp Out | 2 | High | |
| 3 | H-E2_air In | 3 | H-E2_air Out | |
| 4 | H-E2_air Out | 4 | H-E1 In | |
| 5 | | No | Flow rate(m) | |
| 6 | Exp.V1 In | 1 | Geothermal | |
| 7 | Exp.V1 Out & H-E1 In | No | Pump On/Off(P) | |
| 8 | H-E1 Out | 1 | Geothermal | |
| 9 | H-E2_geo In | No | Specific heat(Cp) | |
| 10 | H-E2_geo Out | 1 | Liquid in the Geo. loop | |
| 11 | Chamber_geo | No | Comp. Output | |
| 12 | Chamber_roo | 1 | PVT Out | |
| 13 | Ambient | 2 | Battery Out | |

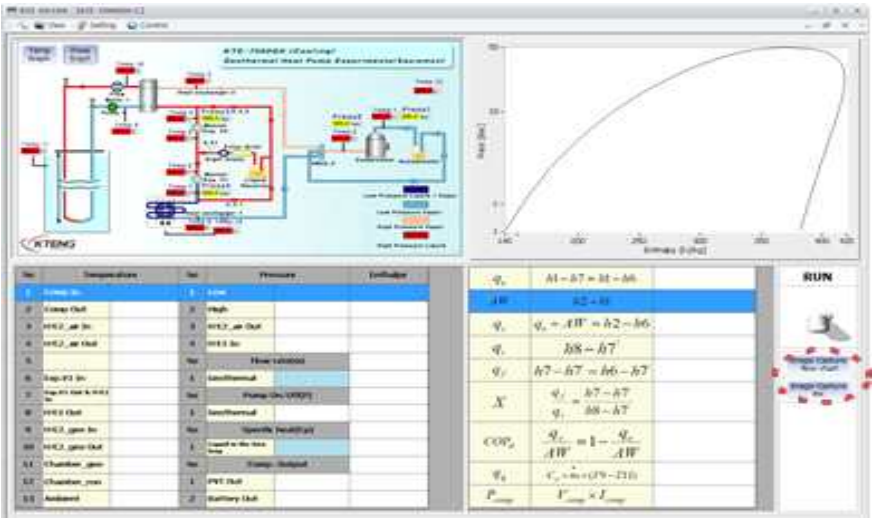
| | |
|---|---|
| $q_e$ | $h1-h7=h1-h6$ |
| $AW$ | $h2-h1$ |
| $q_c$ | $q_e+AW=h2-h6$ |
| $q_r$ | $h8-h7'$ |
| $q_f$ | $h7-h7'=h6-h7'$ |
| $X$ | $\frac{q_f}{q_r}=\frac{h7-h7'}{h8-h7'}$ |
| $COP_H$ | $\frac{q_c}{AW}=1-\frac{q_e}{AW}$ |
| $q_g$ | $C_p \times m_1 \times (T9-T11)$ |
| $P_{comp}$ | $V_{comp} \times I_{comp}$ |

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

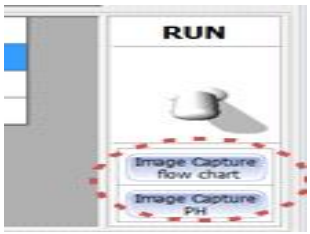



(4)You can always check the temperature

## 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



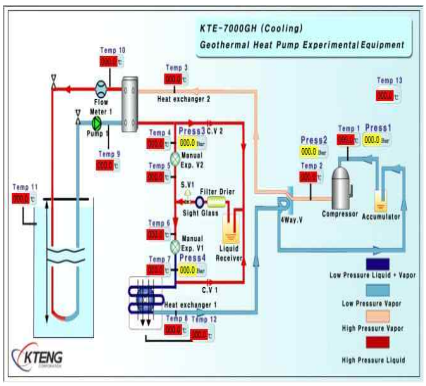
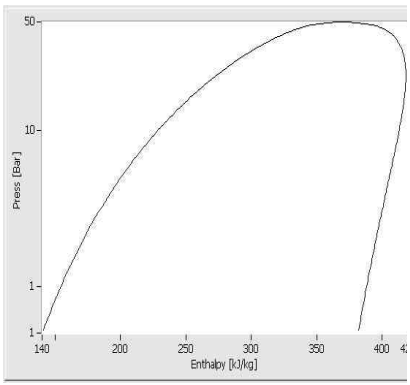




Diagram capture(Flow Chart)

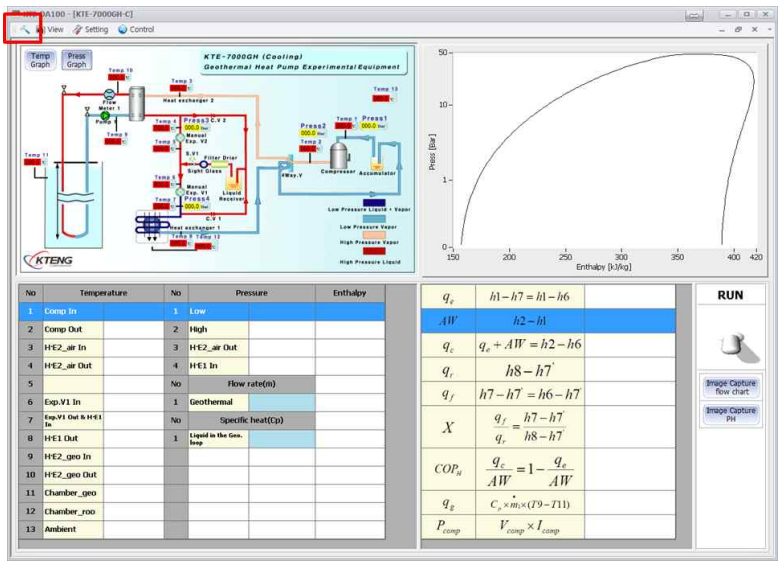



PH line capture

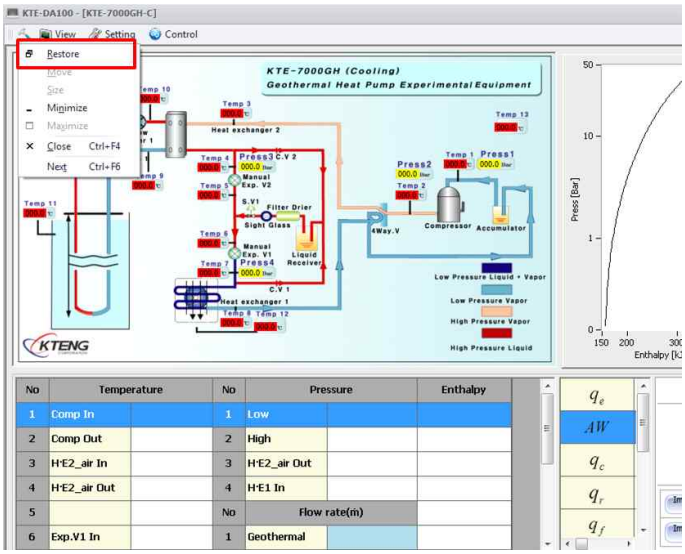
(2) Monitor when choosing
- Diagram(Flow Chart) capture
- PH line capture

## ② Function for collecting data tools

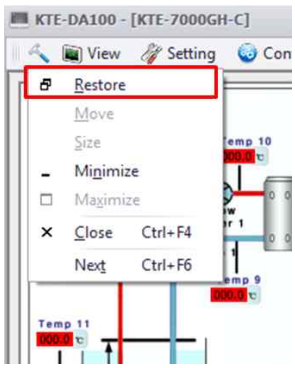
### i )Tools

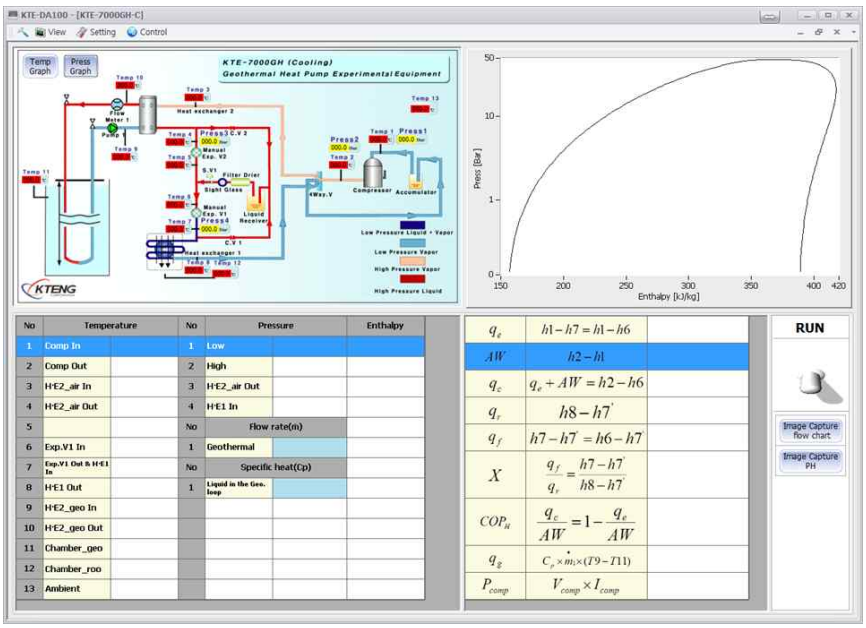



(1) Click  in Tools

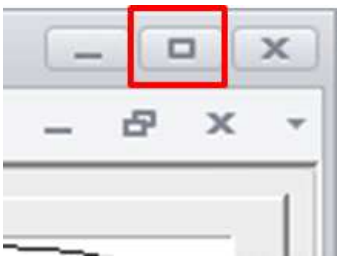


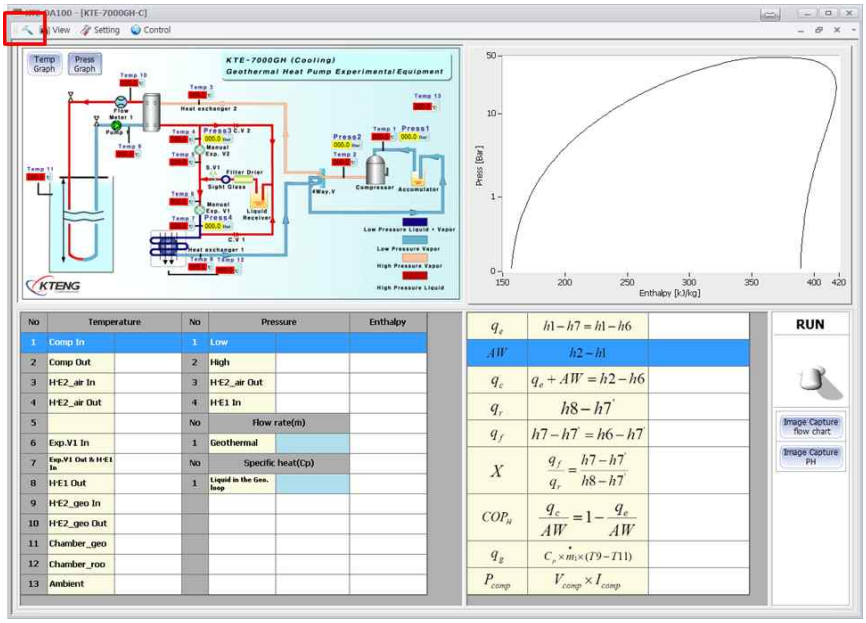

(2)When you click (R) for before size, the window is activated for moving



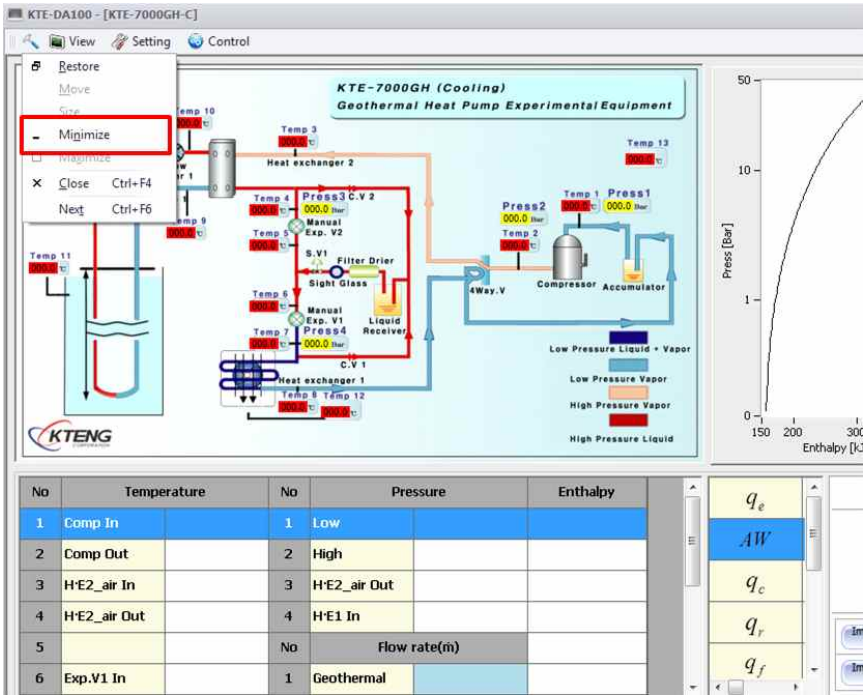




(3) Click that button, the window is bigger.

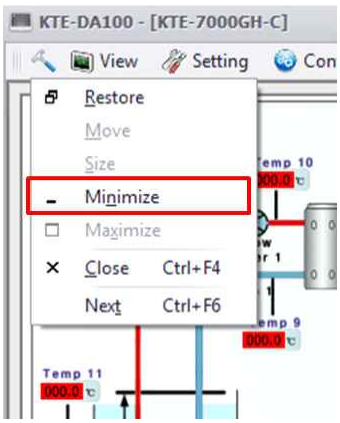





(4) Click 



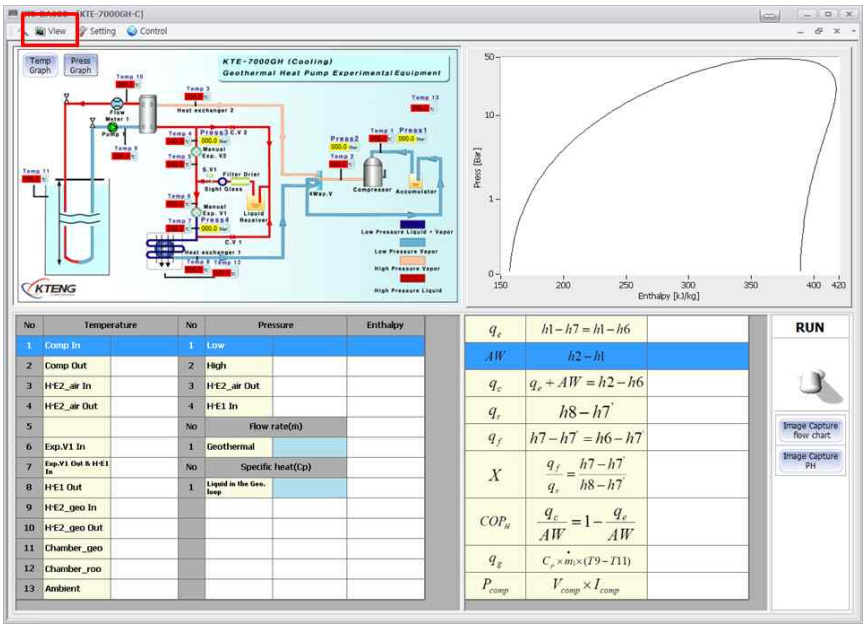

(5) When click the minimum(N), indicate bottom of the left side.



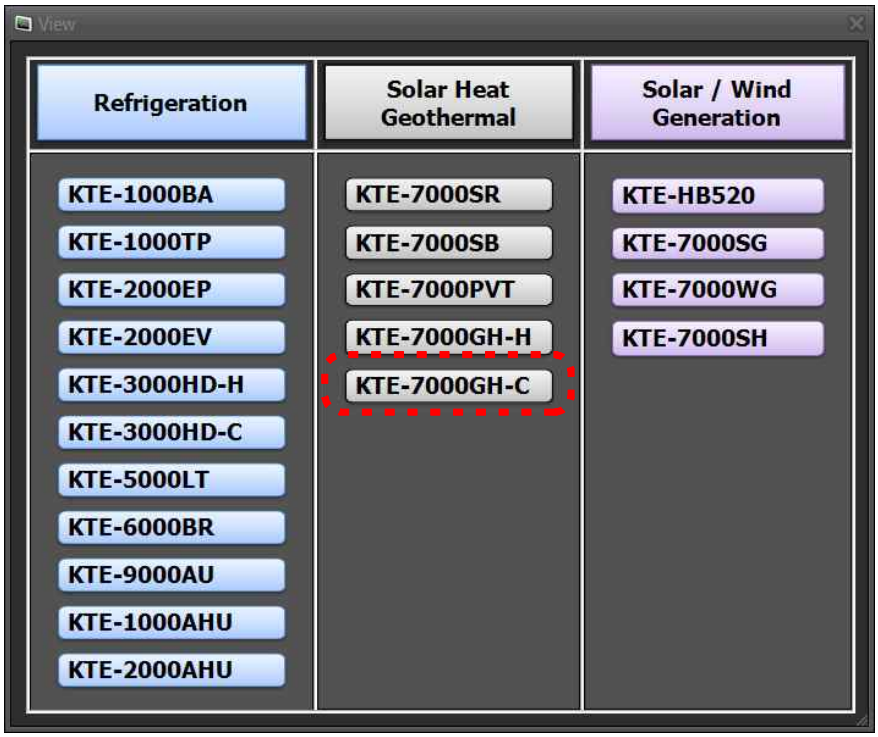


(6
When click whole monitor, it is returned.

## ii) View



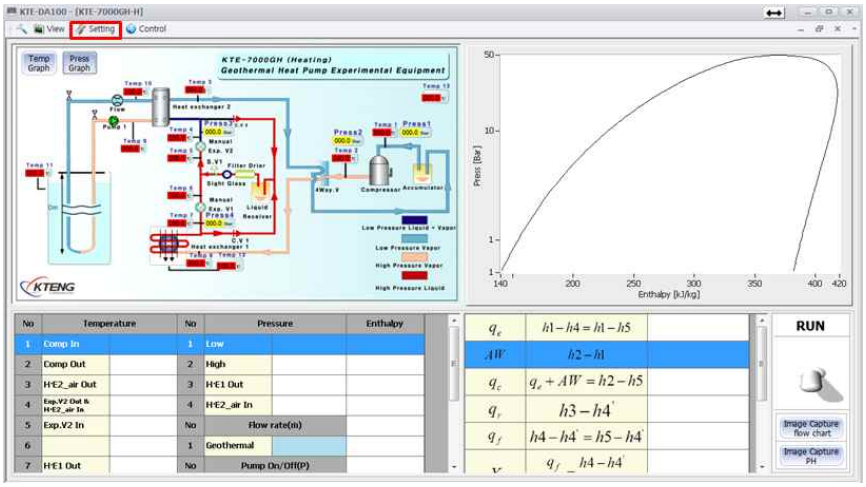

(1) Click the view in Tools



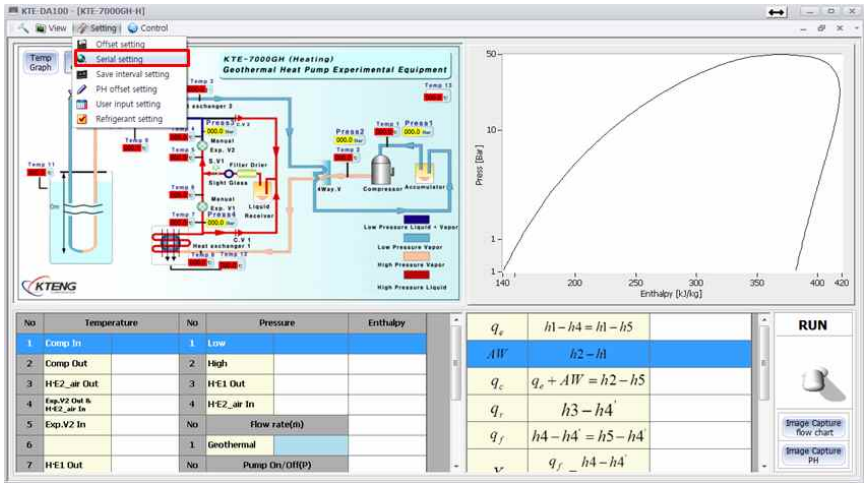

(2)
When you click the view and click Model name then it goes to main sreen and it indicates program screen which is connected with real equipments

## iii) Setting

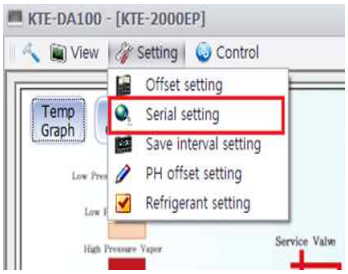
### a) Serial setting



(1) Click Setting

(2) Click Serial setting

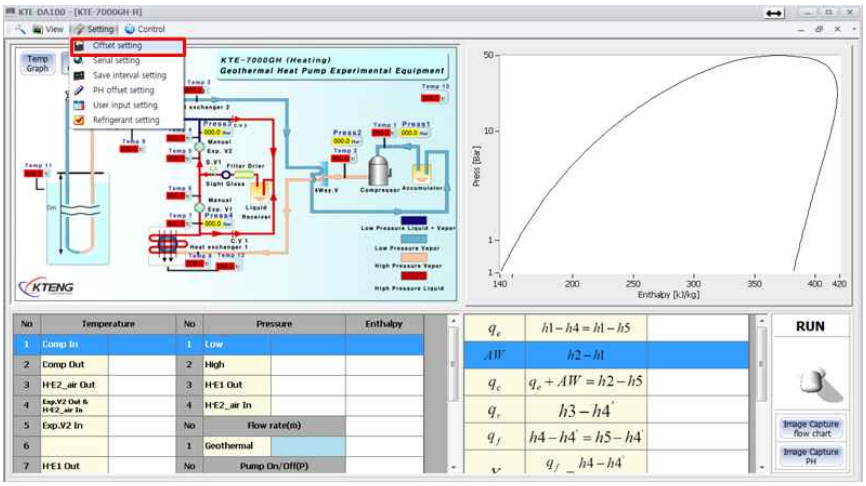




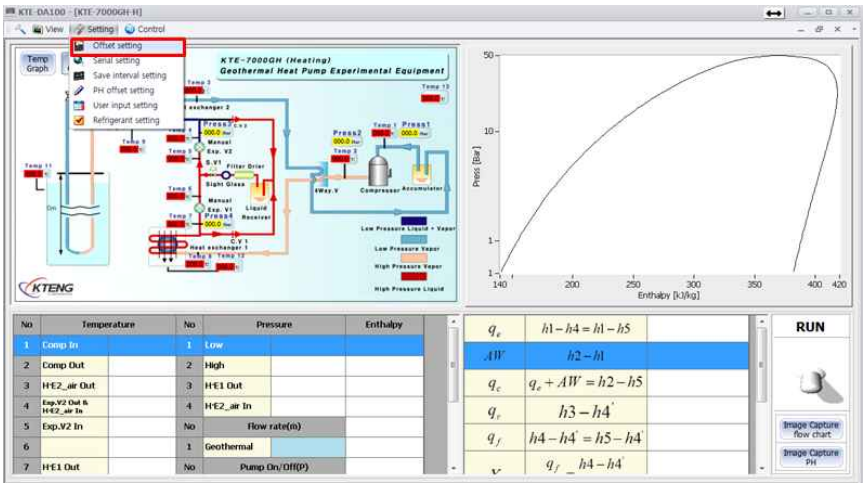
(3)
COM No is changed depend on port location. choose COM No and Click OK

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

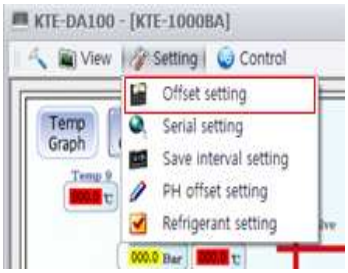
## b) Offset setting

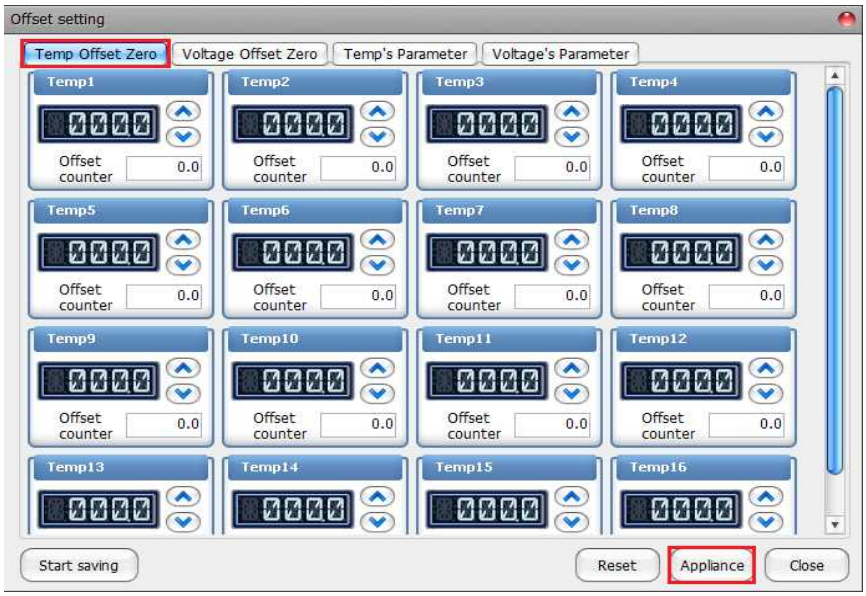


(1) Click Setting in Tools

(2) When you click Offset setting, below screen is indicated



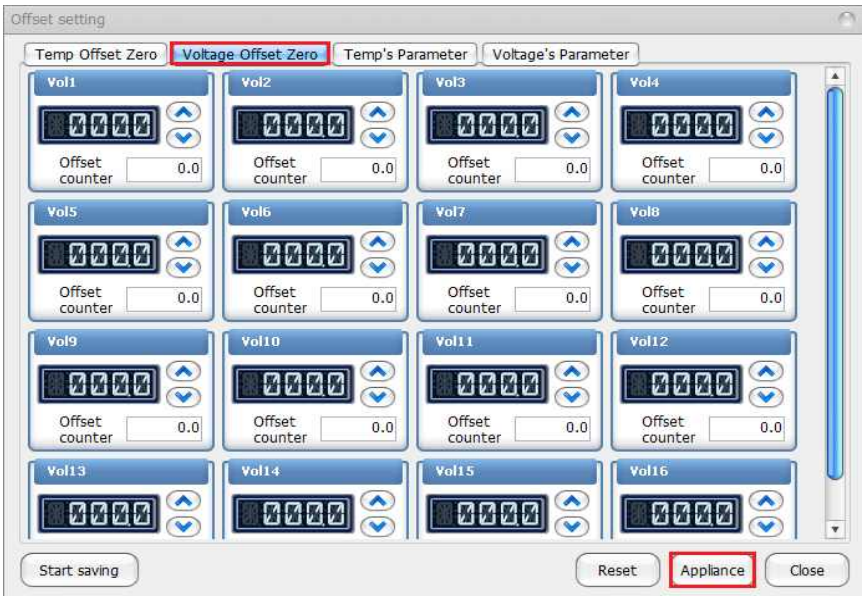

(3) Temp Offset Zero is that can control temperature

: 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

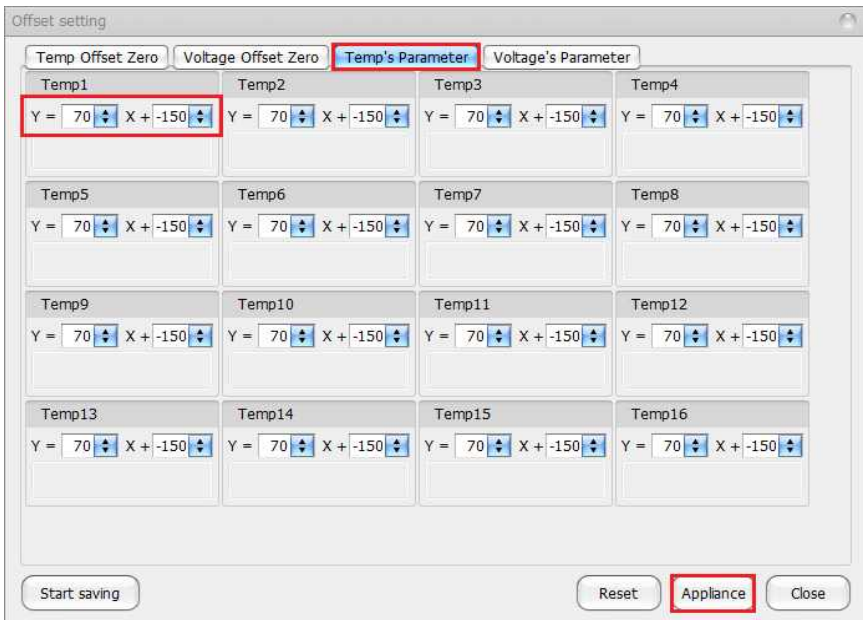



(4) Voltage Offset Zero is a part of can control voltage

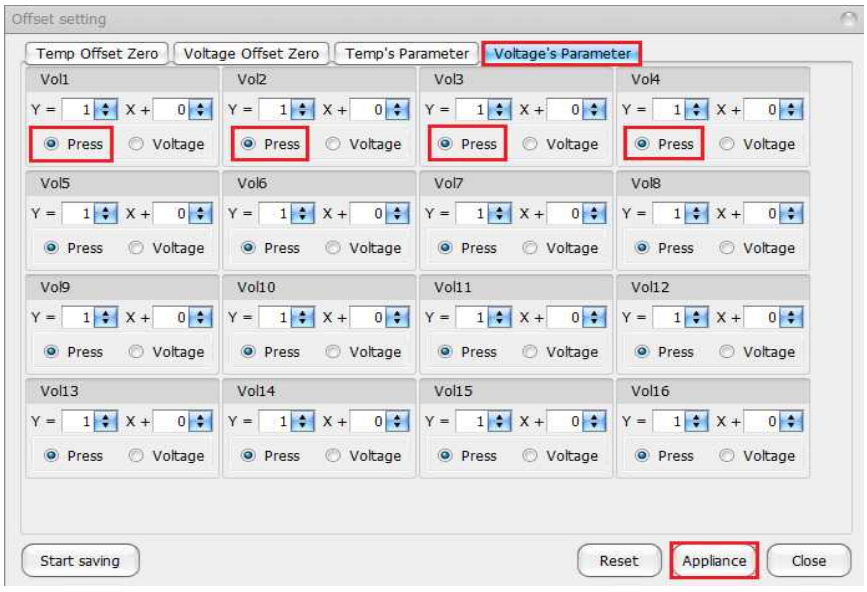
: You can control using direction key

Offset counter 0.0 : It is indication for voltage figure

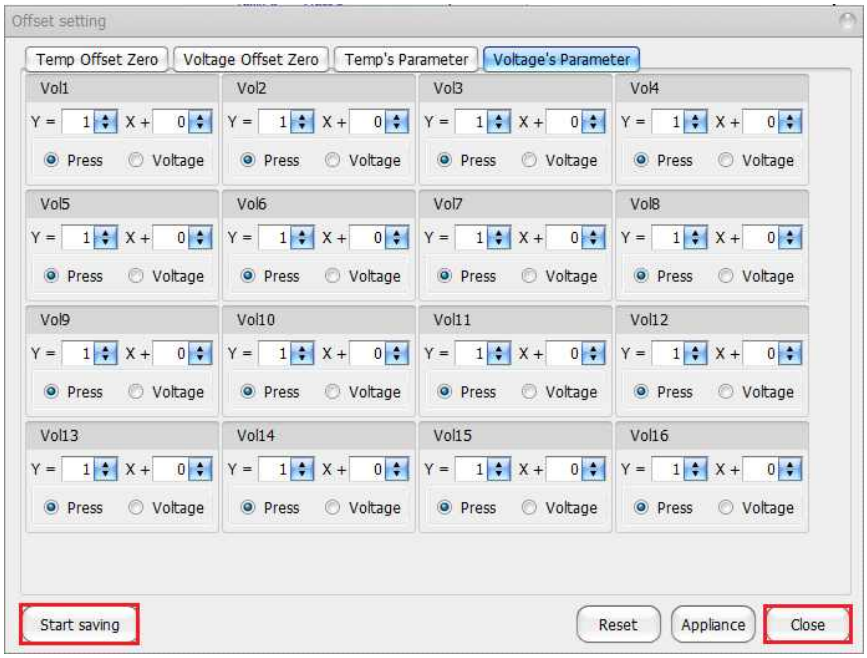
Click the application then click the Close for applying the figure




(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

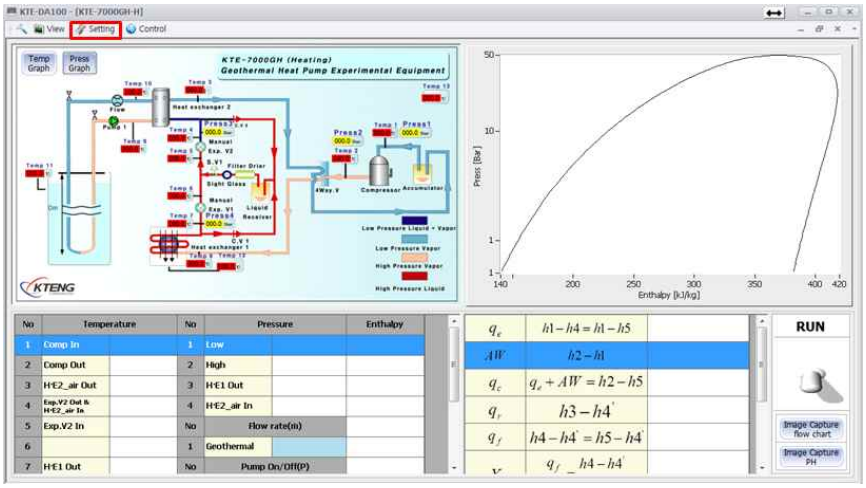



(6) Voltage`s Parameter has a function which can input the figure for changing input figure, You can set as choosing Pressure, Voltage. Click“Application" and click "Close" for Application.

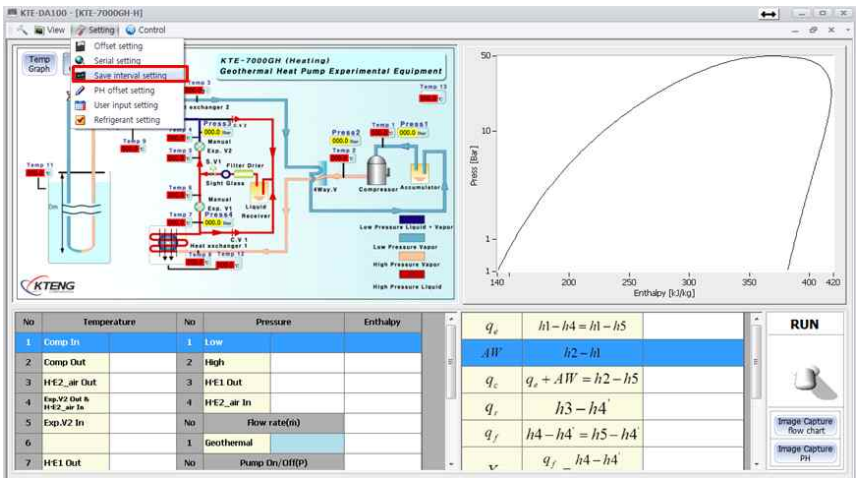



(8) Start saving set figure and Click "Close" on the left screen

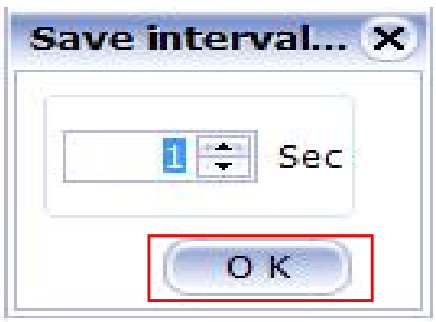
c) Save interval setting




(1)Click Setting

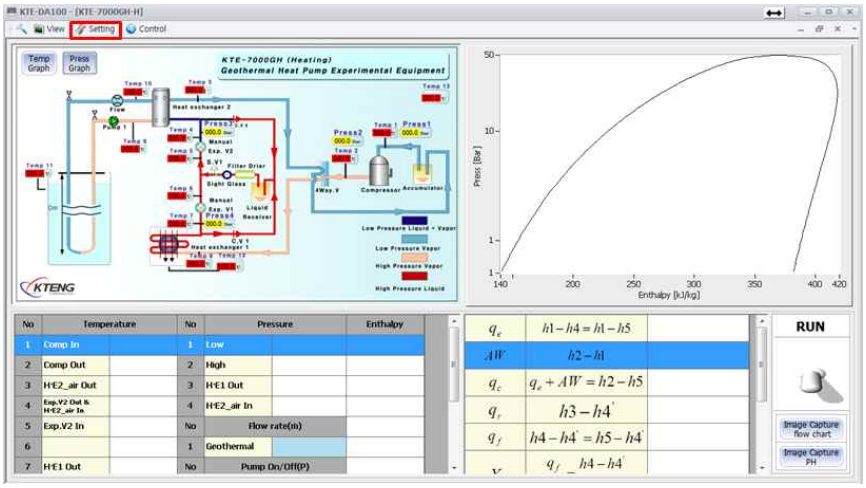

(2) Click Save interval setting

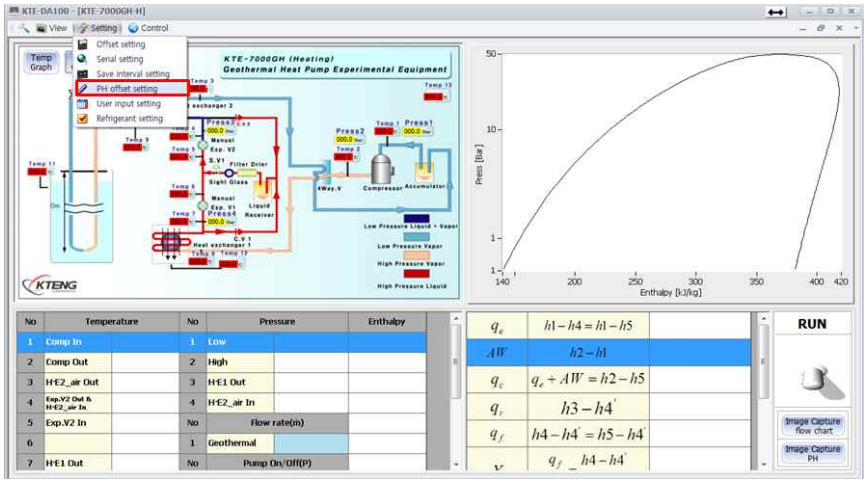

Save interval setting

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)

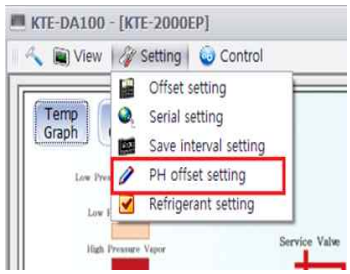
## d) PH offset setting

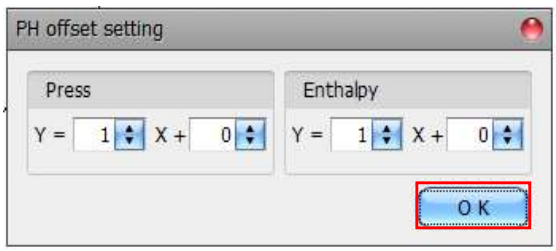



(1)Click Setting


(2) Click PH offset setting



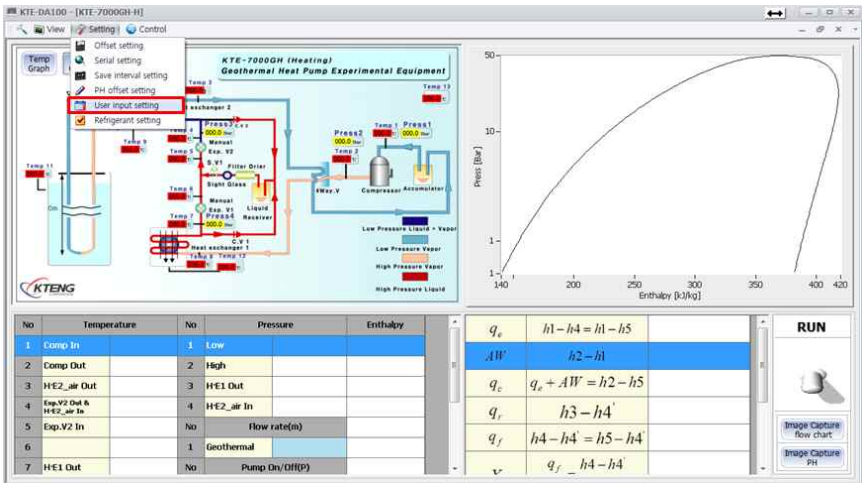

(3)On the main screen

The PH seondopyo Press,

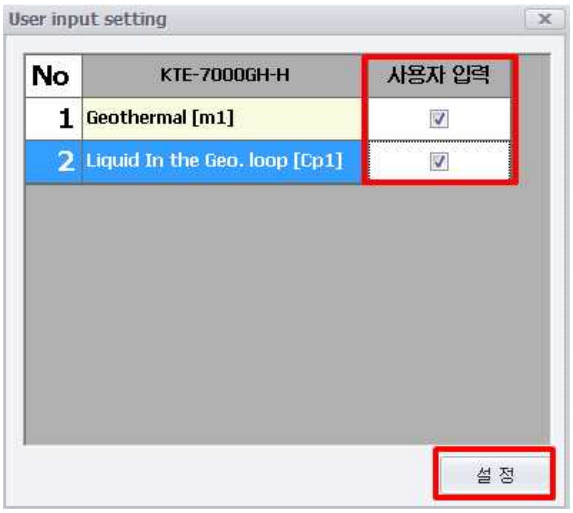
The axis values of the Enthalpy

Adjustment function

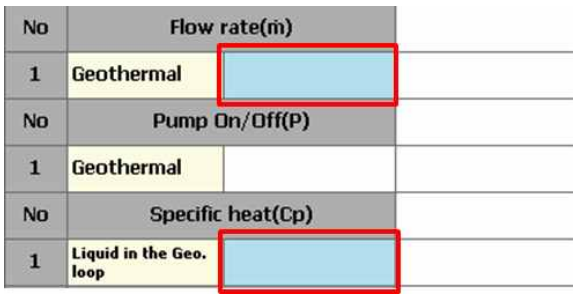
## e) User Input setting




(1) User Input Setting click




(2) Check No.1 (Geotheraml) and No.2 (Liquid In ther Geo.loop) then the parameter input windows in data table are activated.




(3) Parameter input window in data table.

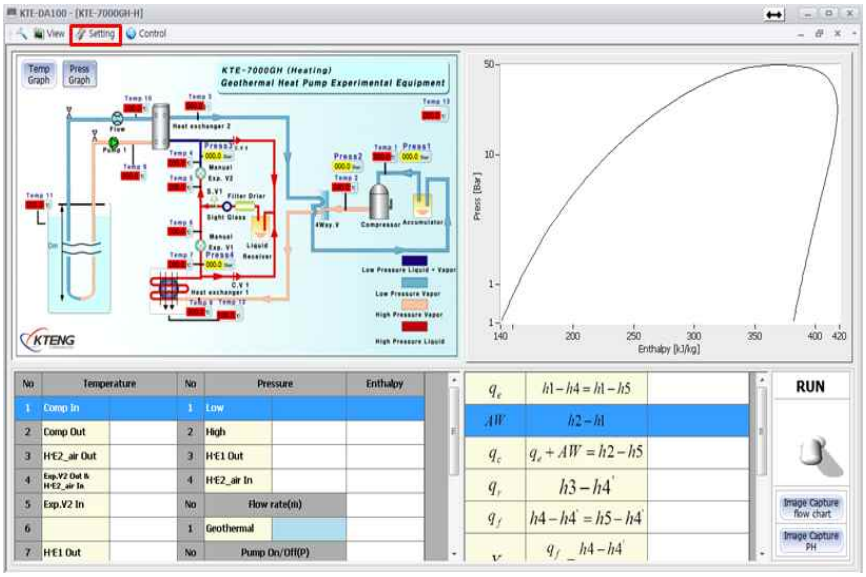
>Unit: Geothermal(g/s), Specific capacity (J/K·℃)

>Value

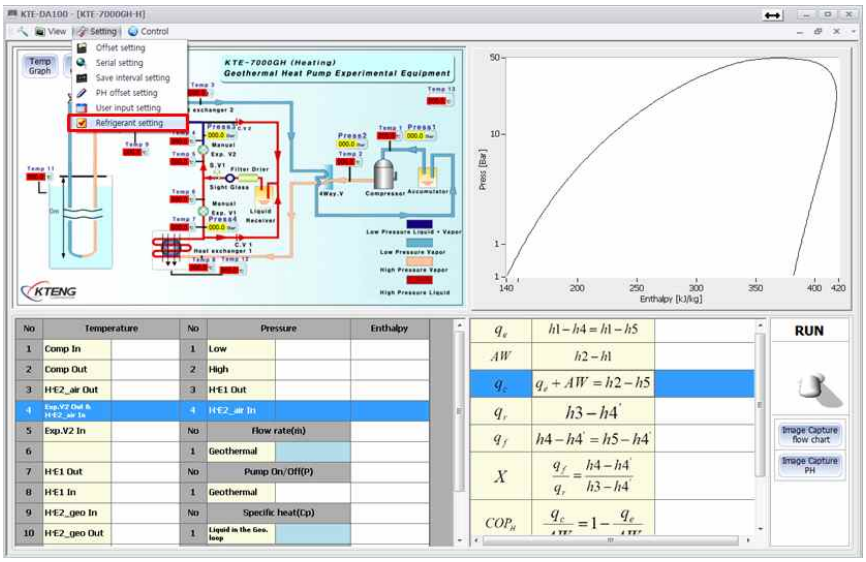
Geothermal: refer to flow meter

Cp: 4.2 J/K·℃ (atmosphere)

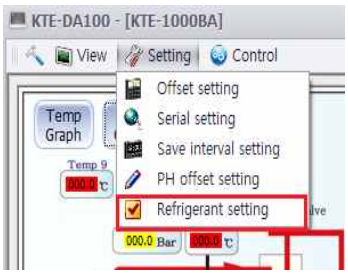
## f) Refrigerant setting

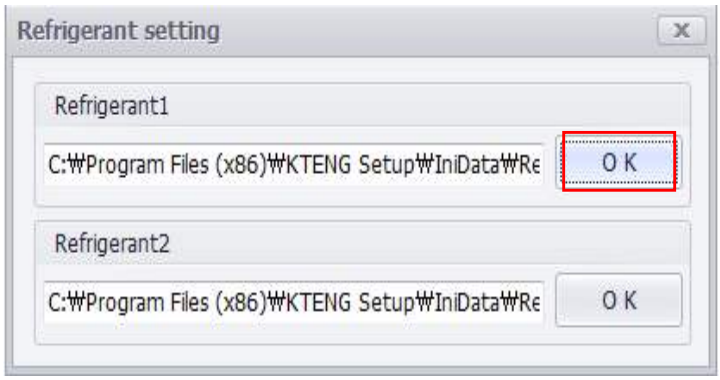



(1)Click Setting

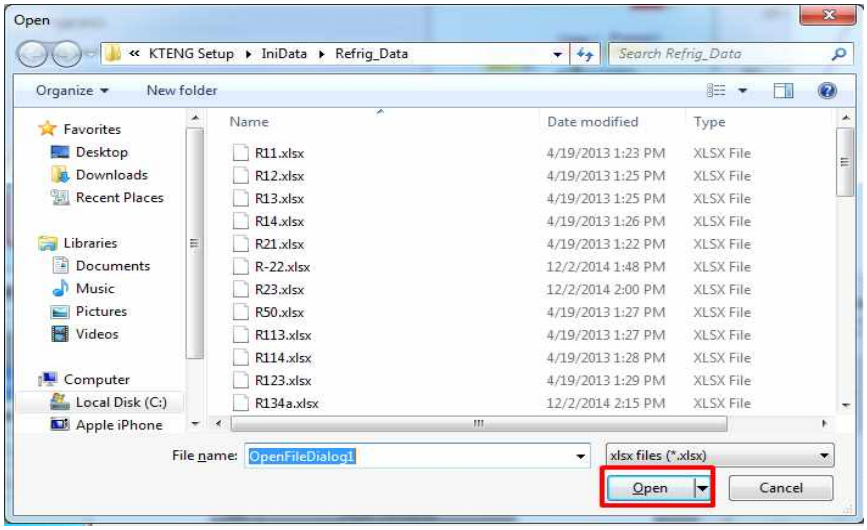




(2) Click Refrigerant setting



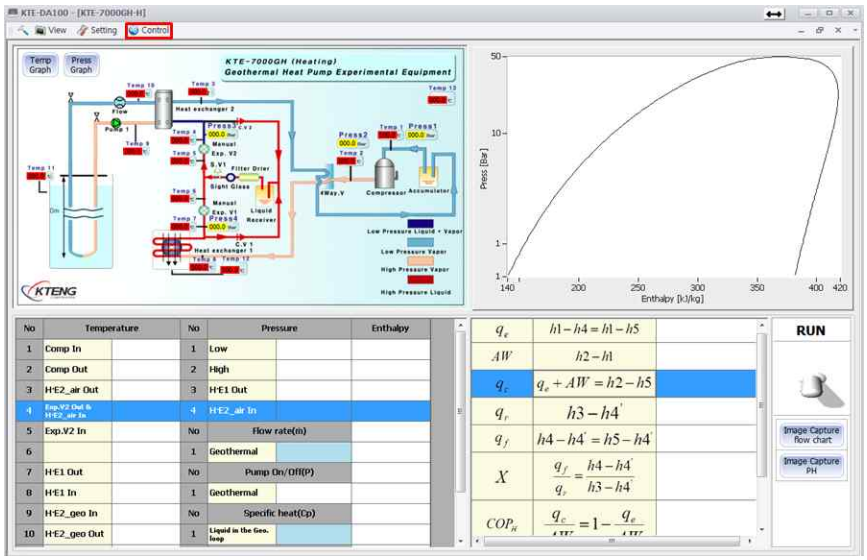

(3) Refrigerant setting Isafunctionfor selectingthe refrigerant-1won refrigeration cycle Refrigerant thousand -2won refrigeration cycle is selected for the selection of the Refrigerant 2Refrigerant1 and canbe appliedto the program. Click " OK "



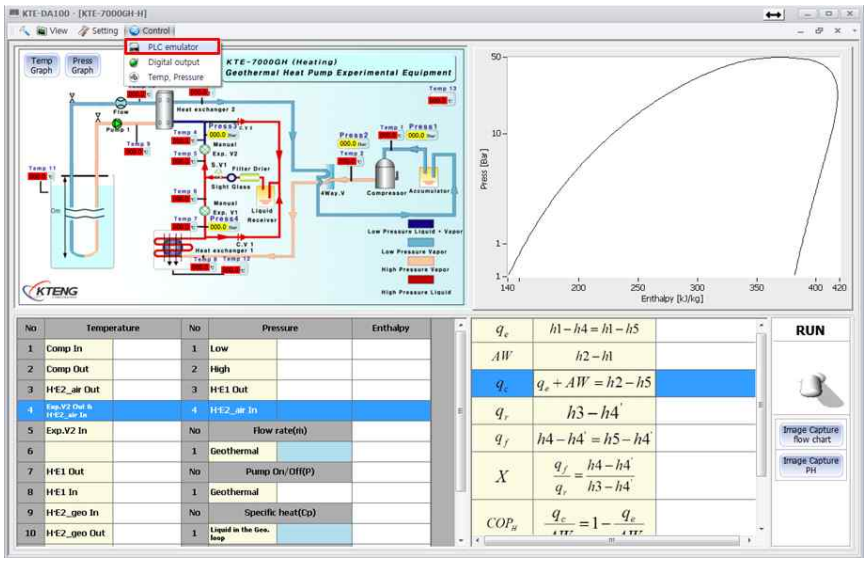

(4) Then refrigerant lists come up and choose refrigerant that is matched with system. And click the 'open' button then refrigeration properties apply to program.

## iv) Control

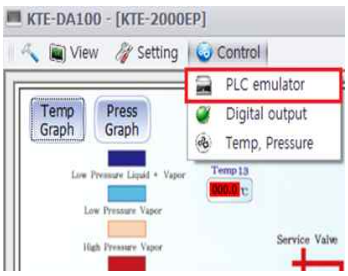
### a) PLC emulator

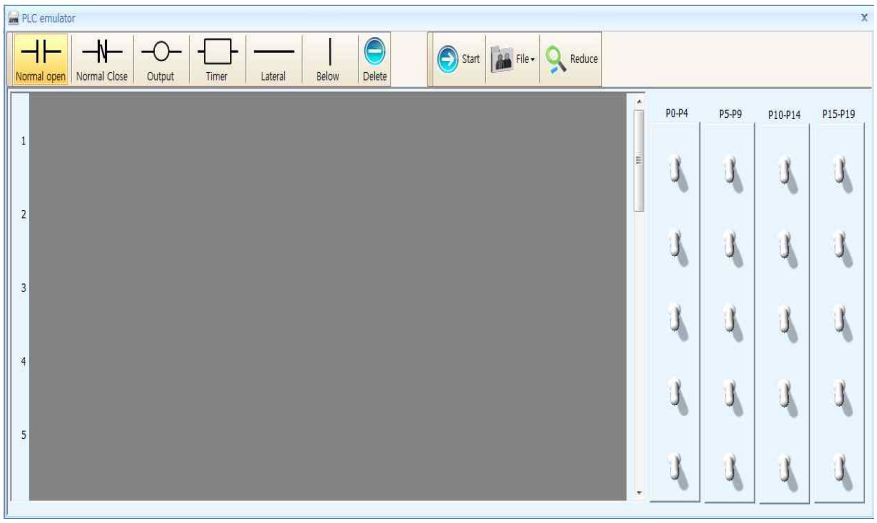



(1) Clock Control in Tools

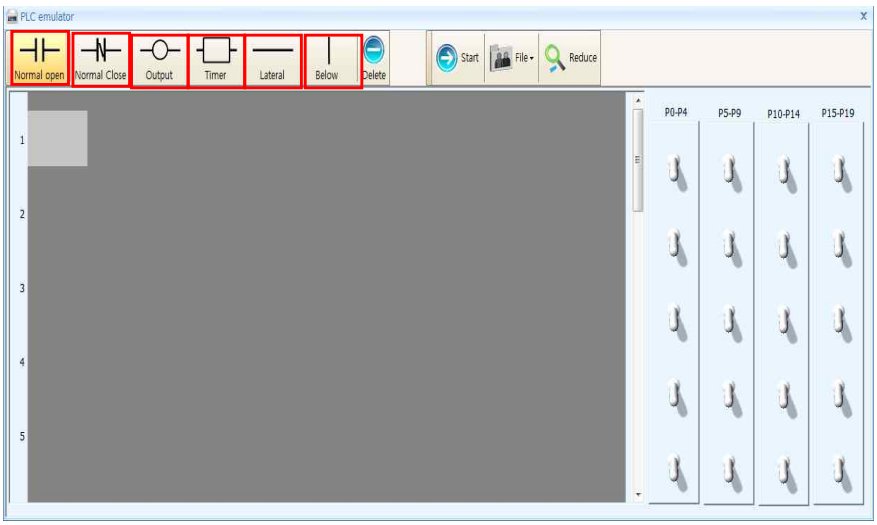




(2) Using PLC, The function for ON/OFF and control timer about all equipments.



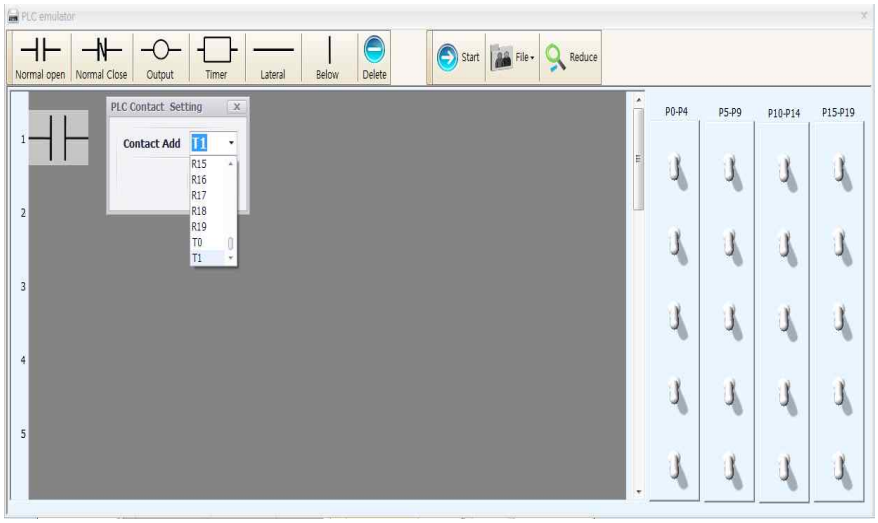



(3)When Click“PLC emulator"
Indicate the window such as left screen




(4)Using method is that after selecting the zone first, programming with inputting command


| Command | Explain |
|---|---|
| Normal open | Normal Open |
| Normal Close | Normal Close |
| Output | Coil(Load) |
| Timer | Timer |
| Lateral | Horizontal Extending Line |
| Below | Vertical Extending Line |
| Delete | Delete |
| Start | Start |
| File | Open Recent File |
| Reduce | Reduce Screen |

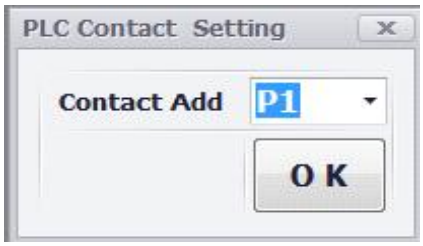



(5) Double click the marker then set P,R,T

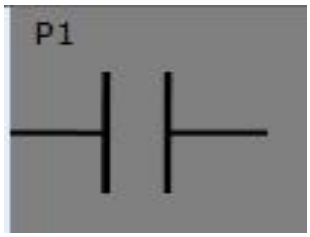
P : Push

R : Relay

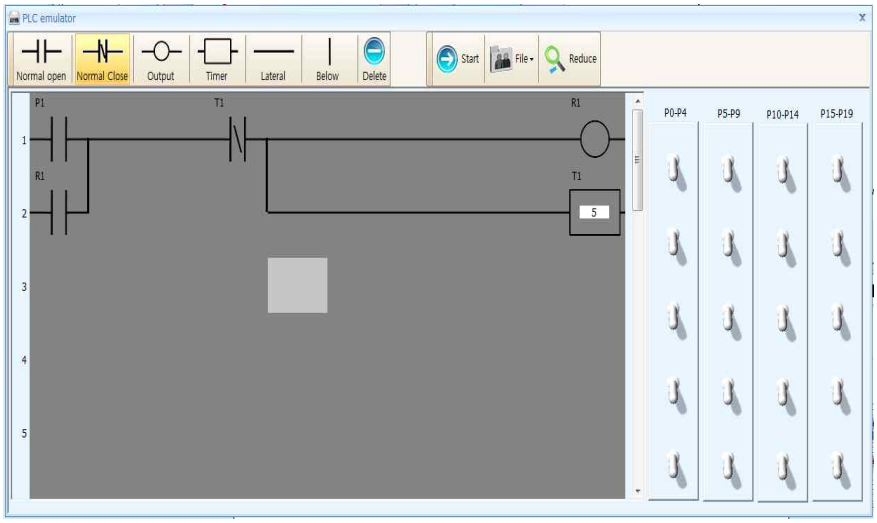
T : Timer



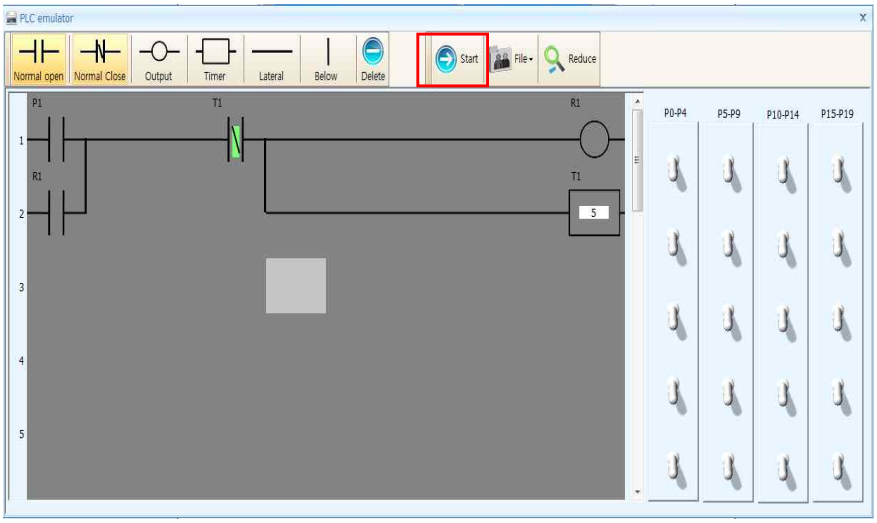

- Set P1 then Click“OK"



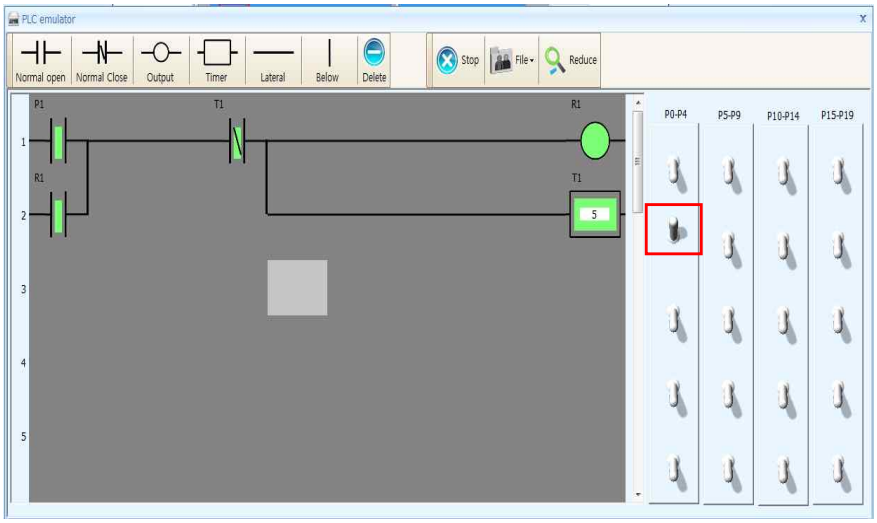

- Indicate P1 the top of the left side




(6)It is example using command

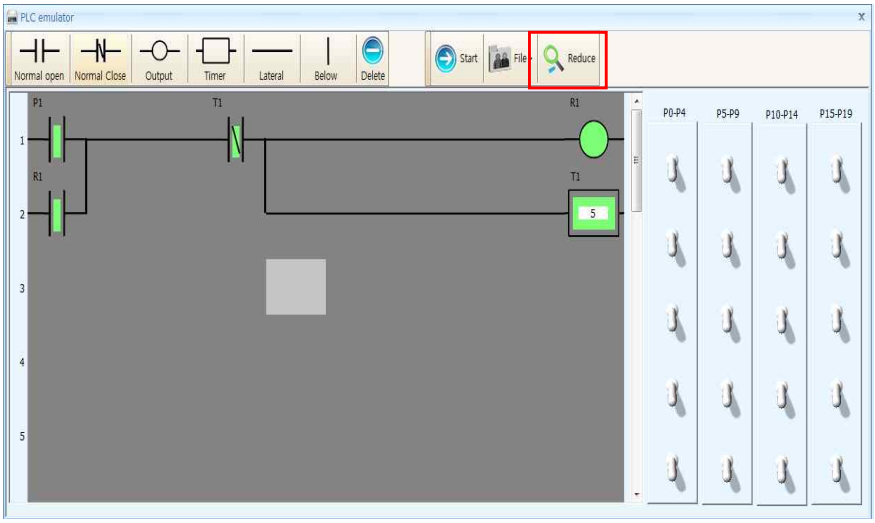



(7)Click Start then indicate mark which is T1-B




(8)Detach, press the P1.If R1 is a woman become a contact is closed, andt he self-maintenanceof R1 at the same time as the set time T1 is also a woman(Sec) after the b contact of T1Opensbeing supplied to R1

As Dunn power is cut off.Being returned to its original position

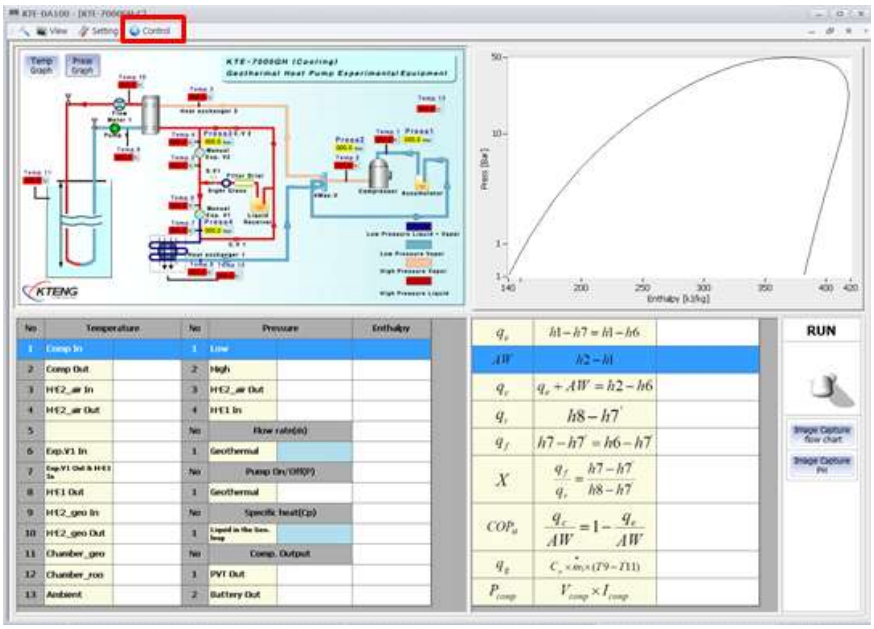



(9)Click Reduce


(10)When you click "Reduce", left screen is indicated.

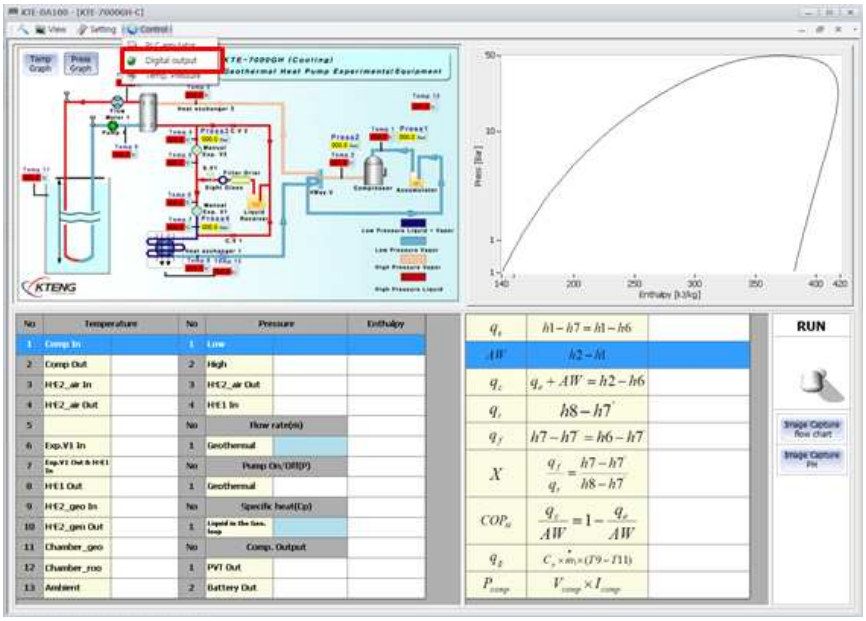
Click view of PLC, it is returned

b) Digital output

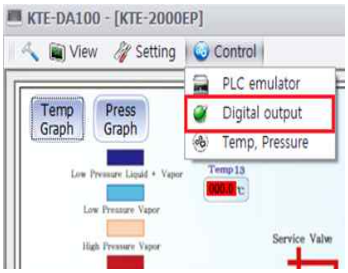


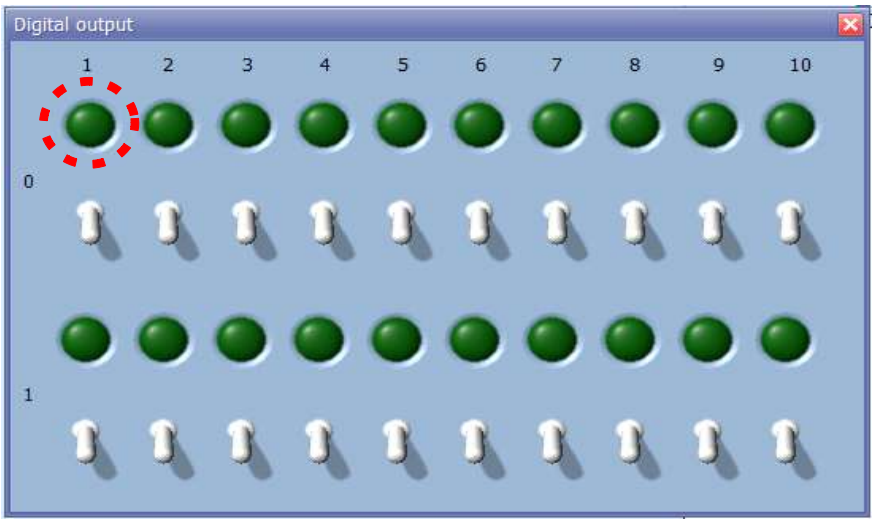

(1) Click

" Control " in Tools



(2)Click"Digital output"

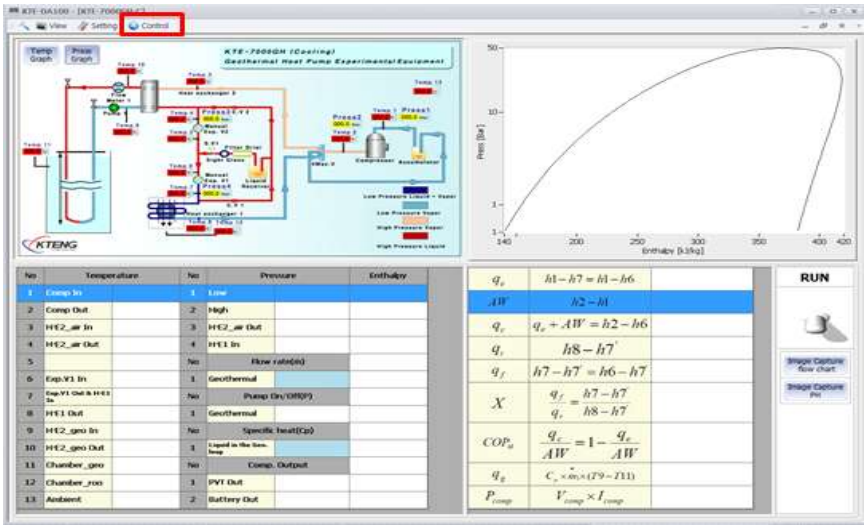


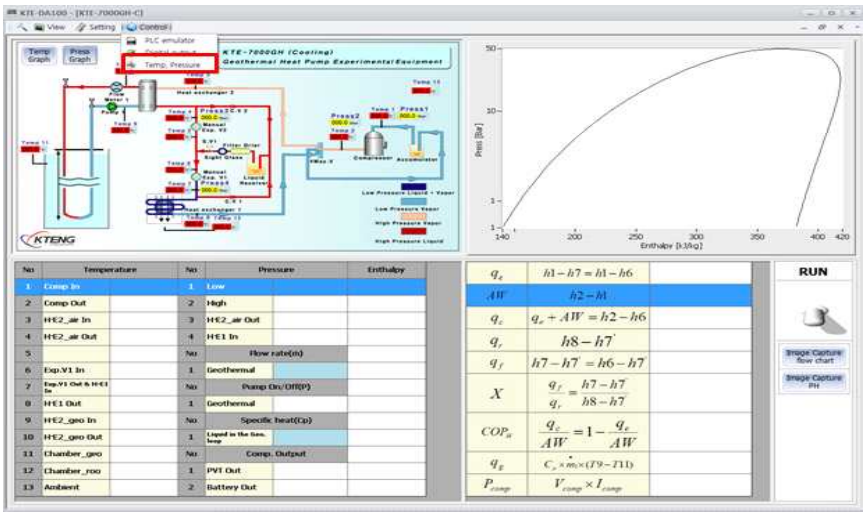

(3)Digital output is the second comp by number And to the switch ON / OFF When you work with equipment to operating the stand relay and the operation or without through the lamp Function to determine

(4) Green circle (comp) top numbers are located on the control panel comp 1 from above

## c) Temp, Pressure

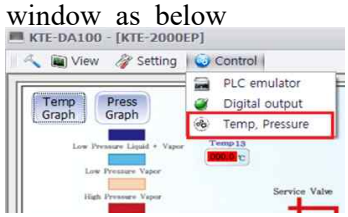


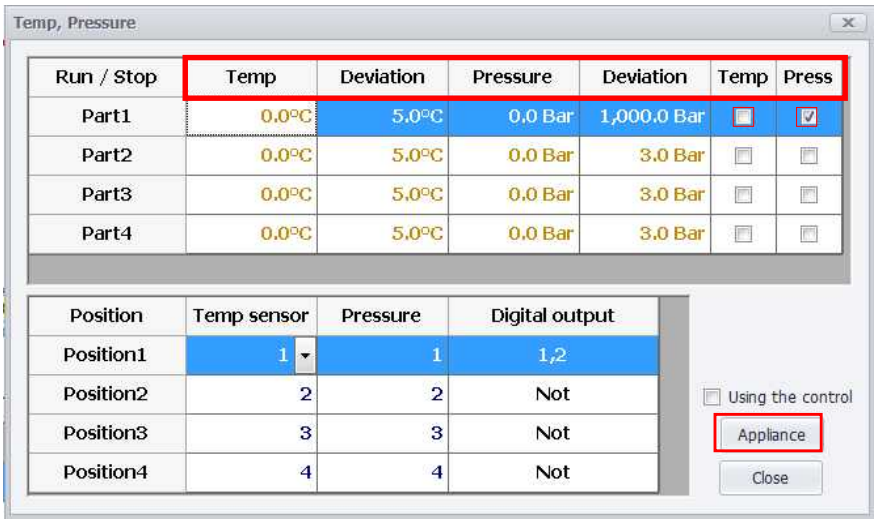
(1)Click "Control"

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

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

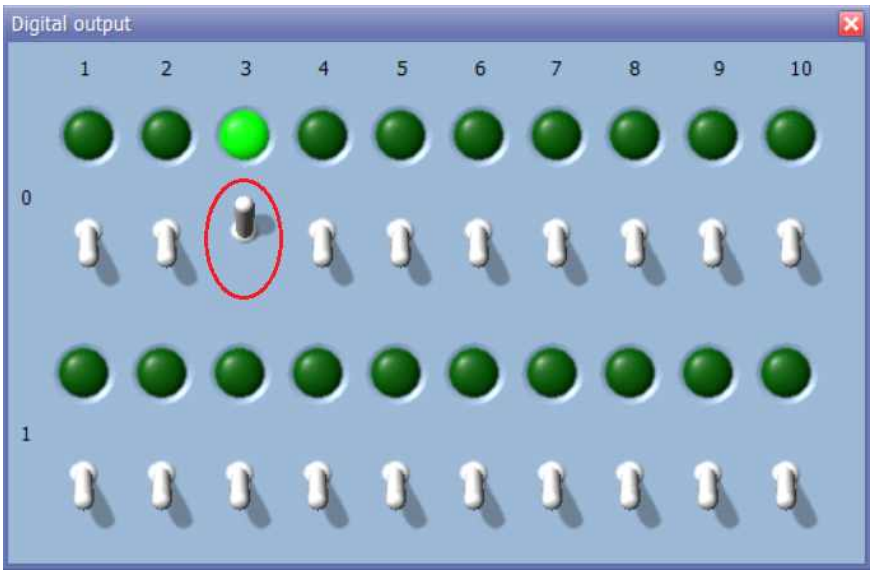


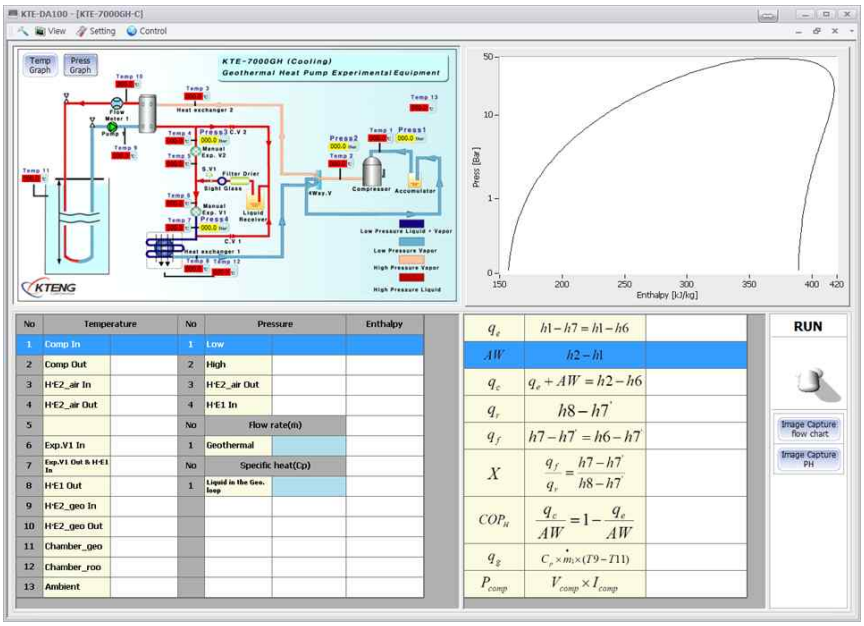

(3) Temp(settemperature), Deviation, Pressure(set pressure)

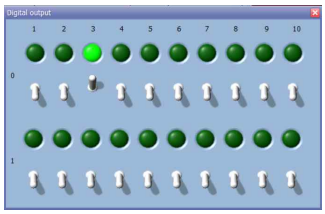
Deviation is indicated deviation and it can be saving the figure you want and it can choose both Temp and Pressure
Temp sensor : Selection for pressure sensor location
Digital output : Selection output port what you want to control
After setting, Click “Appliance” and “Close"

※ When ON condition, Step (3→4→5→1→2)

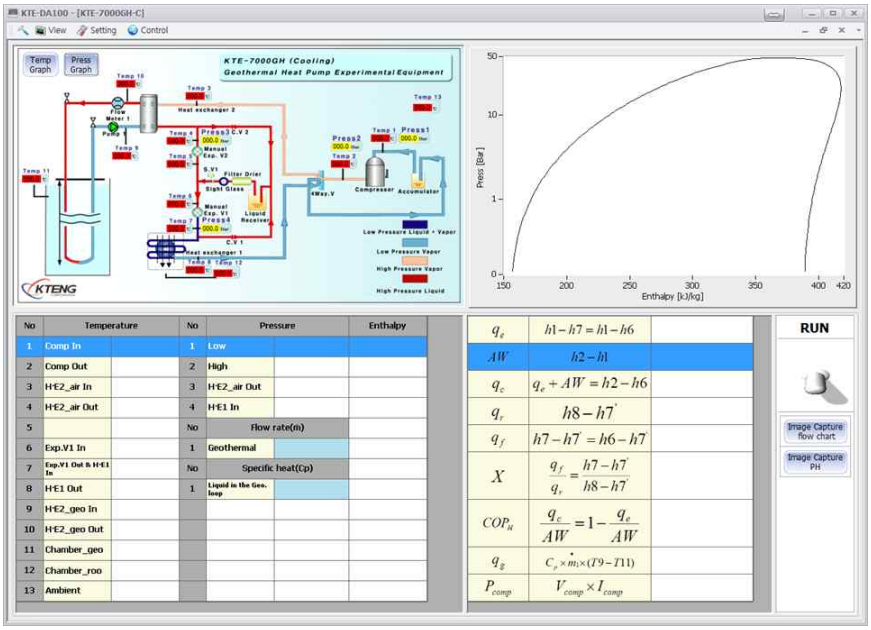


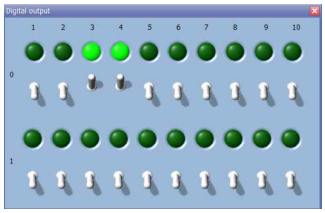

(7) Like left picture, Set 3(CFM) is On, Next operate 4(EFM), Next operate 5(SV), Next operate 1(COMP)
(The reason operating compressor lastly is when operating on no load conditon, there are effection which is big load in compressor)



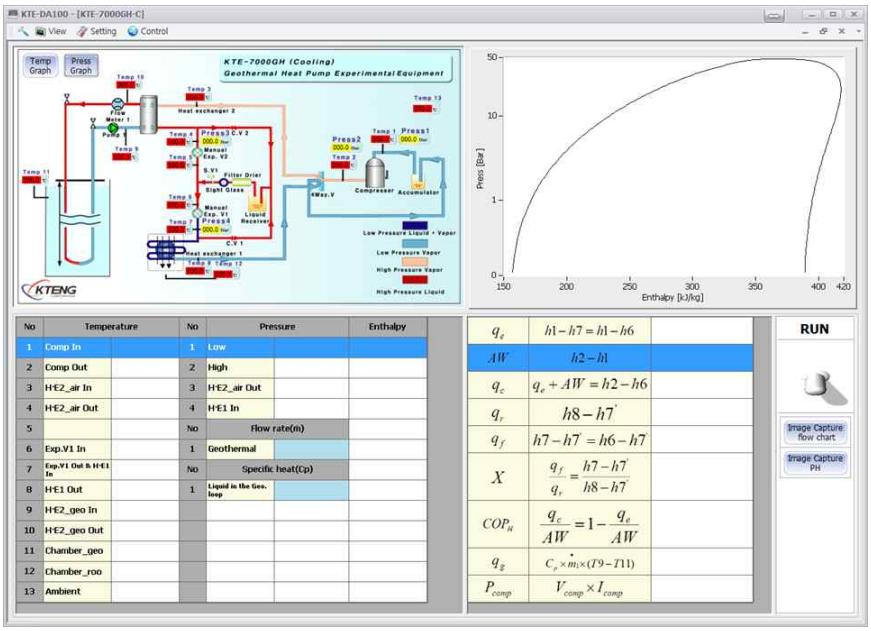
① Compressor ON

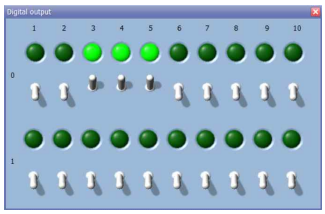



① Compressor ON

② Evaporator ON




① Compressor ON

② Evaporator ON

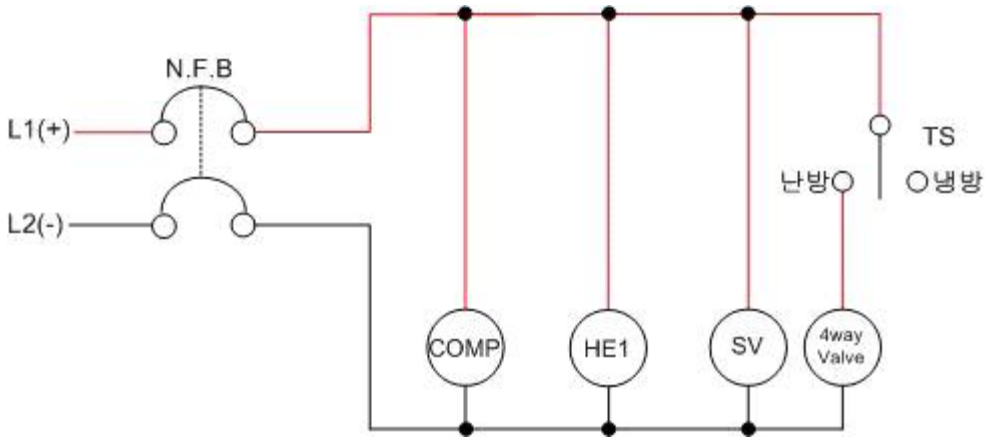
③ S.V ON

# 4. Circuit Configuration on Geothermal Heat Pump Experimental Equipment

| Experiment Description | Practice 1. Circuit configuration of reverse refrigeration flow direction in "Geothermal heat pump refrigeration system". | Class time (hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To understand the principal of reverse refrigeration flow direction using 4-way valve.<br>② To know how to build the basic circuit configuration of the system<br>③ To understand the principal of cooling and heating operation of the system. | |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH) | · Screw driver | · #2× 6× 175mm | 1 |
| | · Fill nipple | · 150mm | 1 |
| · Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Wire stripper | · 0.5~6mm2 | 1 |
| | · Hook meter | · 300A 600V | 1/Group |

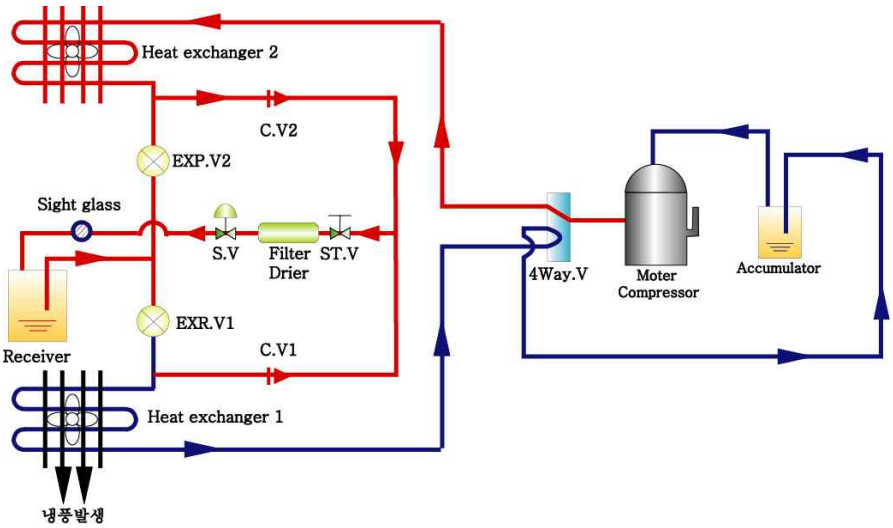
**Control Circuit**



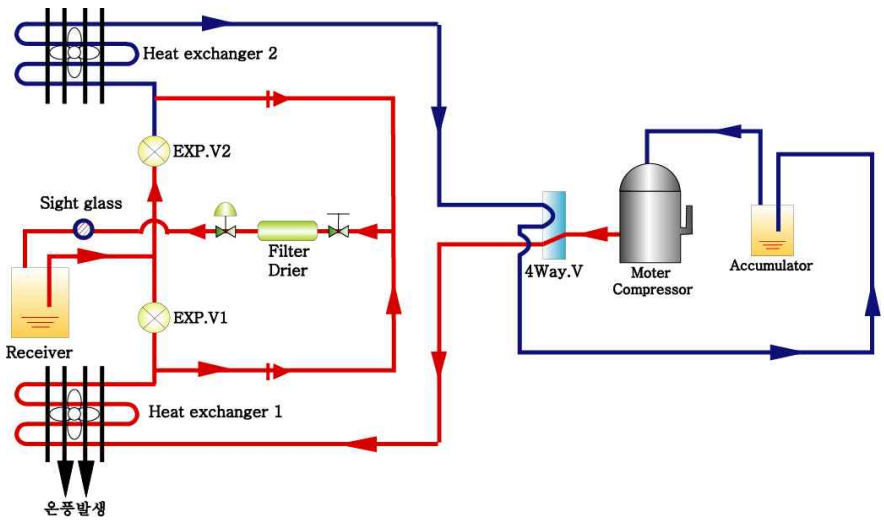

L1, L2 : Line Voltage
N.F.B : Nofuse circuit breaker
HE1 : 1 Heat Exchanger Fan Motor
COMP : Compressor
SV : Solenoid valve
4way valve : Reversing valve
TS : Toggle witch

1. Configure circuit
   (1) Geothermal environmental chamber temperature set up.
   (2) Configure circuit using banana jacks
   (3) When N.F.B is on, Toggle switch is OFF(Toggle switch ON is Heating)
   (4) Pump On of control panel of Geothermal environmental chamber

Schematic diagram of heat pump system cycle




Cooling mode cycle




Heating mode cycle

COMP : Compressure

HE1 : Heat Exchanger1 (Fan type 1)

HE2 : Heat Exchanger2 (Plate type 2)

S.V : Solenoid Valve

4-Way.V : 4-Way Reversing Valve

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

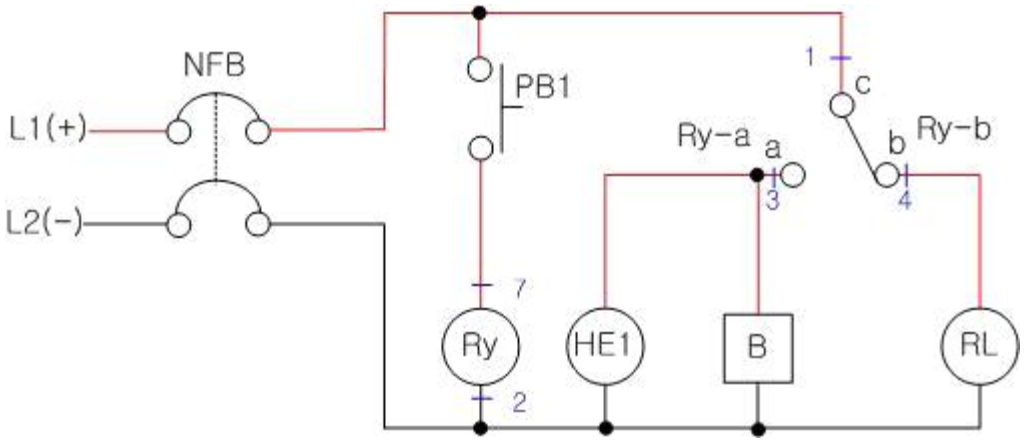
1. Preparation the experimental equipment and check electric state and refrigerant charging state.
2. Understand the function of operating circuit.
   (1) Able to explain the progress that refrigerator starts when NFB is on.
   (2) Able to explain the principal of heating cycle comparing with cooling cycle when TS (Toggle switch) reverses.
3. Understand the function of 4-way reverse valve.
4. Able to construct the circuit configuration using banana jack cables on the experiment equipments

| Evaluation | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 2. Circuit configuration using contact point "c" of toggle switch and Ry device. | Class time (hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To know how to construct circuit by using relay and toggle switch<br>② To understand the working principal of relay and toggle switch<br>③ To descript about configuration circuit using contact point "c" of Ry | |

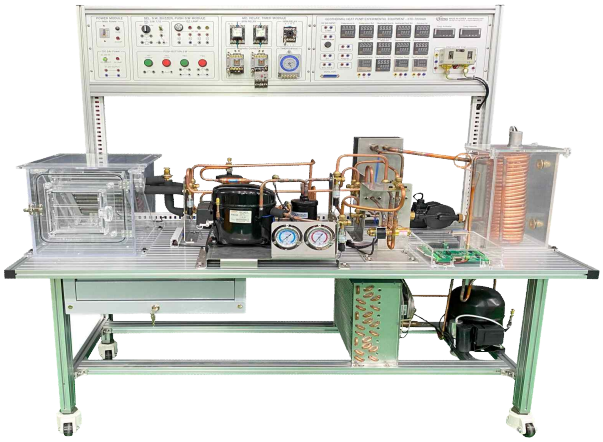
| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire stripper<br>· Hook meter | · #2× 6× 175mm<br>· 150mm<br>· 0.5~6mm2<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**




L1, L2 : Line Voltage
PB : Push button
N.F.B : No fuse circuit breaker
B : Buzzer
HE1 : Heat Exchanger 1 Fan Motor
Ry : Relay
RL : Red Lamp

1. Configure circuit
(1) N.F.B switch power on
(2) Configure circuit using banana jacks
(3) When N.F.B is on, HC2 and RL are ON because contactor RY-b is closed, and for contactor RY-a is open, HE1 and Buzzer are OFF. (Under PB1 is open)
(4) When PB1 is pushed, current flows on Relay coil at the same time contactor RY-a is closed, so HE1 and Buzzer are ON, RL is OFF



Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Configure circuit using banana jack cables and operating.
3. Understand the composition and theory of operation of Relay.
   (1) Contactor "a" means working contact (normal open connection), initial a from "arbeit" contact
   (2) Contactor "b" means breaking contact (normal closed connection), initial b from "breaking" contact.
4. Understanding the function of operating circuit.
   (1) Able to explain the running process when PB is pushed.
   (2) Able to explain the running process when PB is released.
5. Describing contact "c" of refrigeration circuit.

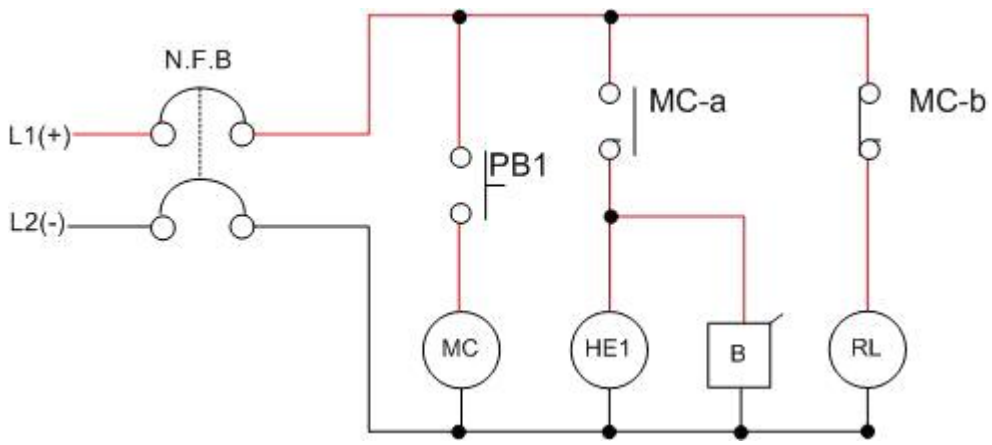
| Evaluation | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 3. Circuit configuration by applying a and b contacts of magnetic contactor(MC). | Class time (hr) |
|---|---|---|
| | | 8 |

| Experiment Objectives | |
|---|---|
| | ① To know how to buid circuit configuration using magnetic contactor (MC)<br>② To understand the working principal of MC<br>③ Able to descript about circuit configuration using a and b contact of MC |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH) | · Screw driver | · #2×6×175mm | 1 |
| | · Fill nipple | · 150mm | 1 |
| · Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Wire stripper | · 0.5~6mm2 | 1 |
| | · Hook meter | · 300A 600V | 1/Group |

**Control Circuit**




L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
HE1 : 1 Heat Exchanger Fan Motor
B : Buzzer
MC-a : MC (normal open) "a" contact
MC-b : MC (normal closed) "b"contact
PB : Push button
RL : Red Lamp
MC : Magnet contactor coil

1. Configure circuit
   (1) When N.F.B is on, HC2 and R.L are ON because contactor MC-b is closed, and for contactor MC-a is open, HC1 and Buzzer are OFF. (Under PB1 is open)
   (2) When PB1 is pushed, current flows on magnetic coil at the same time contactor MC-a is closed.
   (3) Contactor "a" means working contact, initial a from "arbeit" contact
   (4) Contactor "b" means breaking contact, initial b from "breaking" contact.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

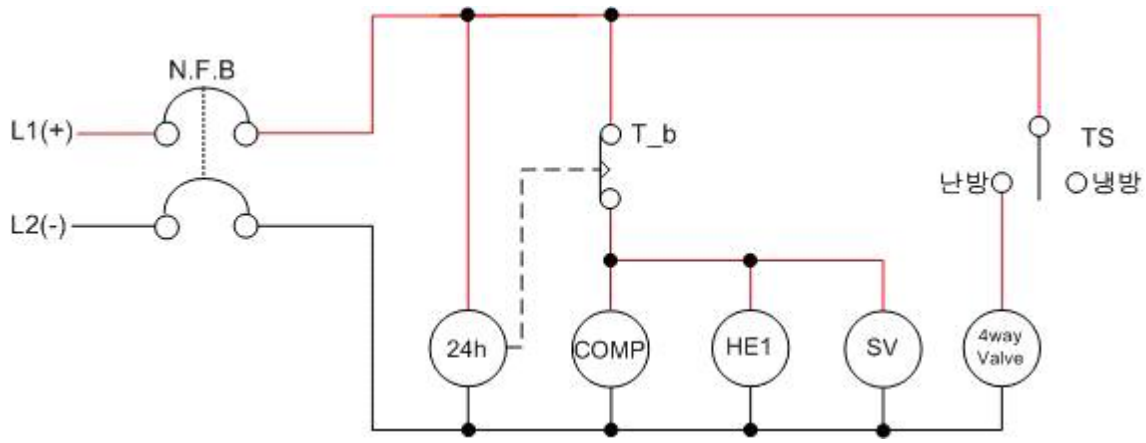
1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2 Practicing for more than 2 times with banana jacks cable using equipment, tools and materials.
3. Understanding construct and principal of MC.
4. Understanding the function of operating circuit.
   (1) Able to explain the running process when PB is pushed.
   (2) Able to explain the running process when PB is released.
5. Describing contact "a" and contact "b" of refrigeration circuit
6. Configure circuit using banana jack cable and operating.

| | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluation | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 4. Circuit configuration by applying time switch | Class Time (hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To understand the working principle of timer in the equipment<br>② To know how to construct a circuit configuration using contact point "c" of timer | |

| Experiment equipments | Tool and material | Spec. of tool | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH) | · Screw driver | · #2×6× 175mm | 1 |
| | · Fill nipple | · 150mm | 1 |
| · Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Wire stripper | · 0.5~6mm2 | 1 |
| | · Hook meter | · 300A 600V | 1/Group |

**Control Circuit**




L1, L2 : Line Voltage
NFB : No Fuse circuit breaker
24h : Timer
COMP : Compressor Motor
HE1 : 1 Heat Exchanger Fan Motor

T_b : Timer “b”contact
TS : Toggle S/W
SV : Solenoid valve
4way valve : Reversing valve

1. Circuit configuration
   (1) When NFB is on, DC 24V Power, and timer is set ON, T_b is closed, COMP, HE1 and SV is operated, TS is OFF(Cooling), TS is ON(Heating)
   (2) When timer is set OFF, T_b is opened, COMP, HE1 and SV is stopped.
   (3) “NO”means is Normal Open, it is same“a”contact.
   (4) “NC”means is Normal Close, it is same“b”contact.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

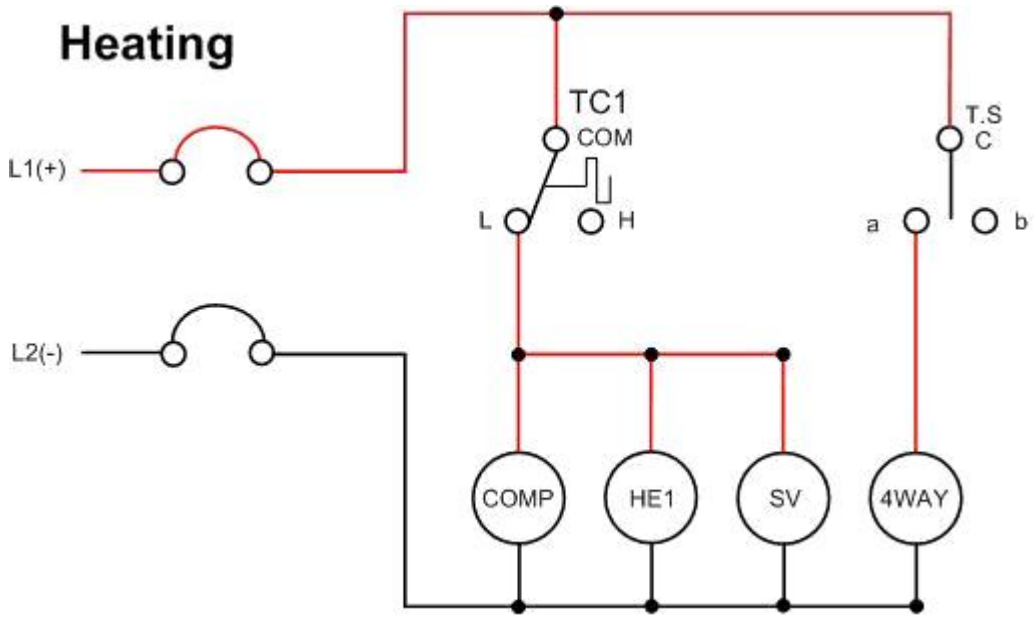
1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Build circuit configuration more than 2 times using banana jack cables and operating.
3. Understand the composition and theory of operation of Timer
4. Understand the function of operating circuit.
   (1) Able to explain the running process when timer is set to operate.
   (2) Able to explain the running process when timer is set stopping.
5. Describing "NC" contact and "NO" contact of refrigeration circuit.
6. Configure circuit using banana jacks and operating.

| | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluation | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

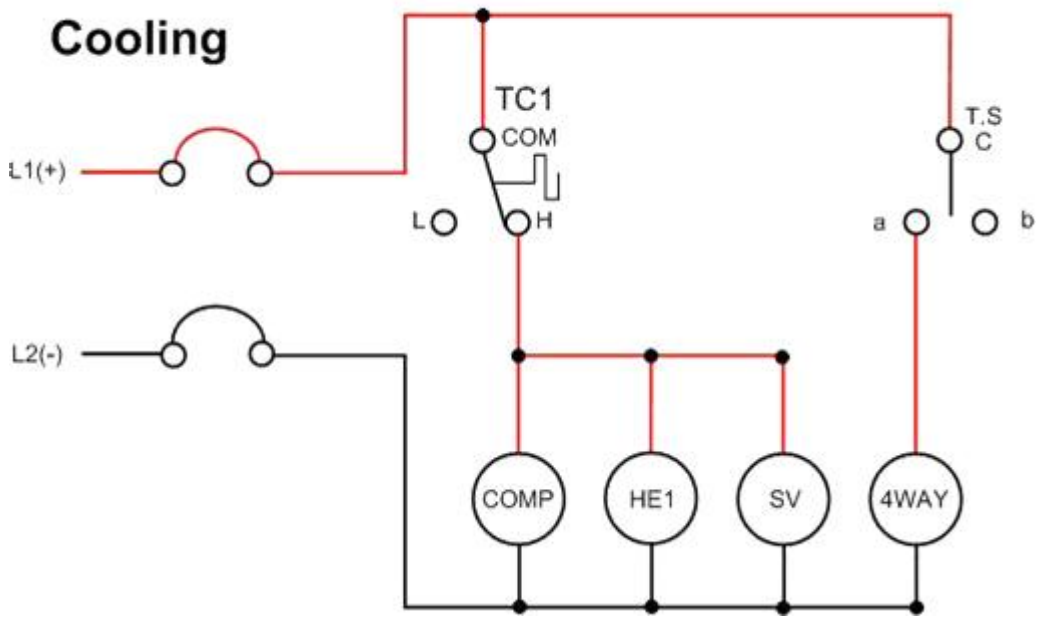
| Experiment Description | Practice 5. Circuit configuration with temperature automatic control | Class time(hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To know how to make circuit configuration by using temperature control switch on cooling and heating heat pump refrigeration system.<br>② To understand the use of temperature control switch and how to adjust it.<br>③ To understand the application of the circuit configuration with temperature control switch | |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire Stripper<br>· Hook meter | · #2× 6× 175mm<br>· 150mm<br>· 0.5~6mm2<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**




L1, L2 : Line Voltage
NFB : No fuse circuit breaker
TC1 : Temperature automatic controller
COMP : Compressor Motor
HE1 : Heat Exchanger 1 fan type
TS : Toggle switch
SV : Solenoid valve
4WAY : 4 way valve

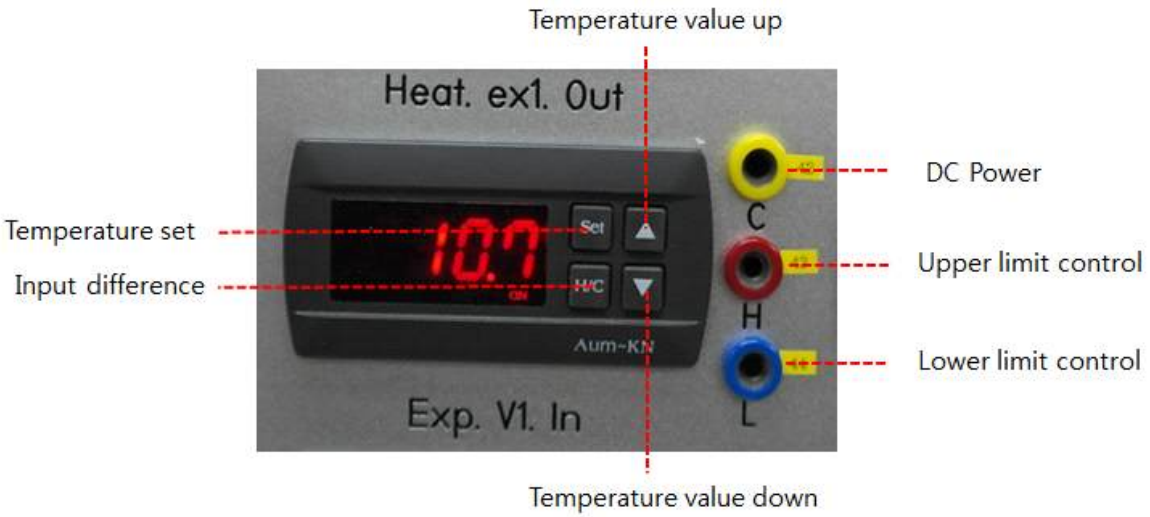



1. Circuit configuration

(1) NFB switch power on

(2) Configure circuit using banana jacks

(3) Temperature set up using the △, ▽ button of Temperature automatic controller




(4) When temperature set up with toggle switch ON ("a" contact, heating), OFF ("b" contact, cooling), pump on of Geothermal environmental chamber.

(5) When temperature is higher then setting temperature in Cooling mode: COMP, HE1 and SV are operating, When temperature is lower then setting temperature in Heating mode: COMP, HE1 and SV are operating.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Build circuit configuration using banana jacks and operate.
3. Understand the composition and operation of circuit configuration with temperature automatic controller.
   (1) Able to explain the running process with setting temperature when Temperature automatic controller is operating.
   (2) Able to explain the process when TS is switched to heating operation during the system running.
   (3) Able to explain the process when TS is switched to cooling operation during the system running.
4. Able to construct the circuit configuration using banana jacks in other equipment.

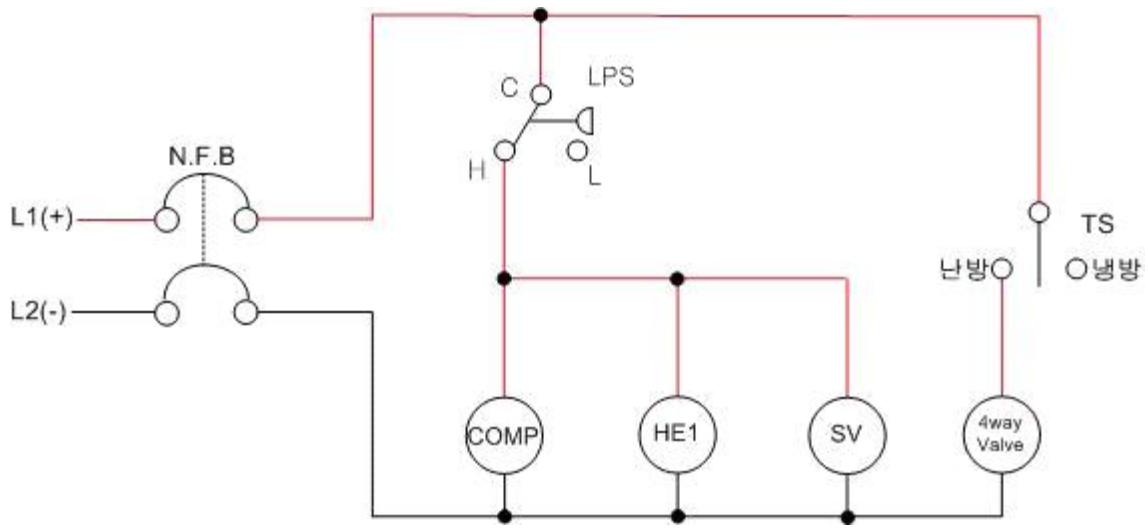
| Evaluation | Evaluation Items | | Max. points | Score | Remarks |
|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | |
| | | Circuit configuration and operation | 10 | | |
| | | The understanding of experiment method | 10 | | |
| | | Report of experimental data and graph construction | 20 | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | |
| | | Discussion and conclusion of the experiment | 20 | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I / II / III / Total |

| Experiment Description | Practice 6. Circuit configuration by applying low pressure control switch (LPS). | Class time(hr) |
|---|---|---|
| | | 8 |

| Experiment Objectives | |
|---|---|
| | ① To understand function and how to use low pressure control switch (LPS)<br>② To understand the construction of circuit configuration with LPS and toggle switch and its application in geothermal heat pump experiment equipment (KTE-7000GH) |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire stripper<br>· Hook meter | · #2× 6 × 175mm<br>· 150mm<br>· 0.5~6mm$^2$<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**



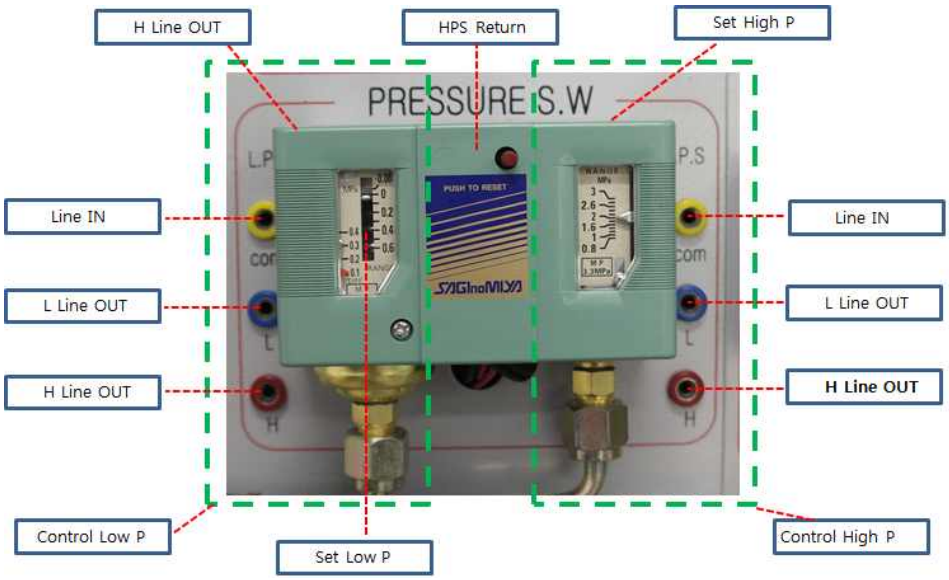

L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
LPS : Low pressure S/W
COMP : Compressor motor
HE1 : Heat Exchanger 1 fan tyoe
TS : Toggle switch
SV : Solenoid valve

1. Circuit configuration

(1) NFB switch power on

(2) Construct the configuration circuit using banana jack cables

(3) Set the pressure by turning the Low-pressure adjustment screw and set the pressure deviation.




(4) Set toggle switch ON("a" contact, heating) or OFF("b" contact, cooling), then pump on of geothermal environmental chamber.

(5) When the input pressure of the compressor is lower than the setting of low-pressure, heat pump is stop working, When the input pressure of the compressor is higher than the setting low-pressure, COMP, HE1 and SV is operated.

(6) The change of inlet pressure of compressor is visible when adjusting the load of HE1

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Build circuit configuration using banana jacks and operate it.
3. Understand the circuit configuration process by applying LPS
   (1) Able to explain how to set the pressure and deviation of the low-pressure switch
   (2) Able to explain the running process with heating cycle when TS (Toggle Switch) reverses.
   (3) Able to explain the running process with cooling cycle when TS(Toggle Switch) reverses.
   (4) Able to explain the running process with load of HE1.

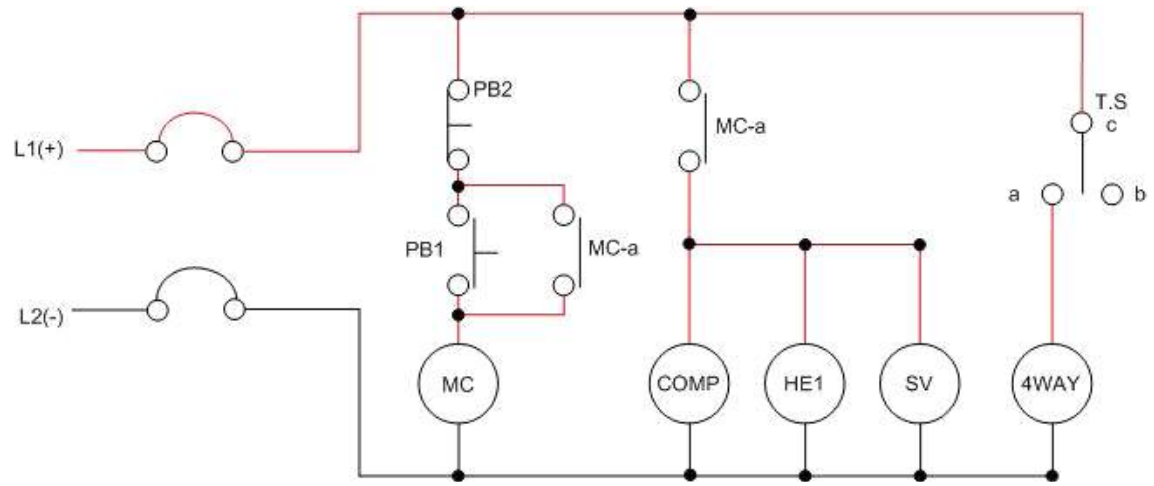
| Evaluation | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 7. Self-holding STOP priority circuit configuration for 4-way valve heat pump experimental equipment | Class Time (hr) |
|---|---|---|
| | | 8 |

| Experiment Objectives | ① To be able to construct and operate a self-holding circuit configuration on geothermal heat pump cooling and heating refrigeration experimental equipment<br>② To understand the working principle of self-holding circuit and it application in 4-way reverse heat pump experimental equipment. |
|---|---|

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH) | · Screw driver | · #2× 6× 175mm | 1 |
| | · Fill nipple | · 150mm | 1 |
| · Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Wire Stripper | · 0.5~6mm2 | 1 |
| | · Hook meter | · 300A 600V | 1/Group |

## Control Circuit




L1, L2 : Voltage line

NFB : No fuse circuit breaker

MC : Magnet contactor

MC-a : MC "a" contact (normal open)

TS : Toggle switch

PB : Push button

COMP : Compressor motor

HE1 : Heat Exchanger 1 fan type

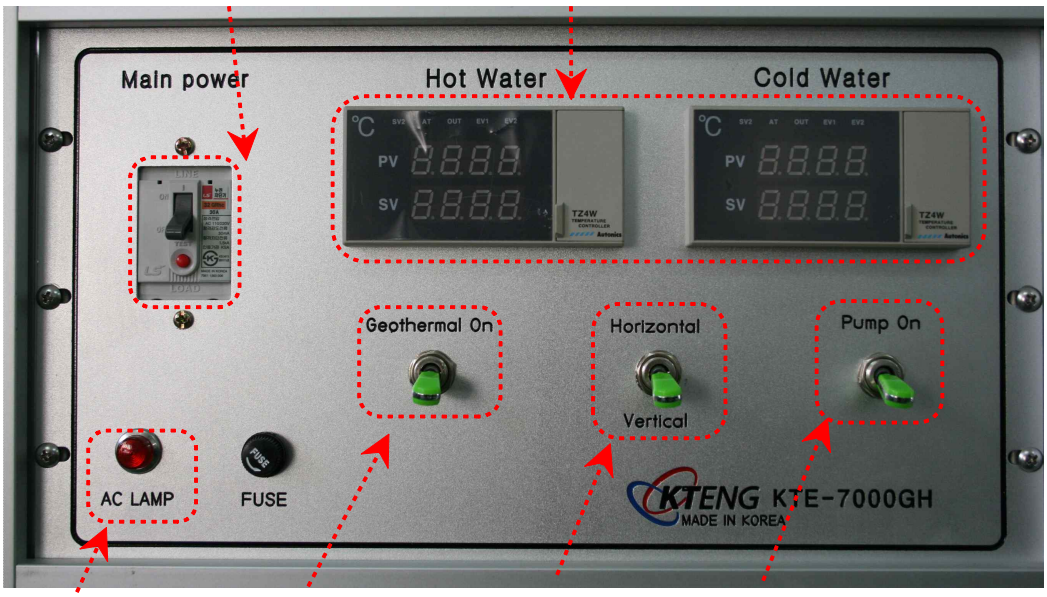
4Way : 4 way V/V

1. Circuit configuration

(1) NFB switch power on

(2) Construct the circuit configuration using banana jack cable.

(3) Refrigerator and heater of geothermal environmental chamber is operating when the main power of geothermal control panel is turned on. When circulation pump is on whether using horizontal or vertical heat exchanger oscillation pipe, flowmeter shows the flow rate of working water.




Control panel of geothermal department

(4) Set the heating mode or cooling mode using the toggle switch ON ("a" contact, heating), OFF ("b" contact, cooling)

(5) Power lamp is indicating when the power is on.

(6) When we push the PB1 button of control panel, MC is magnetized, MC_a contact is closed and the system is operating.

※ Caution

There is a danger of damage, when reverse the toggle switch (change the cooling or heating mode) during operating equipment. After stopping the operating of refrigerator reverse the toggle switch.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Build the circuit configuration using banana jack cables.
3. Able to describe the behavior of the circuit configuration
   (1) Able to describe the process when NFB is switched on
   (2) Able to describe the process behavior when PB1 is pushed
   (3) Able to describe the process behavior when PB2 is pushed
   (4) Able to understand the priciple of first stop self holding circuit configuration

| | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluation | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 8. Manual control circuit configuration on "cooling and heating system" | Class time(hr) |
|---|---|---|
| | | 8 |

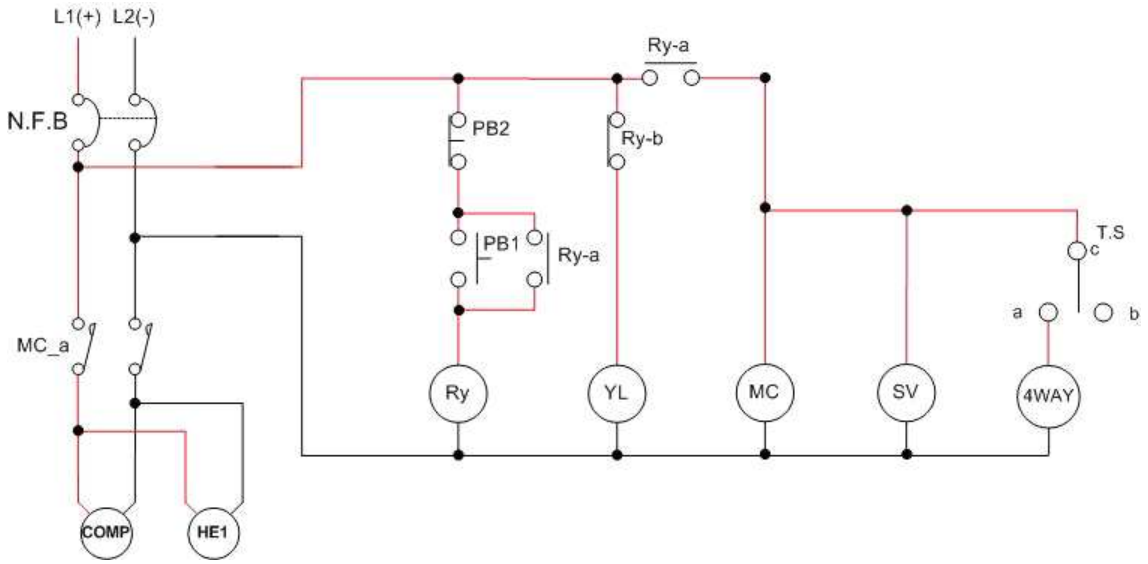
**Experiment Objectives**

① To understand the 4 way reversing valve motion of manual operation of circuit configuration for "cooling and heating heat pump refrigeration system".

② To build self holding circuit configuration on "cooling and heating heat pump refrigeration system using 4-ways reversing valve.

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH) | · Screw driver | · #2× 6× 175mm | 1 |
| · Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Fill nipple | · 150mm | 1 |
| | · Wire Stripper | · 0.5~6mm2 | 1 |
| | · Hook meter | · 300A 600V | 1/Group |

**Control Circuit**




L1, L2 : Line Voltage

N.F.B : No fuse circuit breaker

MC-a : MC "a" contact

HE1 : Heat Exchanger 1 fan type

COMP : Compressor Motor

SV : Solenoid valve

YL : Yellow Lamp

Ry-a : Relay"a"contact

Ry-b : Relay"b"contact

Ry : Relay Coil

PB : Push button switch

TS : Toggle switch

4way valve : reversing valve

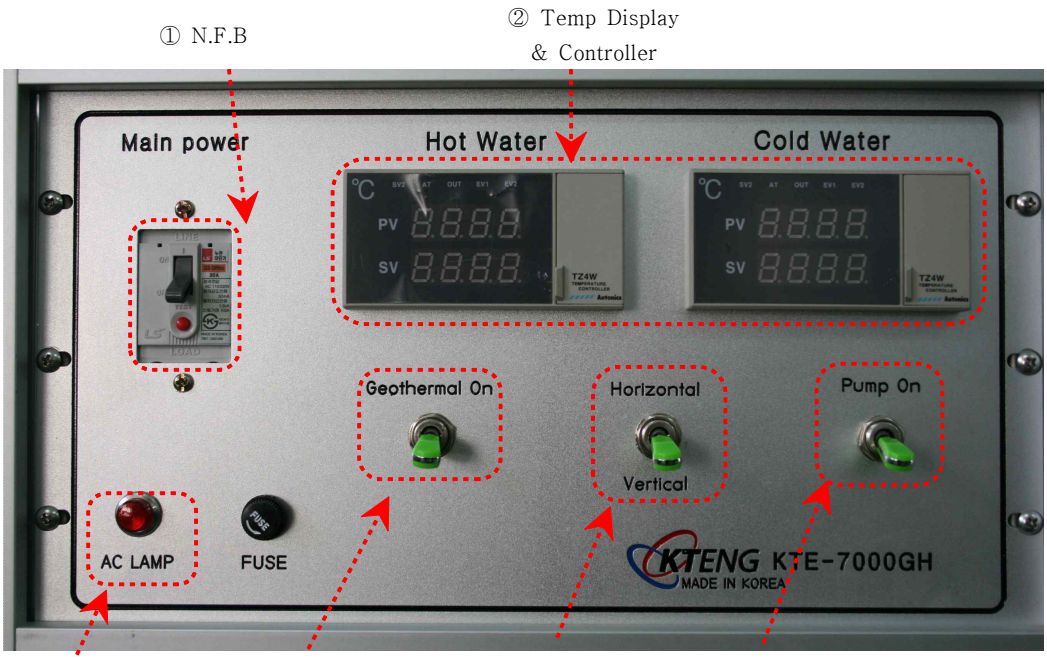
MC : Magnetic Contactor

1. Circuit configuration

(1) NFB switch power on

(2) Construct the circuit configuration using banana jack cable.

(3) Refrigerator and heater of geothermal environmental chamber is operating when the main power of geothermal control panel is turned on. When circulation pump is on whether using horizontal or vertical heat exchanger oscillation pipe, flowmeter shows the flow rate of working water.




Control panel of geothermal department

(4) Set the heating mode or cooling mode using the toggle switch ON ("a" contact, heating), OFF ("b" contact, cooling)

(5) When the main power is turned on, Yellow lamp is on.

(6) When PB1 is pushed, refrigeration system is working and Yellow lamp will be off.

(7) When PB2 is pushed, refrigeration system is not working and Yellow lamp will be on.

※ Caution

There is a danger of damage, when reverse the toggle switch(change the cooling or heating mode) during operating equipment. After stopping the operating of refrigerator reverse the toggle switch.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

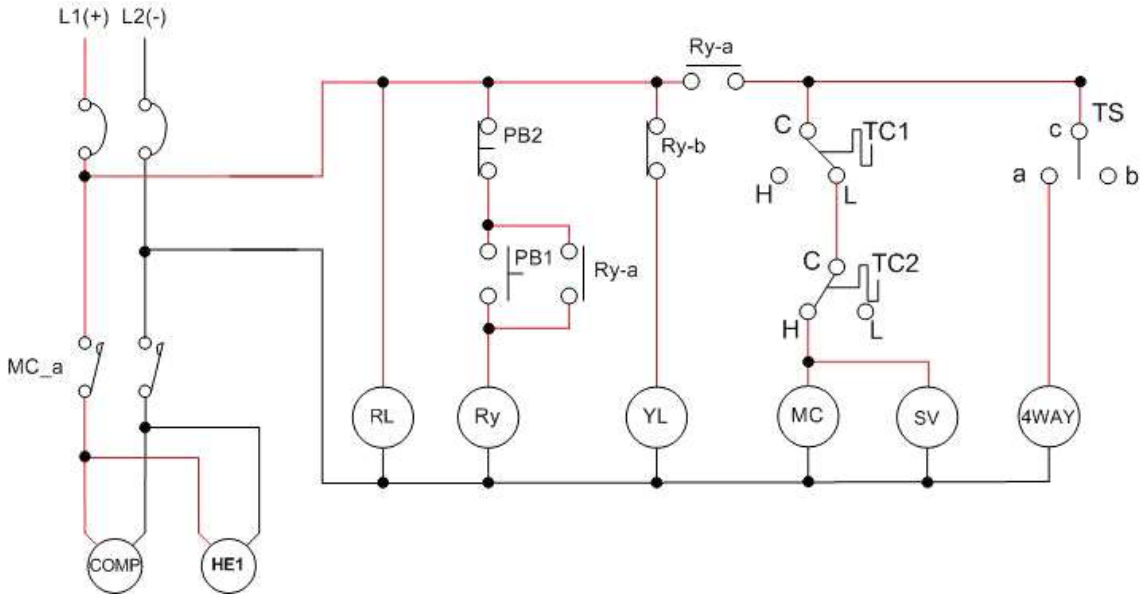
1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Build the circuit configuration using banana jacks and operate it.
3. Able to understand the function of operating circuit.
   (1) Able to explain the process when PB1 is pushed.
   (2) Able to explain the process of cooling mode when reversing the TS
   (3) Able to explain the process of heating mode when reversing the TS
   (4) Able to explain the process when PB2 is pushed.

| | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluation | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 9. Circuit configuration with temperature automatic control on "cooling and heating heat pump refrigeration system" | Class time(hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To understand the role of temperature automatic control circuit on "cooling and heating heat pump refrigeration system".<br>② To know how to build temperature automatic control circuit configuration for heating and cooling on heat pump refrigeration system using 4-ways reversing valve". | |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire stripper<br>· Hook meter | · #2× 6× 175mm<br>· 150mm<br>· 0.5~6mm2<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**




L1, L2 : Line Voltage
N.F.B : No fuse circuit breaker
MC-a : MC "a" contact (normal open)
Ry-a : Relay"a"contact (normal open)
Ry-b : Relay"b"contact (normal closed)
HE1 : Heat Exchanger 1 fan type

PB : Push Button
TC : Temperature switch
RL : Red Lamp
SV : Solenoid valve
Ry : Relay

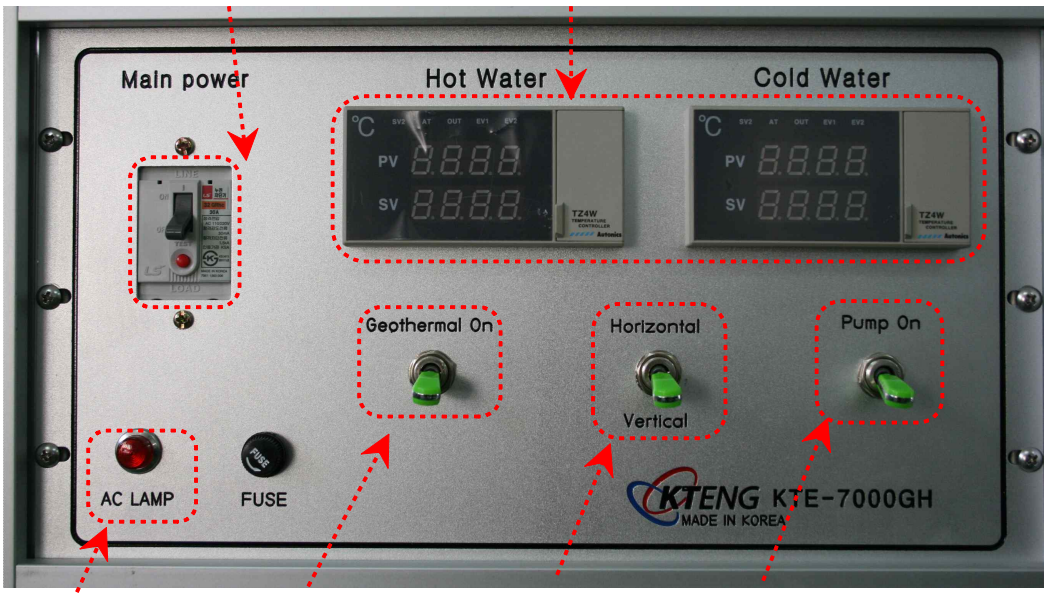
YL : Yellow Lamp
TS : Toggle switch
4way valve : reversing valve
COMP : Compressor Motor
MC : Magnetic Contactor

1. Circuit configuration

(1) NFB switch power on

(2) Construct the circuit configuration using banana jack cable.

(3) Refrigerator and heater of geothermal environmental chamber is operating when the main power of geothermal control panel is turned on. When circulation pump is on whether using horizontal or vertical heat exchanger oscillation pipe, flowmeter shows the flow rate of working water.




Control panel of geothermal department

(4) Set the heating mode or cooling mode using the toggle switch ON("a" contact, heating), OFF("b" contact, cooling)

(5) When the main power is turned on, yellow and red lamps are on.

(6) Set the temperature of TC1 and TC2

(7) When the PB1 is pushed, refrigeration system is working while yellow lamp will be off.

(8) When the PB2 is pushed, refrigeration system is stop working and the yellow lamp will be on.

※ Caution

There is a danger of damage, when reverse the toggle switch (change the cooling or heating mode) during operating equipment. After stopping the operating of refrigerator reverse the toggle switch.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

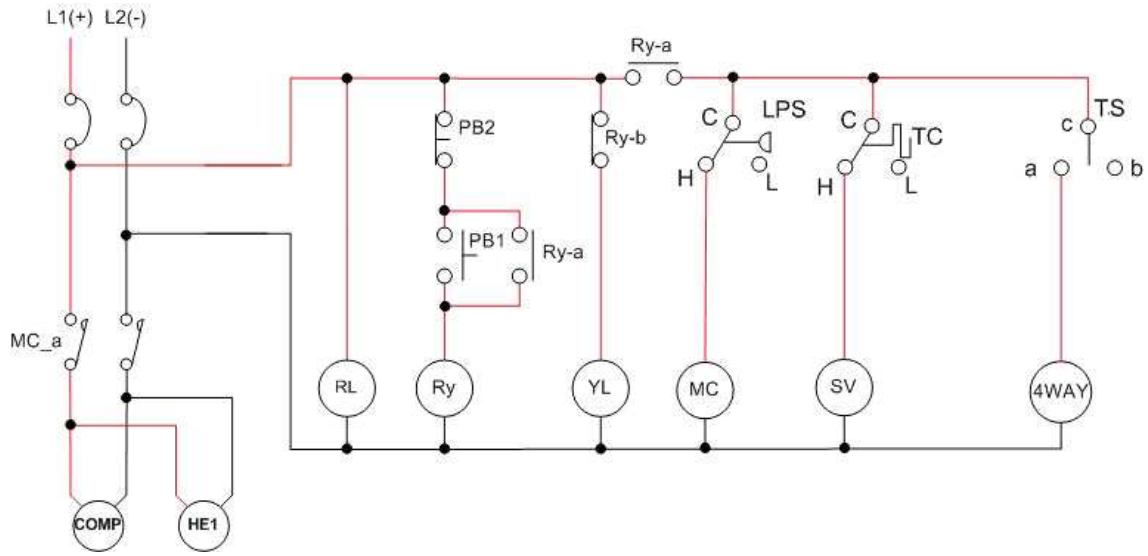
1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Construct the circuit configuration using banana jack cables and operate it.
3. Understand the function of operating circuit.
   (1) Able to explain the process when PB1 is pushed.
   (2) Operating the system with setting temperature of TC1, TC2
   (3) Able to explain the process when temperature automatic controller is working in cooling mode.
   (4) Able to explain the process when temperature automatic controller is working in heating mode.
   (5) Able to explain the process when PB2 is pushed.

| Evaluation | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 10. Circuit configuration with temperature and pressure automatic control on "cooling and heating heat pump refrigeration system" | Class time (hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To understand the role principle of temperature and pressure automatic control circuit for "cooling and heating heat pump refrigeration system".<br>② To know how to build a temperature and pressure automatic control circuit on cooling and heating heat pump refrigeration system using 4-ways reversing valve". | |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire Stripper<br>· Hook meter | · #2× 6× 175mm<br>· 150mm<br>· 0.5~6mm2<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**



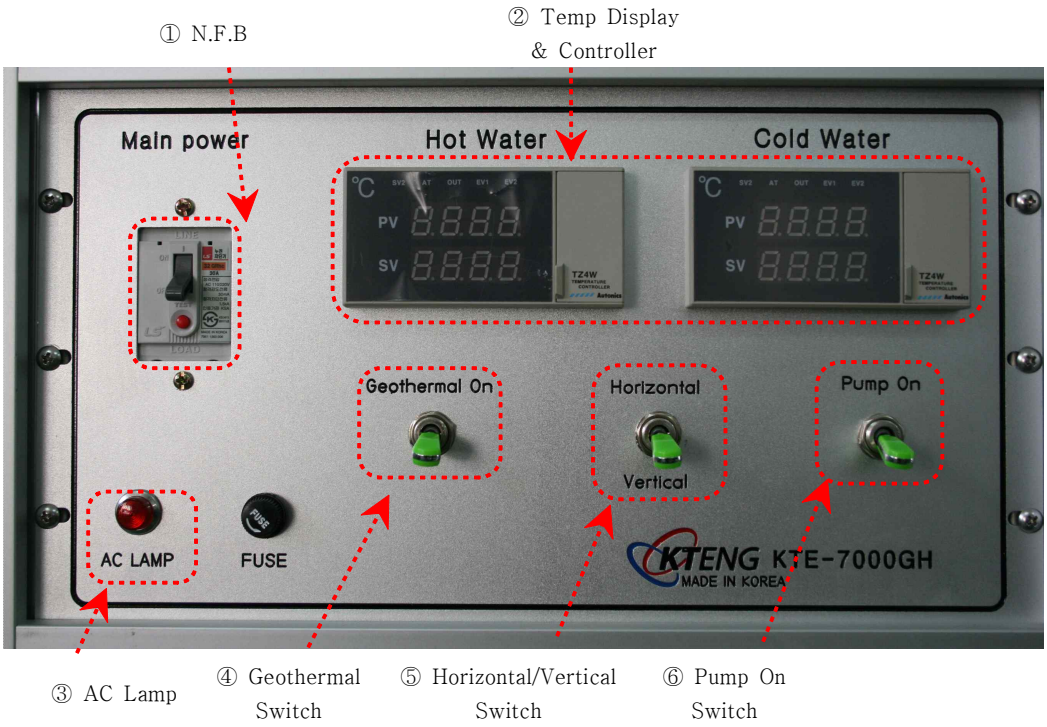

L1, L2 : Line Voltage
NFB : No fuse circuit breaker
MC-a : MC "a" contact (normal open)
Ry-a : Relay"a"contact (normal open)
Ry-b : Relay"b"contact (normal closed
HE1 : Heat Exchanger 1 fan type
PB : Push Button
YL : Yellow lamp
LPS : Low Pressure switch
4way valve : reversing valve
TC : Temperature control switch
MC : Magnetic Contactor Coil
COMP : Compressor
TS : Toggle switch
RL : Red Lamp
SV : Solenoid valve
Ry : Relay Coil

1. Circuit configuration

(1) NFB switch power on

(2) Construct the circuit configuration using banana jack cable.

(3) Refrigerator and heater of geothermal environmental chamber is operating when the main power of geothermal control panel is turned on. When circulation pump is "on" whether using horizontal or vertical heat exchanger oscillation pipe, flowmeter shows the flow rate of working water.




Control panel of geothermal department

(4) Set the heating mode or cooling mode using the toggle switch ON ("a" contact, heating), OFF ("b" contact, cooling) of control panel of mechanical part.

(5) When the main power is turned on, yellow and red lamps are on.

(6) Set the temperature of TC on the control panel of the heat pump division.

(7) Set the pressure and deviation of LPS of control panel of heat pump division

(8) When the PB1 is pushed, refrigeration system is working with self holding circuit and yellow lamp will be off.

(9) When the PB2 is puushed, refrigeration system is not working and yellow lamp will be on.

※ Caution

There is a danger of damage, when reverse the toggle switch(change the cooling or heating mode) during operating equipment. After stopping the operating of refrigerator reverse the toggle switch.기계장치부 제어판의 DC 24V Power ON시 RL

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

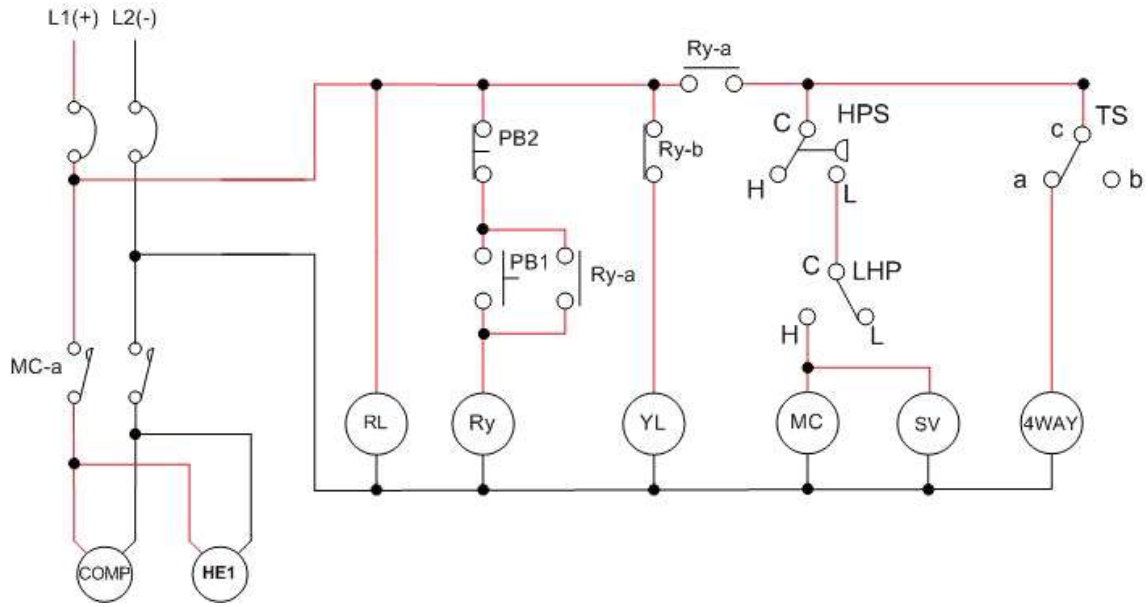
1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Construct the circuit configuration using banana jack cables and operate it.
3. Understanding the function of operating circuit.
   (1) Able to explian the process when PB1 is pushed.
   (2) Able to explain the process in cooling mode when TC and LPS are opened.
   (3) Able to explain the process in cooling mode when TC and LPS are closed.
   (4) Able to explain the process in heating mode when TC and LPS are opened.
   (5) ABle to explain the process in heating mode when TC and LPS are closed.
   (6) Able to explain the process when PB2 is pushed.

| Evaluation | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

| Experiment Description | Practice 11. Pressure automatic control circuit configuration on geothermal cooling and heating experimental experiment | Class time (hr) |
|---|---|---|
| | | 8 |
| Experiment Objectives | ① To understand the principle of pressure automatic control operation on 4 way reversing valve cooling and heating experimental equipment.<br>② To understand how to build a pressure automatic control circuit configuration | |

| Experiment equipments | Tool & material | Spec of tools | Qty |
|---|---|---|---|
| · Geothermal heat pump experimental equipment (KTE-7000GH)<br>· Refrigeration Electric Sequence experimental equipment (KTE-4000SQ) | · Screw driver<br>· Fill nipple<br>· Wire tripper<br>· Hook meter | · #2× 6× 175mm<br>· 150mm<br>· 0.5~6mm2<br>· 300A 600V | 1<br>1<br>1<br>1/Group |

**Control Circuit**




L1, L2 : Line Voltage
NFB : No fuse circuit breaker
MC-a : MC "a" contact (normal open)
Ry-a : Relay"a"contact (normal open)
Ry-b : Relay"b"contact (normal closed
SV : Solenoid valve

PB : Push Button
YL : Yellow lamp
RL : Red Lamp
COMP : Compressor
Ry : Relay Coil
TS : Toggle switch

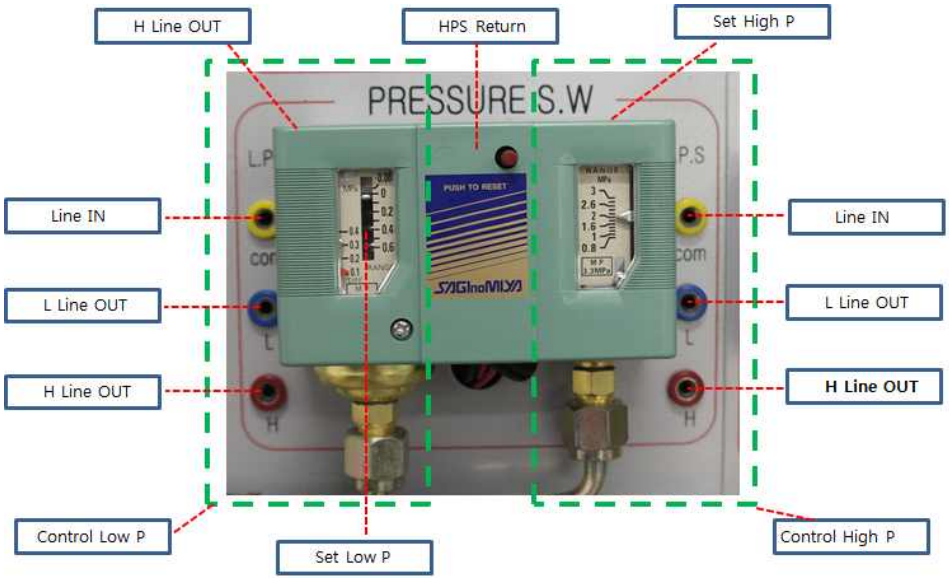
LPS : Low Pressure switch
MC : Magnetic Contactor Coil
4way valve : reversing valve
HE1 : Heat Exchanger 1 fan type
TC : Temperature control switch

1. Circuit configuration

(1) NFB switch power on

(2) Construct the configuration circuit using banana jack cables

(3) Set the pressure by turning the Low-pressure adjustment screw and set the pressure deviation.




Pressure switch

(4) Set toggle switch ON ("a" contact, heating) or OFF ("b" contact, cooling), then pump of geothermal environmental chamber.

(5) When the main power is turned on, yellow and red lamps are on.

(6) Set the pressure and deviation of LPS and HPS of control panel of heat pump division

(7) When the PB1 is pushed, refrigeration system is working with self holding circuit and yellow lamp will be off.

(8) When the PB2 is puushed, refrigeration system is not working and yellow lamp will be on.

※ Caution

When the input pressure of the compressor is lower than the setting of low-pressure, heat pump is stop working, When the input pressure of the compressor is higher than the setting low-pressure, COMP, HE1 and SV is operated.

Geothermal heat pump experimental equipment
(KTE-7000GH)

Requirement points

1. Preparation the experimental equipment, tools and material and checking of electric state and refrigerant charging state.
2. Construct the circuit configuration using banana jack cables and operate it.
3. Understanding the function of operating circuit.
   (1) Able to explain the process when PB1 is pushed.
   (2) Able to explain the process in cooling mode when LPS is opened.
   (3) Able to explain the process in cooling mode when LPS is closed.
   (4) Able to explain the process in heating mode when LPS is opened.
   (5) ABle to explain the process in heating mode when LPS is closed.
   (6) Able to explain the process when PB2 is pushed.

| | Evaluation Items | | Max. points | Score | Remarks | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluation | I Experiment (50 Points) | Check the status of preparation and safety testing | 10 | | | | | |
| | | Circuit configuration and operation | 10 | | | | | |
| | | The understanding of experiment method | 10 | | | | | |
| | | Report of experimental data and graph construction | 20 | | | | | |
| | II Analysis (30 Points) | The accuracy graph construction due to analysis | 10 | | | | | |
| | | Discussion and conclusion of the experiment | 20 | | | | | |
| | III Presentation (20 points) | Time ( ) minutes<br>Points ( ) | | | I | II | III | Total |
| | | | | | | | | |

# 5. Failure and Correction

## 5-1. When power is not connected

If there is no power even if NFB is switched on, we can check on the back side to make sure that power cable is connected as shown in the figure below,



AC LAMP indicates power connection

NFB power connection on the back panel

① Make sure that power cord is plugged in already

② Power Cord is connected to power output

## 5-2. When temperature displays are off


※Temperature displays in OFF condition

Check the power cord installed on the back panel

Back panel of temperature displays

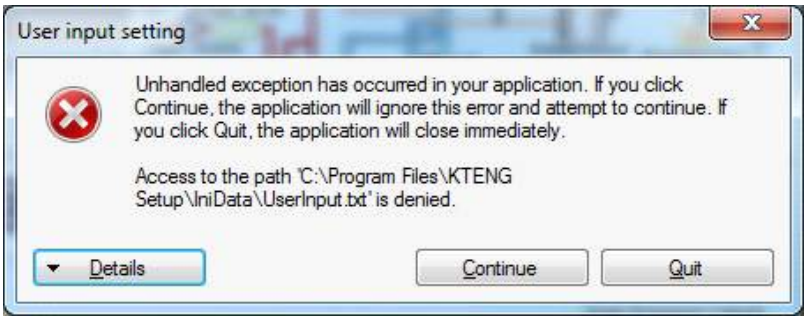
① Make sure that the power cord is plugged in.

② Power cord extension can be use to connect 2 panel

## 5-3. DA-100 access error

1) Error window

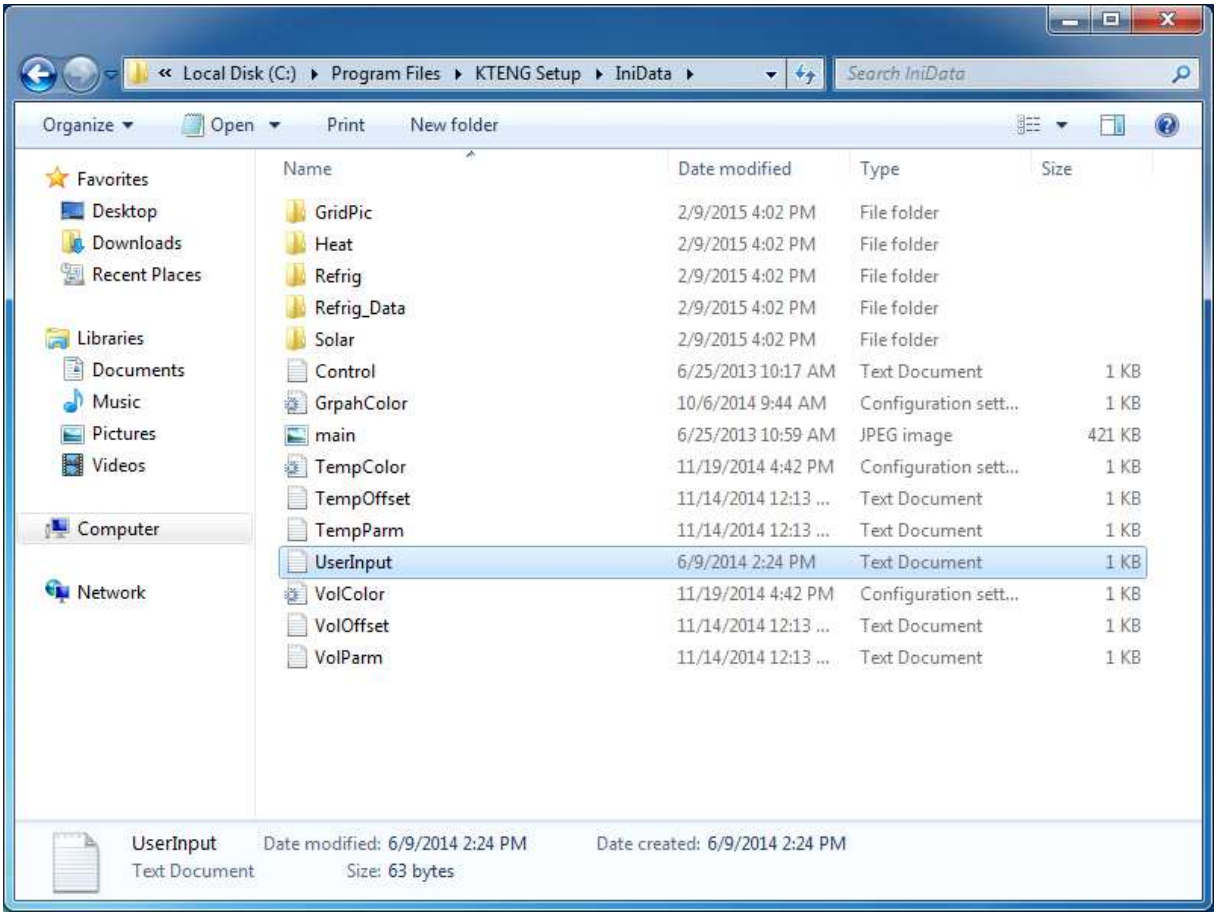
Access error may happen when follow p.41 to set a “User Input Setting”.



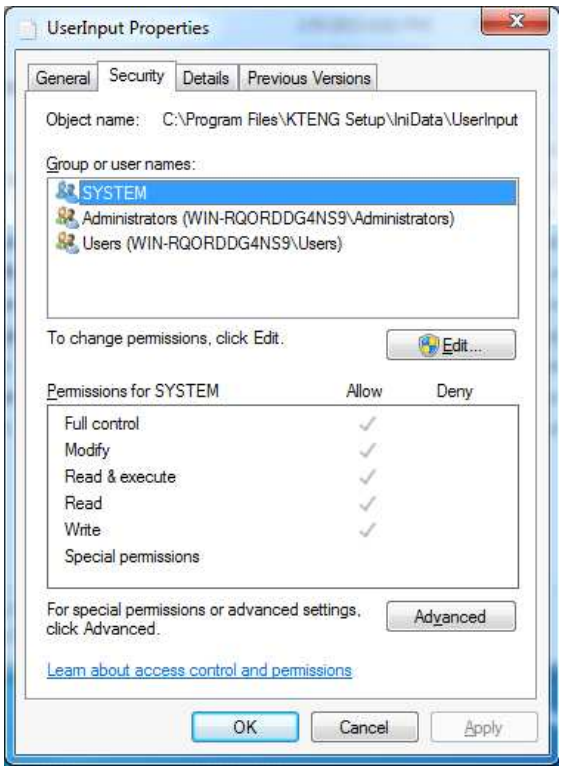
2) Solution

2-1) Open folder: Local Disk(C:)\Program files\KTENG Setup\IniData.

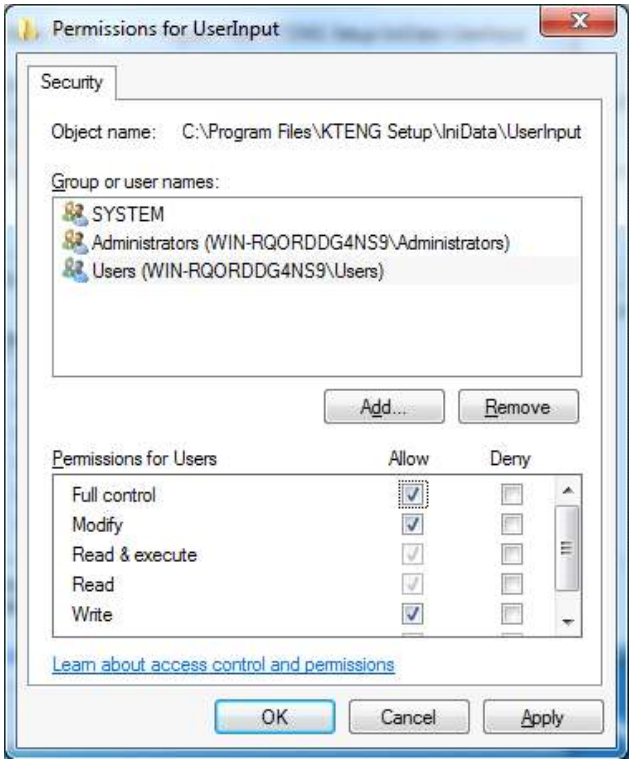
Right click the “UserInput” and click the “property“




2-2) Click the “Security” and click the “Edit”



2-3) Click the “Users” in Group or users names. Click the “Full control” in Permissions for Users. Click the “Apply” and “OK”.




## 5-4. For complex failure

If there are other complex failures our after sales (A/S) service will help and processed quickly.

# 6. The Equipment Usage Notification

## 6-1. Power supply

(1) The experimental equipment uses main power of single phase and AC 220V
(2) Process sequence in the use of the equipment is plug in the power cord, construct circuit configuration with banana jack cables, switch ON the NFB and also DC 24 toggle switch.
(3) The control panel is designed for save utilization as it is in DC circuit, but please take attention with positive (+) and negative (-) currents to avoid short-circuit.
(4) Base of the control panel is made by aluminum therefore user need to avoid the banana jack tip from touching the base when its one end is connected to the positive (+) port and the NFB and DC toggle are switched ON.

## 6-2. Machine devices

(1) Refrigerant charging at low and high pressure side, it has to be careful to make perfectly installation of fill nipple and make sure that there is no leak.
(2) In case of manual expansion valve, we should understand how to operate it correctly
(3) Initial setting value of super heat and sub cooling 5±2℃
(4) Heat exchanger 1 is made form transparent acrylic, therefore it's need to be careful by avoiding it from such big impact.
(5) All parts are connected by welding, please do not disassemble them by your self to avoid the declining of equipment performance, please contact us if you find any problem as we our best on after sales service.

## 6-3. Data acquisition device and software

Data acquisition device can be used after the following process
(1) Construction circuit configuration
(2) Toggle switch is at ON position
(3) USB To Serial gender of PC or Laptop is connected already to the Data acquisition device.
(4) Click "RUN" button on the program installed in PC or Laptop

## 6-4. General information

(1) In order to use this equipment, it is better if we should follow the manual book
(2) Within the period of after sales service (1 year after inspection) if there is disassembly by user due to repairing of the equipment and it is still found problem then if user call us for repairing it will be charge.
(3) If there is failure operation of the equipment, please contact us for consultation.

# 7. Patent and Authentication

## CERTIFICATE OF PATENT

| | | | |
|---|---|---|---|
| PATENT NUMBER | 10-0432527 | APPLICATION NUMBER | 2002-0002662 |
| | | FILING DATE | Jan. 17 2002 |
| | | REGISTRATION DATE | May. 11. 2004 |

TITLE OF THE INVENTION: Stop valve, sold valve, 4way valve controls type heatpump system

PATENTEE: KTENG Co. Ltd., (141111-0******)
601 Postechno B/D 234-1 Sangdaewon-dong Jungwon-gu
Seongnam-si Gyeonggi-do Korea

INVENTOR: Kim, Chul Su
122-701 Jangan town Kunyoung Apt., Bundang-dong
Bundang-gu Seongnam-si Gyeonggi-do Korea

THIS IS TO CERTIFY THAT THE PATENT IS REGISTERED ON THE REGISTER OF THE KOREAN INTELLECTUAL PROPERTY OFFICE

Oct. 30. 2009

COMMISSIONER,
THE KOREAN INTELLECTUAL PROPERTY OFFICE

No. 119813

## PROGRAM REGISTRATION

| | |
|---|---|
| PROGRAM REGISTRATION NO. | 2006 - 01 - 134 - 004226 |
| PROGRAM TITLE | Data acquisition & Monitoring program |
| CREATIVE DATE | Mar. 18. 2006 |
| REGISTRATION DATE | Aug. 16. 2006 |
| PROGRAM COPYRIGHT REGISTER&NATIONATY | Republic of Korea KTENG Co. Ltd., |
| SOCIAL NO. CORPORATION NO. | 141111-0****** |

THIS HAS BEEN REGISTERED WITH RECORDING AS ARTICLE 23-1 AND 16 OF THE COMPUTER PROGRAM PROTECTION LAW.

Aug. 16. 2006

PROGRAM DELIBERATION MEDIATION COMMITTEE

NO. C-2008-009452

## COPYRIGHT REGISTRATION

| | |
|---|---|
| 1.Work Title | Air conditioning & Refrigeration Electric control simulation for national skill certification and craft competitions |
| 2. Work Type | Literature |
| 3. Register name | KTENG Co.,Ltd. |
| 4. Corporate company registration No. | 141111-0019270 |
| 5. Copyright owner | |
| 6. Corporate company No. | |
| 7. Creative date | Sept. 16. 2008 |
| 8. Announce date | |
| 9. Reference | Owner : KTENG Co.,Ltd. Creative Sept. 16. 2008 |
| 10. Registration date | Sept. 29. 2008 |

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Sept. 29. 2008

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## COPYRIGHT REGISTRATION

| | |
|---|---|
| 1.Work Title | Air conditioning & Refrigeration Mechatronics system control work |
| 2. Work Type | Literature |
| 3. Register name | KTENG Co.,Ltd. |
| 4. Corporate company registration No. | 141111-0019270 |
| 5. Copyright owner | KTENG Co.,Ltd. & 1person |
| 6. Corporate company No. | |
| 7. Creative date | July.11. 2007 |
| 8. Announce date | |
| 9. Reference | Owner : KTENG Co.,Ltd. & 1 person (Co-Register) Creative : July. 11. 2007 |
| 10. Registration date | July. 26. 2007 |

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July. 26. 2007

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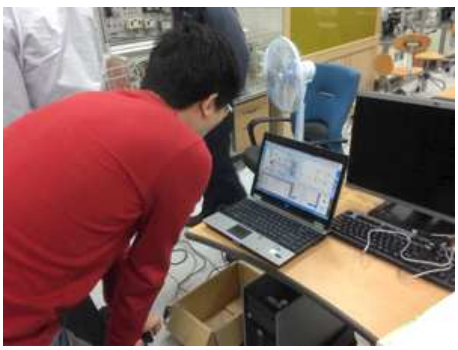
# Educational lab equipment training programs

KTE-101 : Standard Refrigeration System Experiment Practical Course
KTE-102 : Refrigerant Parallel Valve Automatic Control Experiment Practical Course
KTE-103 : E.P.R(Evaporation Pressure Parallel Control) Refrigeration Experiment Practical Course
KTE-104 : Heat Pump System Performance Experiment Practical Course
KTE-105 : Cryogenic Cold & Heat(Dual Refrigeration) System Performance Experiment Practical Course
KTE-106 : Brine Refrigeration(Ice-storage Refrigeration) System Performance Experiment Practical Course
KTE-107 : Vehicular Heating and Cooling Performance Experiment Practical Course
KTE-108 : Air-conditioning System Performance Experiment Practical Course
KTE-109 : Chiller Method Air-conditioning System Performance Experiment Practical Course
KTE-201 : Solar • Wind Power Control Basic Circuit Configuration Practice
KTE-202 : Solar Generation Test Practice
KTE-203 : Solar System Equipment Configuration Practice
KTE-204 : Wind Power Generation Test Practice
KTE-205 : Solar • Wind Power Hybrid Generation Practice
KTE-206 : Hydrogen Fuel Cell Generation Practice
KTE-301 : Solar Radiant Energy Measurement Practical Experiment
KTE-302 : Solar Hot water boiler Performance Practical Experiment
KTE-303 : Geothermal Heat Pump Cooling & Heating Practical Experiment
KTE-304 : Solar-Thermal Combined Geothermal System Practical Experiment
KTE-401 : LED Basic Theory & Performance Assessment Practice
KTE-402 : LED Application System Configuration Practice
KTE-403 : LED Lighting Equipment Practice
KTE-404 : LED Media Facade Lighting Practice
KTE-405 : LED Luminescent property analysis Experiment
KTE-406 : OLED Unit Element Characteristic Evaluation Experiment
KTE-501 : PLC Automation Control Practice Basic
KTE-502 : PLC Automation Control Practice Intermediate
KTE-503 : PLC Automation Control Basic Advanced
KTE-601 : Sequence Control Practical Basic Course
KTE-602 : Sequence Control Practical Intermediate Course
KTE-603 : Sequence Control Practical Advanced Course
KTE-701 : Power Equipment Basic Course
KTE-702 : Power Equipment Intensive Course
KTE-901 : Water-based Fire Extinguishing Equipment
KTE-902 : Gas Fire Extinguishing Equipment
KTE-903 : Alarm Equipment
KTE-904 : Fire Extinguisher
KTE-905 : Evacuation Equipment
KTE-1101 : Robot Control Practical Basic Course
KTE-1102 : Robot Control Practical Intermediate Course
KTE-1103 : Robot Control Practical Advanced Course
KTE-1201 : Welding Machine Practical Basic Course
KTE-1202 : Welding Machine Practical Intermediate Course
KTE-1203 : Welding Machine Practical Advanced Course
KTE-1301 : Basic Pneumatic Practice
KTE-1302 : Electro-pneumatic Basic Practice
KTE-1303 : Electro-pneumatic Intermediate Practice
KTE-1401 : Automatic Control Mechatronics Basic Practice
KTE-1402 : Automatic Control Mechatronics Intermediate Practice
KTE-1403 : Automatic Control Mechatronics Advanced Practice



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 CORPORATION

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**overseas@kteng.com | http://www.kteng.com**
**11, Meorusut-gil, Opo-eup, Gwangju-si,**
**Gyeonggi-do, 12771, South Korea**