INSTITUT DE PHYSIQUE NUCLEAIRE D'ORSAY

User manual : The cooling system

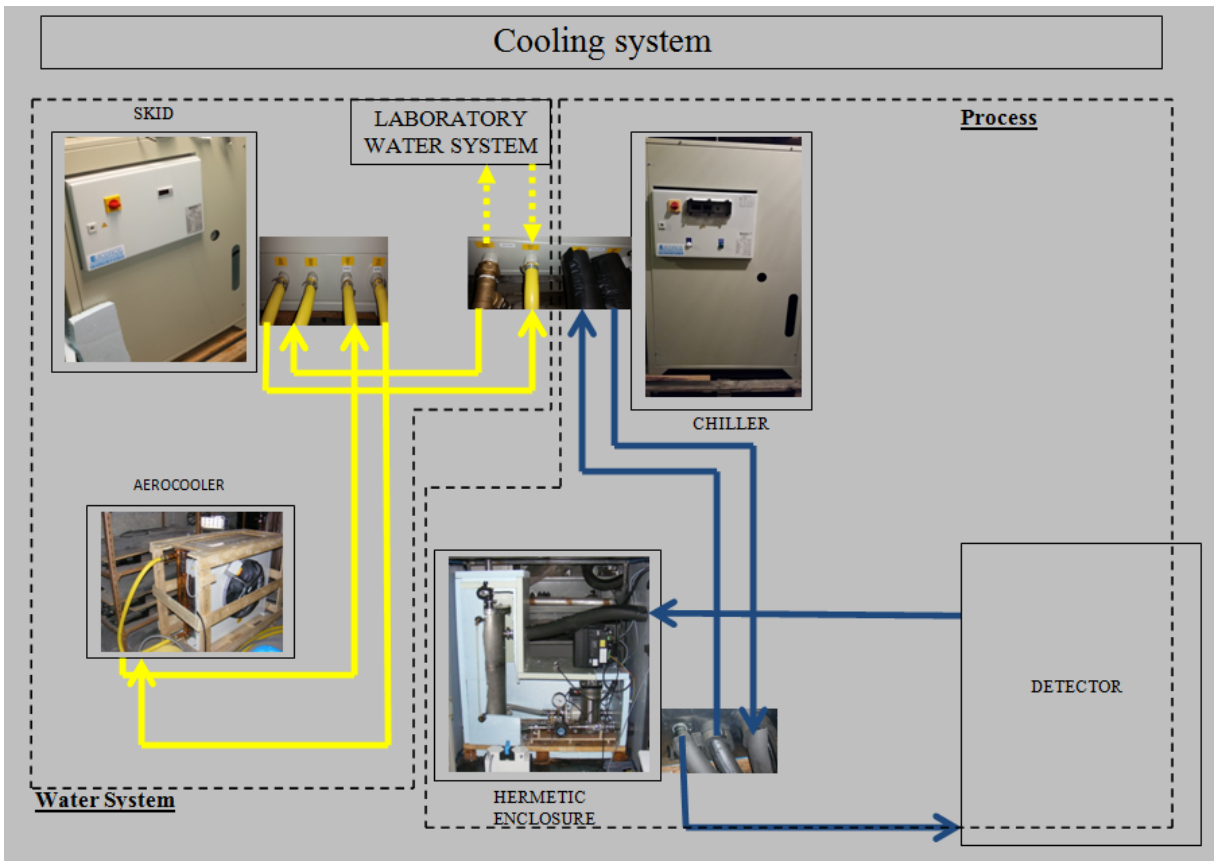
PANDA Project

21/08/2015

05/11/2015 : At the end of this manual, here is an important update and recall to use.

Summary

I) Description



Picture 1 : Circuit de refroidissement

The cooling system contains (see picture 1):

- ✓ A chiller : For cooling the liquid in the process
- ✓ A skid: which allows to remove heat from the cooler with a water circuit.
- ✓ An aerocooler: which allow a cooling the water circuit from a fan.
- ✓ A laboratory water system: which allows to remove heat from the cooler with a water circuit. It will allow to replace the skid and aero cooler in the water system.
- ✓ A hermetic enclosure including :

    1. A Grundfos pump: allowing flow of the coolant (see chap. V.2).
    2. A tank: containing of coolant.
    3. Two manometers: which allow to know the pressure in the cooling circuit.
    4. A heating resistor: Allowing a power supply (1.5 kW).
    5. A flow meter: Allows to control the flow (see chap. V.1).
    6. A vacuum pump: Allowing to reduce the pressure our cooling system (see chap. V.4).
    7. A safety valve (3bar)

A cooling liquid: which is composed of a mixture of water and glycol or a mixture of water and methanol (see chap. V.5).

II) Hydraulic connections

⚠ **When installing the chillers, make hydraulic connections before electrical connections**

Connect the aerocooler to skid (see picture 1).

Connect the chiller to skid.

Connect the hermetic enclosure to the chiller.

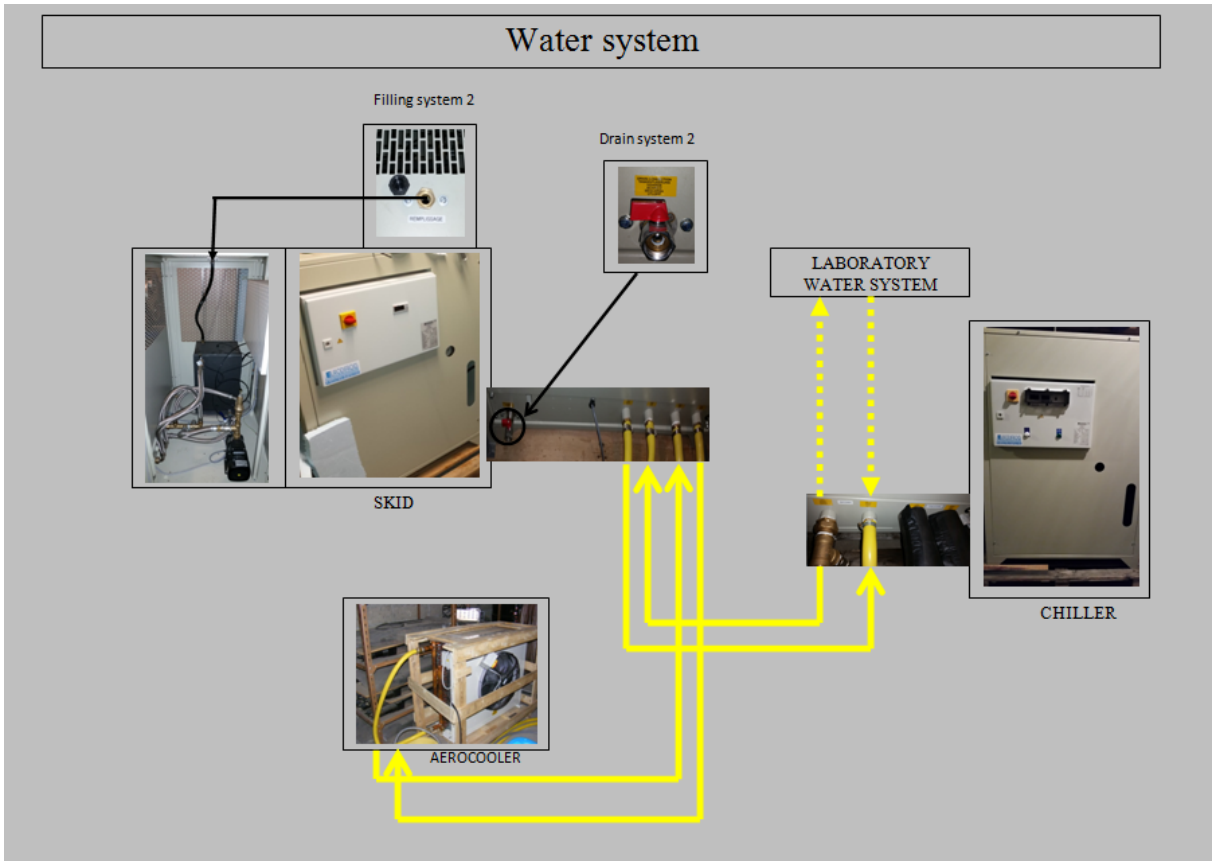
Connect the hermetic enclosure to calorimeter.

Add the coolant.

Advices:

1. To avoid condensation on the pipes and reduce energy losses, isolate the piping network with insulating tubing.
2. Observe the connection dimensions of the cooler, prevent excessive distances between the cooler and the airtight container, so as not to increase the pressure loss.
3. Respect the direction of fluid flow to cool.
4. Purge the system to remove air from the cooling system.
5. If you want to use the system of water of the laboratory instead of the skid and aero cooler, connect the chiller directly to the laboratory water system.

II.1) Hydraulic connections: Water system



Picture 2 : Water system

Water system filling (see picture 2):

1. Open all isolating valves, close a drain system 2.
2. With a Skid and chiller switched off, fill the skid tank to the maximum level.
3. Start up the skid.
4. After starting up the pump, wait about one minute while the pump is primed and air is vented from the circuit and then switch its power supply.
5. Check if there is no leakage on the connections.
6. Check the level in the process tank and repeat operation 1 if necessary.

Hydraulic settings:

The Skid should not operate outside the min / max flow-pressure on the rating plate. To this we must adjust the discharge pressure of the skid.

Press button KM1 which is in the electrical box of skid.

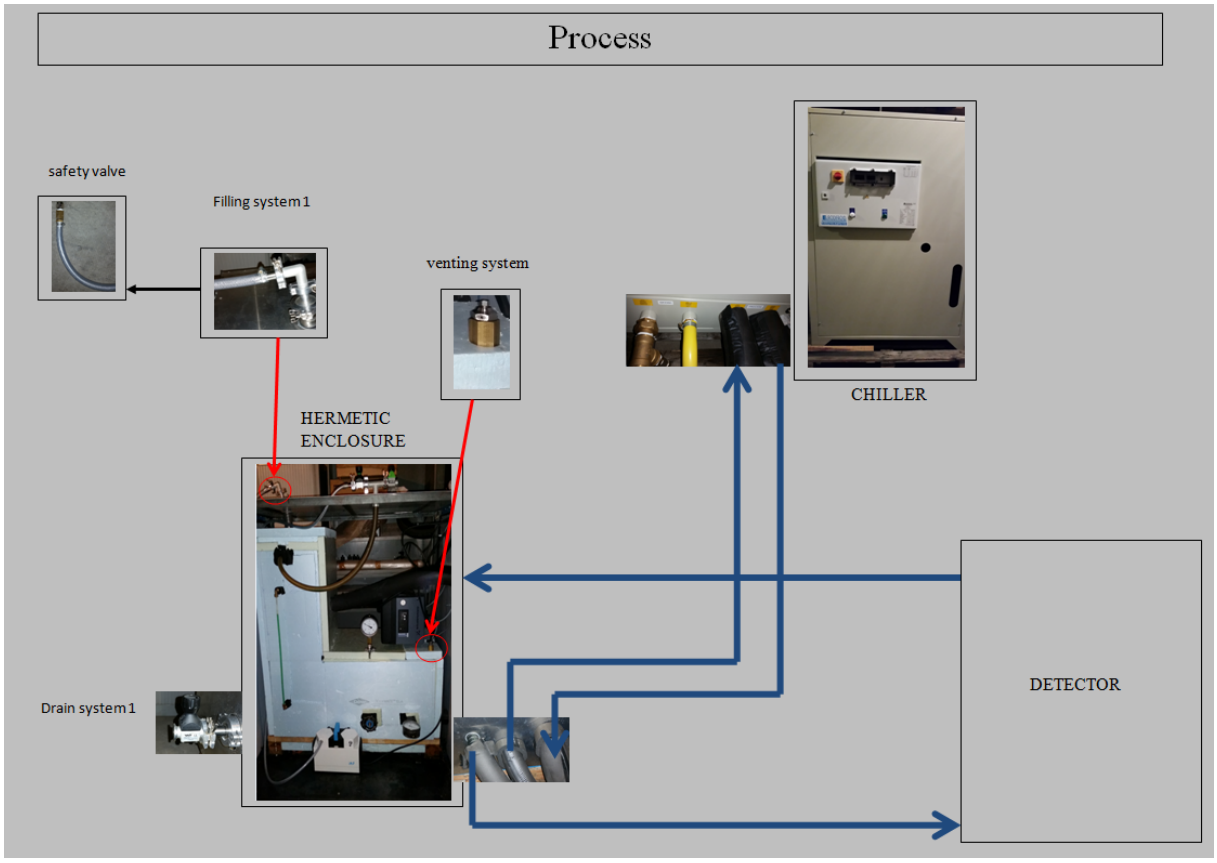
A bypass is installed between the input and output of the skid.

Gradually close the bypass valve to read gauges the desired discharge pressure.

<u>Emptying the water system:</u>

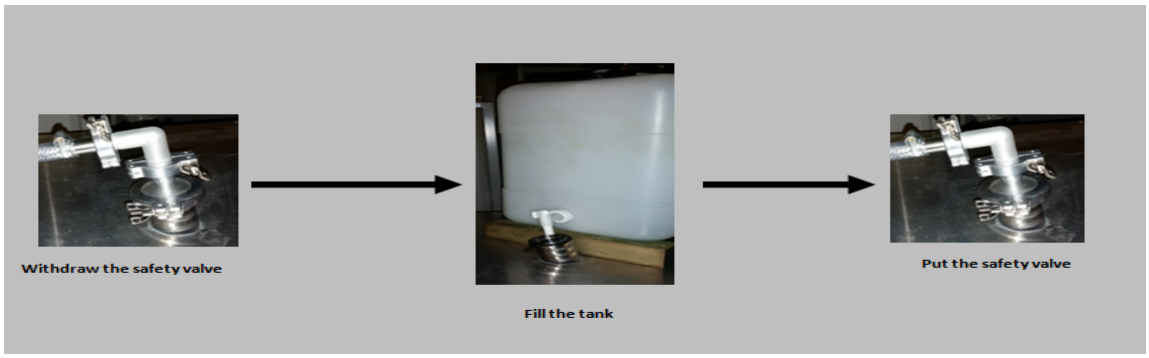
1. Place a container under the drain system2.
2. Open the drain system 2.
3. Wait until the system is empty.
4. Close the drain system.

II.2) Hydraulic connections: Process



Process filling:

1. Open all isolating valves, close a drain system 1 and open the venting system.
2. Fill the process tank.



3. After starting up the pump, wait about one minute while the pump is primed and air is vented from the circuit and then switch its power supply.
4. Check if there is no leakage on the connections.
5. Check the level in the process tank and repeat operation 1 if necessary.
6. Continue to fill and purge the facility until the pump turns without noise and no more air is vented
7. Tighten the venting systems.

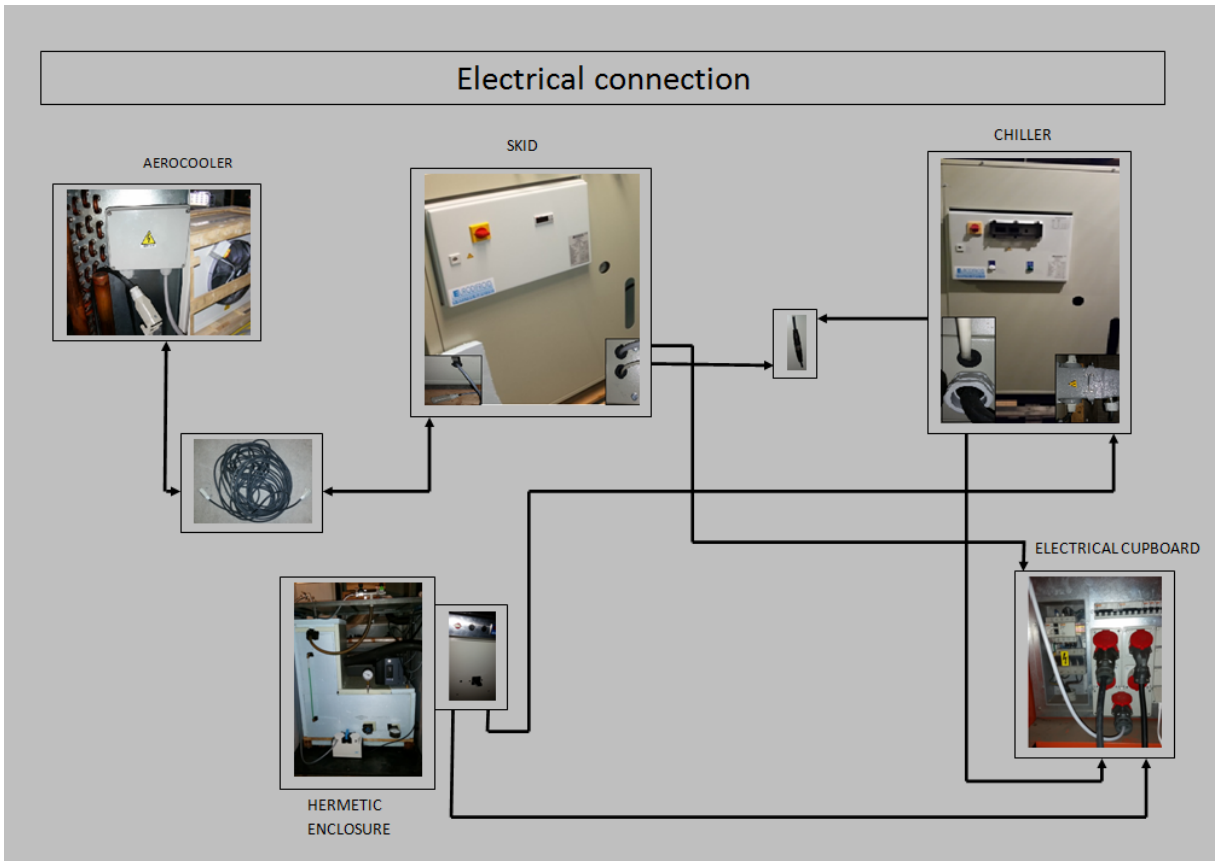
Emptying the process:

1. Place a container under the drain system.
2. Open the drain system.
3. Wait until the system is empty.
4. Close the drain system.

Advices

1. Do an air intake in the circuit.
2. Circulate the fluid in the circuit via the pump.
   ⚠**Warning: The pump must not run dry.**

III) Electrical connections



Installation:

⚠ **When installing the connections, do not use the electricity.**

Connect the aero cooler to skid.

Connect the skid to the chiller.

Connect the chiller to hermetic enclosure.

Connect the aero cooler, skid and hermetic enclosure to the electrical cabinet.

IV) Chiller

IV.1) Presentation

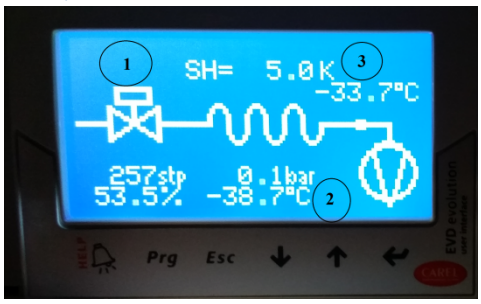
Function: The chiller will help cool the liquid lying in the cooling circuit.

It consists of two screens:

- A main display for setting the cooler.

- A secondary screen «Carrel «to obtain information on various temperatures of the chiller and the opening of the valve in the chiller.

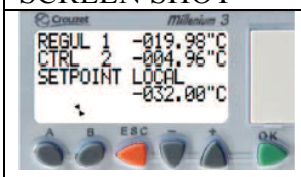
IV.2) The "Carrel"

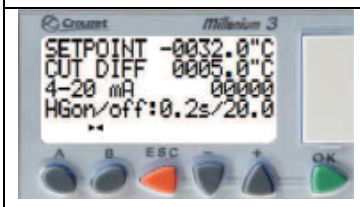
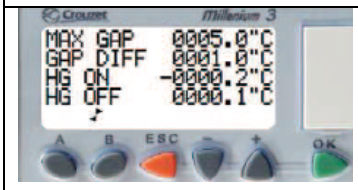


In the "carrel», we have the temperature of the fluid in the chiller (2) which will cool the liquid of the cooling system via a heat exchanger (water and glycol). The temperature of the coolant at the outlet of the cooler is shown in (3).

We also find the percentage of opening of the valve (1), this will have the effect of reducing or increasing the discharge pressure in the skid.

IV.3) Navigation

SCREEN SHOT	DESCRIPTION	AVAILABLE ORDER
	MAIN SCREEN Main display of the controller. It indicates : - The temperature of probe 1 for regulation - The temperature of probe 1 for control -The Steering LOCAL mode , 4-20 mA or Modbus - The set point taken into account for regulation	<u>Navigation</u> -Press A to move to the next screen
	<u>SCREEN STATE 1</u> It indicates : - State of the compressor (ON / OFF) - State of hot gas (ON / OFF) -The theoretical compressor capacity in% - State of autotuning (ON / OFF)	<u>Navigation</u> - Press A to access the next screen. - Press B to move to the previous screen. - Press ESC to return to the main screen.

	SCREEN MENU It provides access the submenu of setting the chiller.	<u>Navigation</u> -Press A to access the next screen. -Press B to move to the previous screen. -Press + or - to scroll. -Press OK to access the submenu in UPPERCASE. -Press ESC to return to the main screen
	MENU ORDER This screen allows you to adjust the instructions in local mode : 1) the EMC Setpoint 2) The temperature differential to cut the cold 3) Activating or not the mode of 4-20 mA.4) 4) Modification of delay ON / OFF hot gas	<u>Navigation submenu :</u> -Press + Or -to select the value to change (highlighted). -Press OK to confirm your selection, the value flashes. -Press + or - to change the value. -Press OK to accept the value. -Press ESC to exit this screen and return to the MENU screen
	SETTINGS MENU This screen allows you to set the main parameters 1) Maximum deviation between the two sensors (MAX GAP). If this difference is exceeded, the compressor is stop. 2) restart differential of compressor on maximum deviation of the two probes (GAP DIFF) 3) Differential engagement hot gas compared to the set point (HG ON) 4) hot gas cutoff differential compared to HG ON	

IV.4) Screen descriptions : Defects

APERCU FACADE	DESCRIPTION	COMMANDE DISPONIBLE
	FAULT CODE: FAULT CIRCUIT COOLING Intervenes in the following cases: - Cut Breaker - Cut of switch HP or BP - Default Customer flow controller - Default security internal of the compressor - Default General SKID - Alarm INVERTER This defect causes the compressor stop. For the resolution of defects, watch the table of diagnosis of the chiller. When the fault disappears, the cooler starts without user intervention.	Clearing the fault

	FAULT CODE 2 : FLOW CONTROLLER FAULT Occurs when there is no flow in the pipe This defect causes the compressor stop. When the fault disappears , the cooler restart without any intervention	- Press + to do disappear the display and return to the main menu when the problem is resolved.
	FAULT CODE 3 : 4-20 mA SIGNAL DEFAULT SET Occurs when there is no 4-20mA signal on the input set point and the unit is in control 4-20 mA.	
	FAULT CODE: DEFAULT PROBE INPUT 4-20 EMC Occurs when there is no 4-20mA signal on the probe 1.	
	FAULT CODE 5 : DEFAULT PROBE 4-20mA EMC Occurs when there is no 4-20mA signal on the probe 2	

IV.5) Fault diagnosis

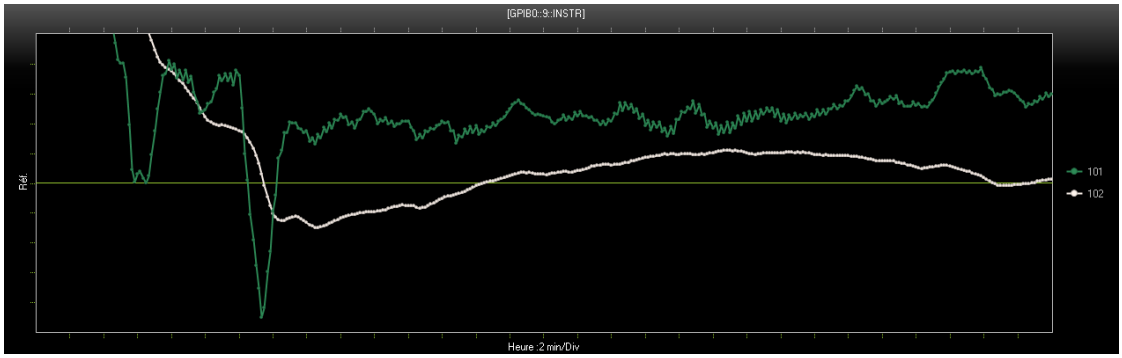
FAULT OBSERVED	CAUSE	CHEK AND REMEDY
Temperature not at required level Pump operating Compressor not operating	Regulation not actuated	Check setpoint on regulator
Refrigerating unit operating inefficiently Air drawn off from condenser is very hot, compressor, fan and pump operating High pressure cutoff	Atmosphere too warm Conderser battery dirty Air flow abstructed Fan rotation reversed	Check operating limits Clean condenser Clear obstructions from vents Reverse two phase (three-phase version)
Pump and fan operating Compressor operating intermittently Outlet condenser air not hot Absorbed current lower than normal value	Not enough gas in frigorifc circuit	Ask for refrigeration specialist intervention to look for gas leakage
Pump and fan operating Compressor stopped Outlet condenser air not hot Low pressure cutoff	Atmosphere too cooler Pressure reducer faulty Not enoughcoolant	Checkoperating limits Ask for refrigeration specialist intervention to look for gas leakage
Pump and fan operating Compressor operating intermittently Pump unadapted or damaged Fluide lack in cooling circuit	Leakage in hydraulic circuit Head loss too important Pump operating in wrong direction	Stop the chiller Check hydraulic circuit Fill up hydraulic circuit Reverse two phases (three-phase version)

Anormal noise from pump Little difference between inlet and outlet temperature Excessive water flow	Water pressure too low at pump outlet Air in the circuit	Pump operating outside curve values Purge hydraulic circuit
Temperature not at required level Operation seems generally correct, compressor intake tube under 18°C, compressor discharge tube above 60°C	Insufficient cooling power to remove heating from process	Check compatibility between chiller and process Check chiller cooling power determination

IV.6) Setting of chiller

We have the setting of chiller following:

- The " Set point " : -32.0°C
- The «Cut diff»: 5°C (it's the difference of temperature in negative when the compressor will stopping.)
- The « 4-20mA »: 0 (local use: the piloting of the automaton is done by the display panel and not RS485).
- The "HG ON/OFF " : 0.2s/20.0s (this corresponds to the opening of the hot gases which is done every 20s in 0.2s). The hot gases will allow to increase the cooling liquid temperature.
- The "HG ON" : Temperature difference between the setpoint and the injection of hot gases : 0.2°C



Canaux		Modifier la vue de l'axe Y				Données en cours	Repères				Vues contextuelles
ID Couleur	Graphique	Echelle Y		Dépl. réf. Y			M1	M2	Donnée	Alarme	Barre
101		0,15	C	-31,3	C	-30,85000 C	☐	☐	☐	☐	☐
102		0,15	C	-25	C	-24,98200 C	☐	☐	☐	☐	☐

The green curve (101) corresponds to the temperature sensor being located in the center of the tube containing the coolant.

The white curve (102) corresponds to the temperature sensor being at the surface of the tube.

At the beginning of the experiment, the chiller has been put into operation. The compressor inside the chiller starts operation at 100%. The liquid temperature decreases to -32.2 ° C , ie our set point (-32 ° C) and the difference in gas temperature (0.2 ° C). When the liquid temperature is less than -32.2 ° C , compressor capacity decreases to 66% and one sees the activation of the hot gases . This activation of the hot gases will reduce by two compressor capacity. This gives a power of 33%. In addition, the injection of hot gas with an opening of 0.2 seconds every 20 seconds will go supply heat to the cooling system .

Due to the thermal inertia of our system, the temperature does not stop at -32.2 ° C but can drop to -33 ° C.

Once the liquid rises in temperature to -32.2 ° C , the hot gases stop operating , and the power of the compressor increases.

The liquid temperature will again diminish and the hot gases will activate when one is below -32.2 ° C.

This cycle will be repeated until we obtain a stability - 25 ° C at the surface of the pipes.

VI) Equipment of hermetic enclosure

VI.1) Flow meter

VI.1.1) Presentation

Function: The flow meter informs the flow circulating in the circuit.

Use: The flow meter operates when the power box of the hermetic enclosure is in ON.

VI.1.2) Fault diagnosis

Symptom	Cause	Remedy
Empty display	1. No power supply	Power supply Check MAG 5000/6000 for bended pins on the connector
	2. MAG 5000/6000 defective	Replace MAG 6000
No flow signal	1. Current output disabled	Turn on current output
	2. Digital output disabled	Turn on digital output
	3. Reverse flow direction	Change direction
	Incorrect or no coil current	Check cables/connections
	Measuring pipe empty	Ensure that the measuring pipe is full
	Internal error	Replace MAG 6000
	No load on current output	Check cables/connections
	MAG 5000/6000 defective	Replace MAG 6000
	Initializing error	Switch off MAG 6000, wait 5 s and switch on again
Indicates flow with no flow in pipe	Measuring pipe empty	Select empty pipe cut-off
	Empty pipe cut-off is OFF	Ensure that the measuring pipe is full
	Electrode connection missing/electrode cable is insufficiently screened	Ensure that electrode cable is connected and sufficiently screened
Unstable flow signal	Pulsating flow	Increase time constant
	Conductivity of medium too low	Use special electrode cable
	Electrical noise potential between medium and sensor	Ensure sufficient potential equalization
	Air bubbles in medium	Ensure medium does not contain air bubbles
	High concentration of particles or fibres	Increase time constant
Measuring error	Incorrect installation	Check installation
	No SENSORPROM® unit	Install SENSORPROM® unit
	CT SENSORPROM® unit	Replace SENSORPROM® unit or reset SENSORPROM® unit with MAG CT transmitter
	Deficient SENSORPROM® unit	Replace SENSORPROM® unit
	Wrong type of SENSORPROM unit	Replace SENSORPROM® unit
	Flow exceeds 100% of Qmax.	Check Qmax. (Basic Settings)
	Pulse overflow Volume/pulse too small	Change volume/pulse
	Pulse width too large	Change pulse width
Measuring approx. 50%	Missing one electrode connection	Check cables

Loss of totalizer data	Initializing error	Reset totalizer manually
##### Signs in display	Totalizer roll over	Reset totalizer or increase totalizer unit

VI.2) Pump Grundfos

VI.2.1) Pump operation

Function: The pump allows circulation of the liquid in the cooling system. The pump setting for constant pressure is done from the remote control of the pump. In order to have a constant pressure, the pumps go increase or decrease the rotation speed of the pump.

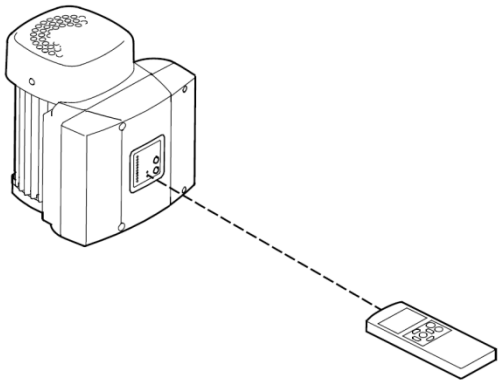
⚠ **Warning:** The pump only shows the positive values of pressure. Therefore, if the pressure is decreased in the cooling system, it must be ensured that the difference between the pressure gauge before the pump and the pressure gauge after the pump is greater than 0 bars. Otherwise, the pump will show 0 bars on the remote control of the pump, the rotation speed of the pump will increase continuously and will damage the device.

VI.2.1) Remote Control Operation of pump

The pump is designed for wireless communication with the Grundfos remote control R100.
R100 communicating with the pump via infra-red light
During communication, the R100 must be pointed at the control panel. When the R100 communicates with the pump, the red indicator light will flash rapidly.

VI.2.2) Screen descriptions

The displays appearing in this menu are status displays only. It is not possible to change or set values. The displayed values are the values that applied when the last communication between the pump and the R100 took place. If a status value is to be updated, point the R100 at the control panel and press "OK". If a parameter, e.g. speed, should be called up continuously, press "OK" constantly during the period in which the parameter in question should be monitored. The tolerance of the displayed value is stated under each display. The tolerances are stated as a guide in % of the maximum values of the parameters.



Picture	Function	Description
	Set point	Set point set Actual set point Actual value In this display, the required pressure is set in [bar]. Mode constant pressure, the setting range is equal to the measuring range of the sensor.
	Actual setpoint	This display shows the actual set point and the external set point in %
	Actual value	This display shows the value actually measured by a connected sensor.
	Speed	The actual pump speed will appear in this display.

V.3) Temperature probes

Function : Temperature sensors will allow to provide the coolant temperature and the temperature of on the surface of the pipe.

We have a first temperature probe which one will fit into a "well" in order to give the liquid temperature .
To get a better accuracy for measurements , we must :

1. Lubricate the temperature probe (this will allow better measurement accuracy) .
2. Place the probe in the well.
3. Closing the well with silicone.
4. Isolate the well with insulation .

We have a second temperature probe that we will put on the pipes (the bottom side of the pipe) in order to know its surface temperature.

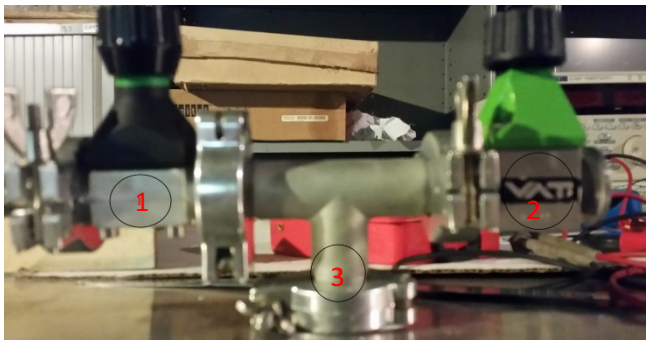
To get a better accuracy for measurements , we must :

1. Lubricate the temperature probe
2. Put the probe on the pipe.
2. Put a clamp.
3. Isolate the pipe with insulation .

V.4) Vaccum pump

Function : The vacuum pump will allow to reduce the pressure within our cooling system. It is connected at the tank .

When the cooling system is in operation, the liquid enters the Grundfos pump with 1 bar absolute pressure . The Grundfos pump delivers 0.8 bar pressure , then we have a liquid that comes out of this pump to a pressure of 1.8 bar absolute . The objective is to decrease the pressure in the cooling circuit with the vacuum pump, we want to have an absolute pressure in the circuit lower than the atmospheric pressure (1 bar) . This will allow , in case of leakage in our system to suck air and avoid letting escape the coolant .



(1) : It is a valve that connects the vacuum pump to the cooling circuit .

(2) : This is a valve which allows a air intake.

(3) : Tank

In the diagram , the (1) corresponds to a valve connecting the vacuum pump to the reservoir (3) via a " tee " . On the other end of the " tee ", we have a another valve (2) for making an air outlet.

Use:

1. Close the valves (1) and (2)

2. Open the vacuum pump and open the valve (1).

the pressure decreases in the cooling system until we have the desired pressure.

3. Close slowly the valve (1) (do not close the valve completely , because the pressure in the system will not be stable) .

The pressure in the cooling system decreases slowly .

1. Slowly open the valve (2) for an air intake , until the pressure in the cooling circuit be stable.

VI.5) Cooling liquid

The cooling systems use a mixture which is compound water and glycol or water and methanol.

VI.5.1) Mixture of water/glycol

To ensure to have no ice formation in our coolant, it takes a 54% concentration of glycol in the mixture corresponding to a temperature where the liquid will freeze at -44 ° C. The chiller can decrease the temperature at -40 ° C and we take 4 ° C safety margin by the uncertainty of the refractometer explains the choice to put the liquid freezing temperature at -44 ° C.

Checking the concentration:
The audit is made using a refractometer which indicates the liquid freezing temperature

VI.5.2) Mixture of water/methanol

To ensure to have no ice formation in our coolant requires a 60% concentration of methanol in the corresponding mixture to a temperature where the liquid will freeze to -74 ° C.

Checking the concentration :

Type of experience	Description	Advantages / Disadvantages
Saturation vapor pressure	- Fill a beaker of mixture of water and methanol. Weigh this mixture and put the beaker under the vacuum bell. - Start the vacuum pump and reduce the pressure. - Write at each different value if we obtain the boiling. - Analyze the results of satured vapor pressure.	Advantages : - Quick measuring point Disadvantages : - Difficulty at defining the value of the saturation vapor

		pressure.
Flash point	- Put the mixture in the beaker. (Mixture very flammable : put a low dose) - Put the beaker in the pan. And fill the pan with the water. - Put the temperature's probe in the water. Don't put the probe in the beaker because there is possible to damage the probe. - Increase the temperature with the hot plate. - For every degree, fire in a wooden rod, and place this wooden rod above the mixture. - At the flash point, take temperature's measure.	Advantages : - Quick measuring point Disadvantages : - Liquid explosive - Difficult to see appear the flame.
Climate chamber	Place a beaker containing the liquid in a climatic chamber. -Decrease the liquid temperature to -40 ° C. -Check The state of liquid (liquid or solid).	Advantages : - Very reliable measuring Disadvantages : - The time of experience is long (about 3 hours)

Area for improvement:

- Use a hydrometer is a possibility to obtain a value of the fastest and most reliable methanol concentration.

V.6) Heating resistor

Function : The heating resistor allows for a 1500 W power input in our cooling circuit. It will also help to avoid thermal disturbances related to the use of hot gas from the chiller .

It is connected to the electrical box of the sealed enclosure . To avoid the risk of increasing the liquid temperature (for the use of highly flammable liquid) , additional security is added by a relay connections . If there is flow in the cooling circuit, the heating resistor turns , otherwise it turns off. The heating resistor may also be turn off via the control panel if there is a flow in the cooling circuit.

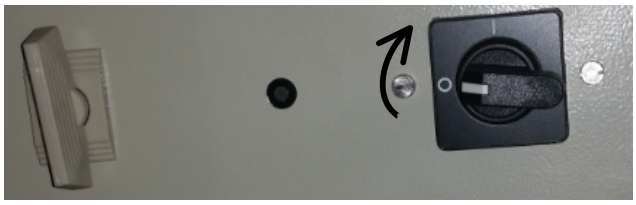
VI) Using the cooling circuit with the remote Grundfos pump and a mixture of water and glycol

VI.1) Openning : cooling system

1. Put a liquid containing a mixture of water and glycol in the cooling circuit. Check that the liquid is between the "min" and "max" . If it is less than the "min" , the liquid must be added . If it is above the "MAX" , remove the liquid. Otherwise , proceed to step 2.

2. Put in undervoltage the cooling system via the control cabinet.

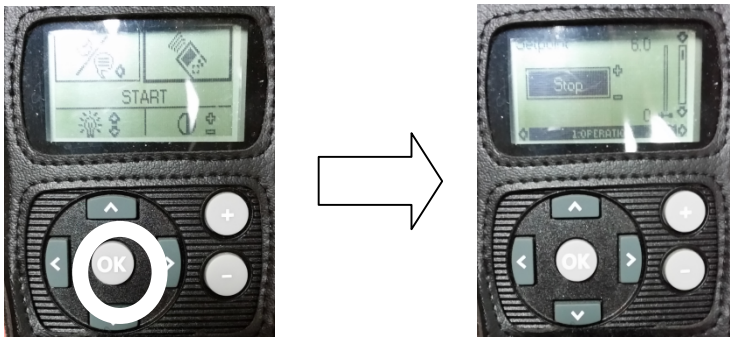
3. Putting into operation the electrical box of the sealed enclosure .



4. Take the remote control of the Grundfos pump (see description of screens chap. V.2.2) .

5. Press 2sec . "OK" on the remote control to turn it on , and press again "OK" to enter the main screen.

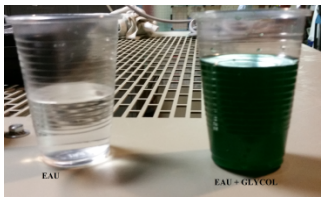
6. Press "OK" to get on the pressure set point screen.



7. Press " +" several times until reaching 0.8 bar pressure and press "OK" to turn on the pump.

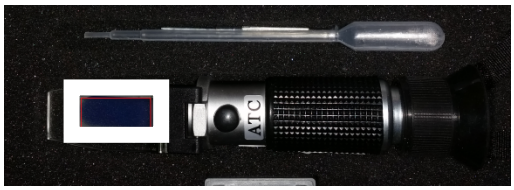
8. Circulating the liquid in the system 5 min.

9. Take the liquid cooling circuit in a container . In another container, take water .

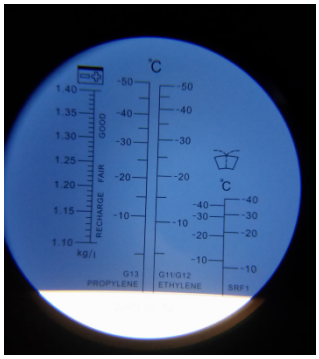


10. Take the refractometer .

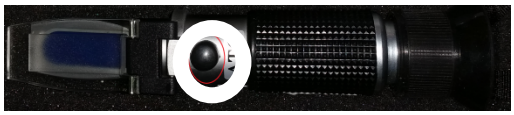
11. Take water and place a few drops on the refractometer . The liquid must cover the entire surface .



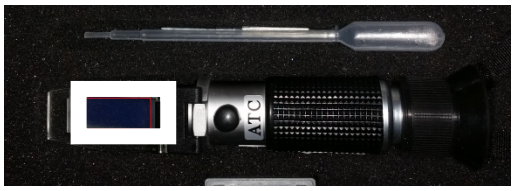
12. Read the graduation corresponding to the dividing line between light and dark area . This measure corresponds to the temperature at which the liquid will turn into ice.



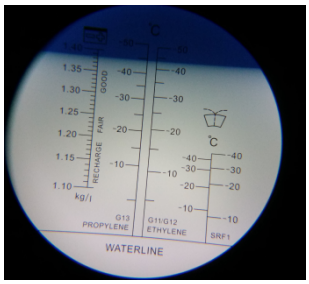
13. If the measurement is 0 ° C , proceed to step 13. If not, remove the black cap , loosen or tighten the eyepiece until the measure is equal to 0 ° C .



14. Take the liquid of cooling system , and place a few drops on the refractometer . The liquid must cover the entire surface .



15. Read the graduation corresponding to the dividing line between light and dark area . This measure corresponds to the temperature at which the liquid will turn into ice.



16. If the measurement is -44 ° C, proceeds to step 16. If the measurement is less than -44 ° C , we need add water to change the concentration of glycol in the cooling circuit and passes to the step 14. If the measurement is greater than -44 ° C , we add the glycol in the cooling circuit and passes to step 14 .

17. Opening of skid

18. Opening the cooler (see operating principle chap. IV.2).

19. Press " +" of the cooler to remove the alarms (see chap. IV.5) .

20. Press "A" of chiller to enter the main menu (see chap. IV.4) .

21. Press "A" of chiller to enter the settings menu.

22. Press "OK" to enter the cooling setpoint adjustment. Adjust the set point at a temperature of -32 ° C.

23. Press " +" or "-" of chiller to set the temperature you want (here: -32 ° C). And press "OK" to confirm the setpoint.

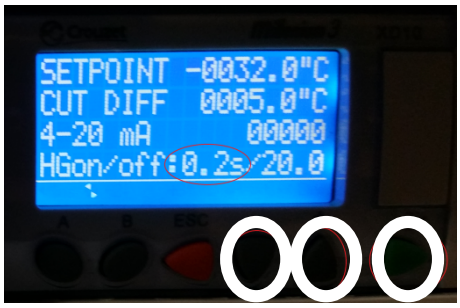
24. Press "-" to descend on "CUT DIFF " . And press "OK" to enter the setting the " DIFF CUT ", we have the difference between the set point temperature (-32 ° C) and temperature (-37 ° C) where the compressor will in stop for 3 minutes (see chap.IV) .

⚠ The stopping of the compressor for 3 minutes will induce an increase in coolant temperature .

25. Press " +" or "-" of chiller to set the temperature difference that we want (here: 5.0 ° C). And press "OK " to confirm the value .

26. Press 2 times "-" to descend on " HGon / off" . And press "OK" to enter the setting the " HGon / off" which corresponds to the timing of the hot gases . That is to say, control of the opening of the hot gases for a certain time . (See chap.IV)

27. Press " +" or "-" of chiller to set the temperature difference that we want (here: 0.2s) . And press "OK " to confirm the value .



28. Press "-" to descend on " HGon / off" . And press "OK" to enter the cooler setting the " HGon / off" which corresponds to the timing of the hot gases . That is to say the time interval before it has an opening of the hot gases . (See chap.IV)

29. Press " +" or "-" of chiller to set the temperature difference that we want (here: 20.0s) . And press "OK " to confirm the value .

30. Press "ESC" three times of the chiller to return to the main screen.

31. Activate the chiller to run the program . The on / off button is located on the sealed enclosure .

32. If we want to decrease the pressure in the cooling system , open the vacuum pump when the pressure difference between the pressure gauge is above 0 bar (see chap.VI.4) . Otherwise, do not open the vacuum pump.

VI.2) Closing: cooling system

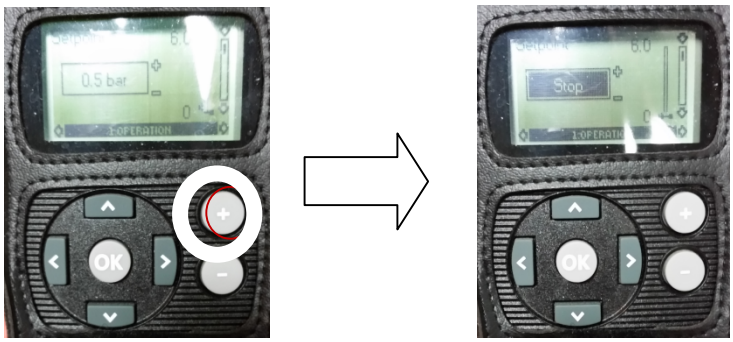
1. Disable cooler. The liquid temperature will increase.

2. When the temperature of the liquid is greater than -20 ° C , turn on the remote of the pump.

3. Press 2sec . "OK" on the remote control to turn it on and press "OK" to enter the main screen.

4. Press "OK" to get on the pressure set point screen.

5. Press "-" repeatedly until "STOP " and press "OK" to stop the Grundfos pump.

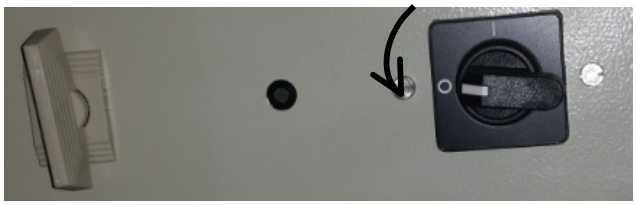


6. If there was a decrease of the pressure in the cooling circuit, turn off the vacuum pump. Otherwise, go to step 7 .

7. Switch off the chiller.

8. Switch off the skid.

9. Turn off the electrical box of the sealed enclosure .



10. Disconnect power from the cooling circuit .

05/11/2015 : Updates, recall and warning to follow :

⚠ **Warning:**

- Do not operate the Grundfos pump without coolant. In case of bubbles, exhaust it with the exhaust valve.
- The flow rate of the fluid must not be less than 8 l / min and must not be greater than 60 l / min. Check the running speed of the pump.
- Wait to have a pressure difference greater than 0 bar between the two gauges to open the vacuum pump. Put the leakless underpressure once you get positive pressure grundfos pump running. Because of its pressure sensor which doesn't accept negative pressure.
- Risk of explosion! Do not leave the heating resistor open when the liquid temperature is at room temperature.
- Fix the laboratory water cooling at a 2 – 3 bar pressure range. This must be checked on the skid manometer.

Recall:

- The sensor REGUL1 must be into the pit in good contact with the liquid to get a fine accuracy of the coolant temperature.
- The sensor Control 2 must be correctly insulated to not exceed 10°C max difference with the REGUL1. If not, the chiller stopped. (currently it works with 7°C difference in running as the control 2 is on the tube surface).
- The hot gas regulation is set for an opening of 0.4s every 10s which is optimized for -32°C. For -20°C or above, you may set for example 1s every 5s to inflate more hot into the fridge circuit as the compressor gains in power for hot temperature.
- To run the chiller without the skid with air fan chiller, an electrical jump is put in between the channel 46 and 54.
- The chiller stops if there is no flow.