MANUAL FOR INSTALLATION, MAINTENANCE AND OPERATION OF INDIRECT GAS HEATERS THROUGH LIQUID BATH

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1 – PRE-COMMISSIONING INSTRUCTIONS

It should be clearly understood that the information presented in the Commissioning Instructions that follow is not intended to revoke or replace the instructions determined by any other competent body and reference should be made to the relevant Standards and/or recommendations on this matter.

Before any Commissioning, it is understood that the appropriate “Cleaning and Purification Procedures” must be performed and all instructions on “Pressurization” and “Occupational Standards for Health and Safety” must be strictly observed.

The recommendations of valve suppliers, such as “open slowly” or “open very slowly” must be strictly observed.

1.1 – HEALTH AND SAFETY

Regulators, valves and other pressurized components that contain toxic gases, flammable gases or other hazardous products are potentially dangerous if not operated and maintained in the correct manner. All users of this equipment must be properly trained and informed of the potential hazards. The personnel responsible for the installation, testing, commissioning, operation and maintenance of the plant must be competent to perform these activities. Instruction manuals are provided to guide operators, but it is assumed that they have a basic level of knowledge. If there are doubts or ambiguities that affect the correct procedures, ask Gascat Ind. e Com. Ltda. We will be pleased to advise or provide the competent service or instruction. DO NOT RISK. Our phone numbers, fax number and e-mail are described below:

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The comments below, while not exhaustive, provide guidance on possible sources of danger to health and safety.

1.2 – NOISE

Regulators, valves and other pressure reducers generate high levels of noise, which can be harmful to people exposed to them for long periods of time. Users must ensure that adequate precautions are taken to protect the health of employees and/or third parties, in accordance with the standards and recommendations in force.

1.3 – INSTALLATION

All equipment, piping and vessels are designed to withstand mechanical stresses, such as torque and bending moments, in addition to internal pressure. However, care must be taken during installation to avoid imposing excessive efforts, which can cause cracks that may result in serious rupture when the regulator is put into operation. Excessive stresses can also be caused due to not supporting the length of the piping, which must be adequately supported.

All regulators, shutoff valves, relief valves etc. must be installed with the correct flow direction.

Impulse lines are important components of any control system and it is essential that they are correctly installed and without isolation valves.

Impulse lines must be adequately supported to reduce excessive vibration, which can cause fatigue rupture. They must also be positioned so that they cannot serve as a foot or hand support. Impulse lines must be slightly tilted so that liquids and condensates flow into the main pipe.

When necessary (in underground installations or indoors), a ventilation pipe must be installed from the Ø ¼" NPT thread and positioned in the hood or diaphragm housing. It must be extended and positioned in a safe and ventilated place, with the vent outlet protected to prevent the access of rainwater and insects that may obstruct ventilation.

Auxiliary systems must not be altered or modified without knowing the operating conditions and permission from the responsible personnel.

1.4 – OPERATION

The same precautions taken for the rest of the station must be adopted for the instrumentation of the heater. For example, depending on the type of regulator, the valve can be positioned fully open. Consequently, when putting a regulator into operation, the shutoff valves must be opened slowly so that the regulator valve can assume its regulating position. If the valves are opened quickly, the upstream pressure can pass downstream through the regulator and over-pressurize downstream of the main line. All regulators etc. must operate with the regulation spring specified by the manufacturer. This is especially important when operating a relief valve or

shutoff valves, as incorrect springs can prevent a relief valve from opening and a shutoff valve from closing. Precautions must be taken to prevent water from entering through the breathing and ventilation openings.

1.5 – MAINTENANCE

For instrumentation of the heater, regulators and valves may contain gases with pressures that sometimes are higher than atmospheric pressure. Before attempting to investigate any problems or perform maintenance on the equipment, it must be safely depressurized. In addition, as most gases can be flammable, toxic, corrosive, that is, dangerous, it may be necessary to purge the installation with an inert gas, such as Nitrogen. Special precautions are necessary for operation with gases such as oxygen or hydrochloric gas and the user must be sure that adequate procedures are in place. Eventually, it is not enough to isolate the high-pressure device since high pressures may be retained downstream of the isolation valves. Do not attempt to remove covers, plugs etc. before this device is properly released. Even so, it is prudent to consider that high pressure gas may be present when removing the covers and plugs. Most regulators use spiral springs as a loading device. It is important to reduce the load on these springs by moving their presser as far as possible. In some cases, it may contain residual load, even when the spring is relaxed within the limits of its housing.

1.6 – FLAME ARRESTER ELEMENT

The flame arrester element is a device provided within the burner assembly. It aims at, without closing the air passage, eliminating the reverse flame propagation from the combustion pipe to the atmosphere. Its existence is essential to provide safety in the vicinity of the burner.

1.7 – BURNER

The burner is responsible for generating the flame that heats the combustion pipe. It is connected to the mixer, through which the gas/air ratio when burning can be manually regulated.

ATTENTION!

- DO NOT REMAIN NEAR THE BURNER INSPECTION WINDOW OR FLAME ARRESTER DURING START-UP!

- ONLY PERSONNEL QUALIFIED FOR THE FUNCTION CAN OPERATE THE BURNER.

- NEVER GENERATE IGNITION OR FLAME OR INSERT A FLARE IF THERE IS GAS RESIDUES IN

PIPING!

- NEVER START THE HEATER START-UP OPERATION WITHOUT COMPLETE UNDERSTANDING THE INSTRUCTIONS IN ITEM 7 OF THIS MANUAL!

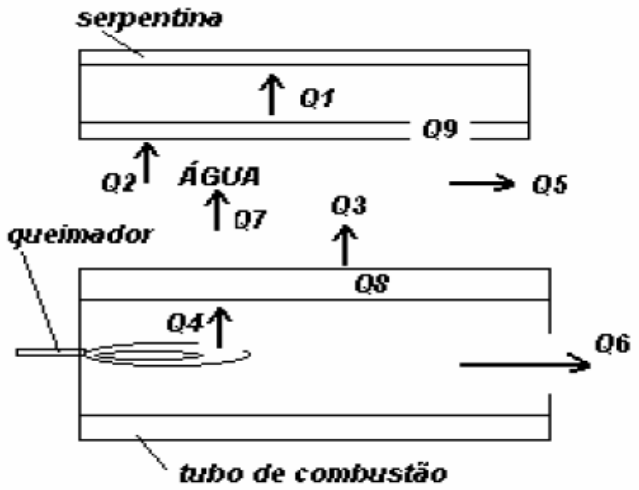
2 – INTRODUCTION

Gascat's liquid bath indirect gas heater is a device that aims at heating Natural Gas before its entry into the pressure reducing station where, simultaneously, its temperature decreases (Joule-Thompson effect) as a result of pressure reduction in pressure regulating valves.

It can be assumed that for every 2.0 kgf/cm² of pressure reduction, there is a decrease of 1 °C in the gas temperature.

3 – PRINCIPLE OF OPERATION

All the heat generated by the system comes from the heating of the combustion pipe walls, where the suction burner is installed (by natural aspiration). The heating of the combustion pipe walls transmits this thermal energy to the water in contact with it and then to the coil that conducts the gas to be heated. In view of the evaporation caused by the heating of the water, it is necessary to periodically replace it. The temperature of the water bath is adjusted between 55 and 80 °C, but it depends on the capacity of the heater. Usually, the water temperature is limited to 90 °C. When this temperature is reached, the heater turns off. To restart it, the technician must be in the field. The gas used for burning, which will generate the heat required for the system, usually comes from a pressure reducing station specially designed to supply gas for utilities.



Indirect heating by liquid bath (water)

Figure 1 - E.g. Indirect heating

4 – CHARACTERISTICS

4.1 – Flowchart.

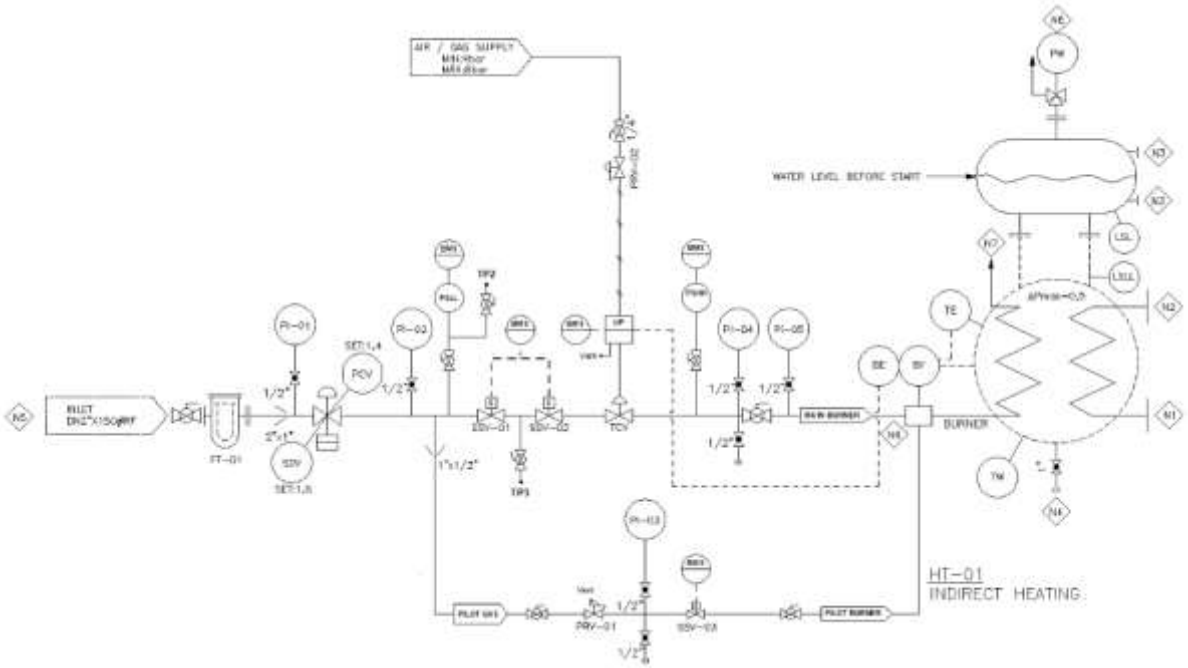


Figure 2 – Flowchart

4.2 – DESCRIPTION OF THE HEATER COMPONENTS

4.2.1 – PROFIRE 2100 AND PROFIRE 2200SB/DB FLAME CONTROLLERS

PROFIRE 2100

PF2100 BMS (Burner Management System) is an advanced electronic system. This control and monitoring system is designed for use in a wide variety of industrial gas heater applications up to 12.5MM BTU/h.

It provides electronic pilot ignition, flame detection, temperature control and remote monitoring. In addition to being an extremely useful tool, it improves safety, preventing the flame from igniting in unsafe conditions.

PROFIRE 2200SB/PROFIRE 2200DB

PF2200-SB/2200-DB controllers are specifically designed to improve the performance and control of a wide variety of Natural Gas heater applications. PF2200-SB offers the most powerful and simple user experience possible and is capable of managing a combustion system. The PF2200-DB model, in addition to having all these characteristics, is capable of managing up to two systems completely independently.

4.2.2 – FLAME ARRESTER

Flame arresters are made of corrugated aluminum that allows the transfer of air but suffocates the fire that tries to escape the same way.

The entry of air happens in a natural way (convection). The superheated air resulting from the burning goes up through the stack and cold air enters through the flame arrester to enrich the mixture and feed the flame.

4.2.3 – PILOT FLAME

The pilot flame consists of the burning nozzle, spark plug, high insulation cable, support, fuel gas conduit and mixer.

Its function is to start the heater start-up. It starts heating and is responsible for lighting the main flame.

The fuel gas is fed by an independent line with a pressure of approximately 0.4 kgf/cm².

4.2.4 – MAIN FLAME

The main flame consists of the burning nozzle, mixer and pilot.

Its function is to maintain the bath temperature as adjusted in the Profire, which is between 55 °C and 80 °C (2 °C dead-band below the set temperature)

The fuel gas is fed by its own line with a pressure of approximately 1.4 kgf/cm². It is possible to implement another line with an intermediate pressure named “LOW-FIRE” (1.0 kgf/cm²). The main flame starts in this condition and then another valve is opened at full pressure.

4.2.5 – SPARK PLUG

The spark plug is responsible for generating the spark that will ignite the pilot's flame. In addition, it ionizes with the flame, thus also indicating the quality of the burning. In the event of a failure or even if the pilot goes out, the plug reads this signal and Profire performs system shutdown to prevent accidents or malfunction.

4.2.6 – FIRE TUBE

The FIRE-TUBE is coupled to the flame arrester at one end and the stack at the other. The main flame and the pilot are inside this device. It also burns fuel gas. The FIRE TUBE heats the water that is around it.

4.2.7 – STACK

STACKS are responsible for exhausting the gases resulting from burning.

They have lifting rings, which can be fixed to the ground for stability.

4.2.8 – COILED TUBING

The coiled tubing is the duct responsible for receiving the cold process gas and returning it heated to the pipeline.

It is heated by the liquid in the main tank (water is often used).

4.2.9 – MAIN RESERVOIR

The main reservoir houses the FIRE TUBE, COILED TUBING, their respective tracks and supports, and also all the liquid necessary for the process.

4.2.10 – EXPANSION TANK

The expansion tank is where the entire system is fed by the liquid that conducts heat. An excess relief valve is placed at its top.

Note: when fed, the expansion tank must be filled to 1/3 of its total volume, since the liquid can expand after heating.

4.2.11 – EXPANSION TANK TOP VALVE

The valve that is installed on the top of the expansion tank is where the system is fed by the liquid that conducts heat. It has a system that eliminates the excess liquid if it expands above the maximum allowed volume. This valve also releases vapors commonly produced by this system.

4.2.12 – LSL (optional item)

The LSL level switch is installed in a strategic location on the expansion tank and indicates when it must be refilled.

This is a separate signal that can be sent to a supervisory system.

4.2.13 – LSLL

The LSLL level switch is installed between the expansion tank and the main reservoir (mandatory) and indicates that the reservoir must be refilled IMMEDIATELY.

This is a separate signal that is sent directly to PROFIRE. When it is interpreted as activated, the heater is turned off.

4.2.14 – PSL

The PSL pressure switch is installed in the main line of the utility skid. It monitors the flue gas supply pressure. Once this gas decreases to a pressure that is not suitable for burning in the main flame, it sends the signal to PROFIRE, which performs the heater shutdown.

NOTE: PSL and PSH pressure switches can be replaced by a pressure transmitter with 4 to 20 mA output.

4.2.15 – PSH

The PSH pressure switch is installed in the outlet line of the main flame. It monitors the flue gas supply pressure directly in the main flame. Once this gas increases to a pressure that is not suitable for burning in the main flame, it sends the signal to PROFIRE, which performs the heater shutdown.

NOTE: PSL and PSH pressure switches can be replaced by a pressure transmitter with 4 to 20 mA output.

4.2.16 – LGT (optional item)

LGT is a level sensor that monitors the liquid proportion of the expansion tank from 0% to 100% of its capacity.

This signal can be connected to Profire or to a remote supervision system.

4.2.17 – "K" TYPE DOUBLE TEMPERATURE SENSOR

The double sensor installed in the main reservoir sends two signals to PROFIRE. A pair of the "k" type sensor is used to control the process temperature (Process temp.), while a second pair is used in alarming high temperature (HIGH temp.).

4.2.18 – UTILITIES SKID

THE UTILITIES SKID supplies fuel gas to feed the system. This module has several fittings for gas control, some with local indication and others send a signal to PROFIRE, which monitors the entire system.

These instruments include:

- Input filter;
- Main Regulating Valve;
- Overpressure shut-off valve;
- Pilot Regulating Valve;
- Relief valve;
- Double shut-off valves;
- Ball valves;
- Manometers;
- Pressure and temperature sensor;
- Solenoid valves;
- Proportional flame control valve;
- Others;

Note: Some of these instruments are optional and m vary according to the need and project.

4.2.19 – PROPORTIONAL VALVE

The 4 to 20 mA proportional control valve is controlled through PID control managed by PROFIRE. It controls the flow of combustible gas to the main flame of the burner.

It opens fully when the bath temperature is well below the desired value and closes slowly when

5 – INSTALLATION

5.1 – GENERAL PROVISIONS

The place for installing the heater must have the following conditions:

- ✓ Easy access, even for service vehicles.
- ✓ Explosion-proof natural or artificial lighting.
- ✓ Away from possible sources of ignition or sparks, as well as from the electrical network.
- ✓ Protected against the risk of collision by vehicles.
- ✓ Adequate ventilation.

5.2 – HEATER INSTRUMENTATION

- ✓ Install the spare components shipped with the heater such as manometers and thermometers, as indicated in the functional flowchart.

- ✓ There is a filter provided at the inlet of each heater. However, due to the physical location of the heater, it may not receive pure natural gas and impurities can affect the fine tuning of valves. Check gas cleanliness.

- ✓ Remove the plugs from the flange ends and valve vents, making sure that there is no risk of water or dirt penetrating.

5.3 – PIPING CLEANLINESS

- ✓ Check piping cleanliness before installing the heater. We recommend a complete purge of the line with nitrogen or compressed air.

5.4 – FLOW DIRECTION

- ✓ Check the flow direction of the installation according to flowcharts and relevant documentation.

5.5 – IMPULSE LINE

- ✓ Install the impulse lines according to the functional flowchart.

5.6 – DRAIN VALVE

- ✓ There is a drain valve in the lower central part of the main tank for draining and changing the water.

6 – OPERATION (START-UP)

6.1 – BEFORE START-UP

- The entire area in the vicinity of the heater must be clear of obstacles and clean for eventual emergency evacuation.
- Perform a detailed inspection of the condition of the flame arrester, burner and connections. Make sure that all fasteners are correctly tightened.
- Make sure that there are no leaks by inspecting gas and water joints.
- Make sure that there is no combustible gas in the vicinity of the heater. It is recommended to
- Close all shut-off valves on the main burner and pilot lines and wait at least 5 minutes, so that any remnants of combustible gas from the combustion pipe or stack are dispersed in the atmosphere.

6.2 – STEP-BY-STEP

It is expected that to follow the steps below all the previous ones have already been checked and that the fuel gas utilities station is watertight and all its valves are closed. It is also expected that all other components are properly installed, as well as the pilot and main burner are properly installed and free from vibrations, leaks and anomalies.

It is also expected that the electrical connection has been performed by specialized personnel, all terminals are identified and tested electrically and the electrical supply is connected to the correct PROFIRE voltage.

It is also expected that the reservoir tank is full (preferably drinking water) and the expansion tank is up to one third of its total level.

SUMMARY OF THE PROFIRE BUTTONS FUNCTIONS

STOP ➔ Turn the heater off immediately;

MENU ➔ Open the menus for navigation;

UP/DOWN ARROWS ➔ Navigate between the Menus, increase and decrease the set values;

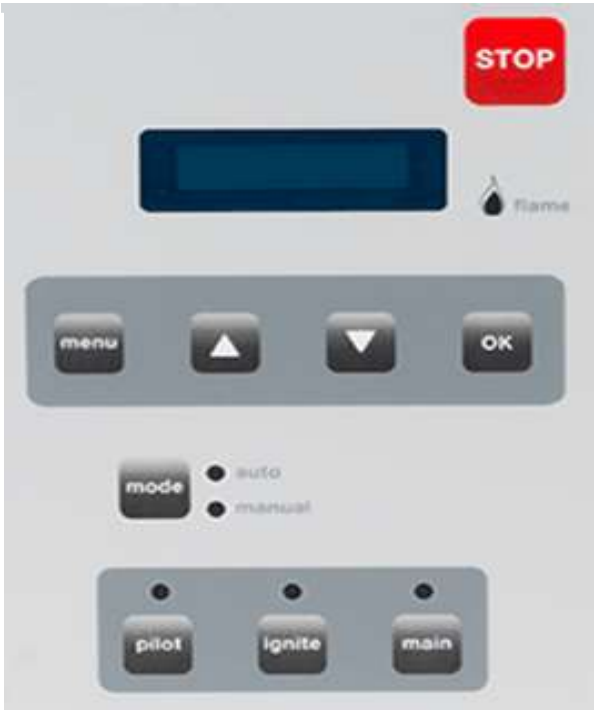
OK ➔ Confirms a selection and/or an adjustment in the Menus;

MODE ➔ Toggles between manual and automatic mode;

PILOT ➔ Releases and cuts off the pilot gas supply in manual mode;

IGNITE ➔ Generates sparks in manual mode;

MAIN ➔ Releases and cuts off the main flame gas supply



1. Slowly open the gas inlet valve and supply the utilities station input filter. If necessary and feasible, drain some of the gas through the drain valve under the filter in order to remove impurities;
2. Monitor the supply pressure of this station on the inlet manometer. It must not exceed the maximum pressure of the regulator just ahead, usually 10 bar.
3. Adjust the main valve according to the engineering flowchart provided in the project. Monitor the pressure upstream of the valve through the manometer;
4. Usually, the regulating valve has a built-in automatic shut-off valve. Adjust it for blocking according to the engineering flowchart provided in the project. Monitor the pressure upstream of the valve through the manometer;
5. If there is a relief or purge valve in the line, adjust it according to the engineering flowchart provided in the project;
6. At this moment, the main line is ready and the Pilot line must be adjusted. For this purpose, open the pilot supply ball valve.
7. Adjust the pilot line regulating valve according to the engineering flowchart provided in the project. Monitor the pressure upstream of the valve through the manometer;

8. Next, the set values of all other instruments in the utilities skid and also in the main heater tank, such as pressure switches, level switches and others, must be checked. The signals of these instruments must arrive closed in PROFIRE so that Start-up is performed.
9. As soon as all instruments are adjusted and pressurized, perform a tightness test of the station to find and remedy possible leaks.
10. Wait 5 minutes and confirm the stability of the system;
11. Energize PROFIRE and wait for it to start;
12. Configure in PROFIRE the necessary items according to the application (for PROFIRE configuration, use the manual). Some examples of items that must be configured: supply voltage (12/24vdc), process temperature (PROCESS TEMP), emergency temperature, PILOT shutdown time, attempt to restart, backlight, commissioning date, etc.
13. First, a manual test must be performed on the heater. For this purpose:
14. Click on the “MODE” button until the manual LED lights up;
15. Click on the “IGNITE” button. At this moment you should hear the spark sound inside the FIRE-TUBE. Otherwise, the plug may be leaning against the side of the burner and sparks are not occurring. Once the spark is heard, proceed to the next step;
16. Release the IGNITE button and wait for the purging time (approximately 60 seconds). Then click again on IGNITE and wait for 2 seconds. Click on “PILOT”. At this moment, the pilot solenoid valve will open and the gas will be released. Next, the flame should light. The quality of the flame is monitored through the blue LED “FLAME” on the PROFIRE front panel. Quality must be close to 100% and stable;
17. As soon as it is stable, the PILOT button can be released;
18. Press the MAIN button WITH THE OUTLET VALVE FOR THE MAIN BURNER CLOSED.
19. Check in the last outlet manometer for the burner if the pressure has risen and equalized with the outlet pressure of the main valve;
20. Slowly open the main flame outlet valve and monitor the burning sound, trying to hear anomalous noises. If they are heard, slowly close the valve until stabilization;
21. At this point, it is necessary to remove the flame arrester cover and regulate the air intake in the mixer until the flame is as blue as possible.
22. Then put the flame arrester cover back and open the main flame outlet valve slowly until it opens completely. If necessary, repeat step 19.
23. As soon as the main flame is stabilized and adjusted, click on “STOP” and stop the heater;

24. After stopped, click “OK” and repeat steps 14, 15, 16, 17 and 18, but this time with the main burner outlet valve open;
25. The system must go into full operation and without anomalies. Wait approximately 5 minutes for the gas to burn through the main flame;
26. Then click on “STOP”. The heater will be completely turned off.
27. Click on the “MODE” button until the auto LED lights up;
28. Click on “OK”.
29. At this point, the heater is already running in automatic mode.

7 – INTERLOCKING

PROFIRE flame management systems have several interlocking systems to shut down the entire system and ensure operational safety, including:

Ionization Sensor – Using a modern ionization system through the flame it is possible to measure the quality of the flame and turn off the heater if the flame is of low quality.

PSL – The signal from a pressure switch is sent to PROFIRE and it turns off the heater in case of low pressure that can compromise the quality of the burn.

PSH – The signal from a pressure switch is sent to PROFIRE and it turns off the heater in case of high pressure thar can compromise the quality of the burn.

LSLL – A level switch sends a very low liquid level signal and PROFIRE performs the system shutdown for safety.

HIGH TEMP – The bath temperature signal is sent via a “k” type thermocouple and PROFIRE turns the system off for safety.

Difference between Process and High Temp. – The bath temperature signal is compared between the sensors. If there is a lag between these signals, the system is turned off after identifying the fault.

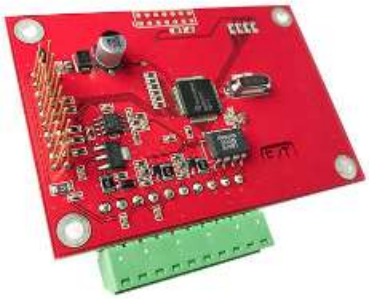
Pilot Fault – If the pilot is turned off improperly, the ionization system detects the fault and PROFIRE turns off the system for safety.

8 – REMOTE SYSTEM OPERATION

The PROFIRE 2100 has optional boards that incorporate functions into the system, including the MODBUS communication board, analog repeated input and output (4 to 20 mA) and datalogger board.

PROFIRES 2200SB/DB already have these functions built into their main board.

Modbus



4-20MA Repeater

Data Logger

In addition to these functions, it is possible to remotely monitor the PROFIRE STATUS, turn it on and off and send the EMERGENCY SHUTDOWN command.

9 – POSSIBLE FAULTS AND CAUSES

Defect	Likely cause	Correction
PROFIRE DOES NOT TURN ON	LACK OF POWER/WRONG VOLTAGE	MEASURE THE VOLTAGE AT THE PROFIRE INLET.
LOW PRESSURE ALARM	LOW PRESSURE	INCREASE LINE PRESSURE.
	PRESSURE SWITCH CONTACT INVERTED, NF WITH NA	TEST WITH MULTIMETER AND INVERT CONTACTS
	DEFECTIVE PRESSURE SWITCH	REPLACE PRESSURE SWITCH
LOW PRESSURE ALARM	HIGH PRESSURE	CHECK WHY THE PRESSURE RISE, REGULARIZE THE LINE PRESSURE.
	PRESSURE SWITCH CONTACT INVERTED, NF WITH NA	TEST WITH MULTIMETER AND INVERT CONTACTS
	DEFECTIVE PRESSURE SWITCH	REPLACE PRESSURE SWITCH
LEVEL ALARM	LOW LEVEL	COMPLETE THE WATER IN THE EXPANSION TANK
	LEVEL SWITCH CONTACT INVERTED, NF WITH NA	TEST WITH MULTIMETER AND INVERT CONTACTS
	DEFECTIVE LEVEL SWITCH	REPLACE LEVEL SWITCH
VOLTAGE ALARM	PROFIRE SET TO 24 VDC AND RECEIVING 12VDC OR VICE-VERSA	ADJUST IN PROFIRE THE VOLTAGE RECEIVED ACCORDING TO THE CONFIGURED VOLTAGE.
PILOT FLAME DOES NOT STABILIZE	PLUG POSITION FAILED	ADJUST PLUG POSITION

MAIN FLAME DOES NOT STABILIZE	PILOT POSITION FAILED	ADJUST PILOT POSITION
LACK OF FLUE GAS	SUPPLY FAILURE	CHECK AND REALIGN THE GAS AT THE INLET
	SHUT-OFF VALVE ACTIVATED	RESET SHUT-OFF VALVE
	OBSTRUCTED FILTER	CLEAN THE FILTER
	REGULATING VALVE IS FAILING	REPAIR THE VALVE

10 – TRANSPORTATION AND STORAGE

Transportation:

Mechanical impacts to the heater must be prevented as there is a risk of damage to its components. It must be transported with utmost care to avoid impacts or excessive stresses on its support structure.

Handling must be made through metallic cables or polyester straps that must be fixed in the appropriate eyelets in the structure, centralizing them in such a way as to prevent the cables from contacting its components. If damage occurs, the anticorrosive paint must be repaired to the original paint patterns.

Storage:

During the storage period, protections and packaging, valve vents, etc. must not be removed. The heater storage location must be away from material or vehicle circulation routes. Storage close to corrosive materials and placing any other material on it must be avoided.

In case of long-term storage or locations with aggressive atmosphere, it is recommended to pressurize the entire system with inert gas (N2) and monitor the pressure during the storage period.

The heaters must be stored in a clean and dry place, protected from the weather. They must be stored in a dry place, covered and positioned so as to facilitate future movements.

11 – General Recommendations

Functional tests were performed on the heater at the end of manufacture.

The criteria and steps for maintenance of instruments are contained in the manuals. However, any doubts regarding the use, operation or maintenance, contact Gascat's technical department, which will give you the appropriate guidance.

Gascat supplies the complete replacement kit on request.

12 – GUARANTEE

We guarantee our products for a period of 12 months from the date of invoicing if they are in operation. For stored products, this period is extended to 18 months. This guarantee covers only the cases when the production defects are evidenced, remaining unnoticed when the product was delivered.

This guarantee is not valid if it is found that the defect or accident was caused by accident, normal wear, improper installation, improper maneuver or use, improper storage, assembly disregarding technical standards or if the buyer has performed repairs or changes in equipment by themselves, without prior authorization from the manufacturer.

The information in this manual contains Gascat's supply conditions, regardless of the verified performance.

The information herein must not be interpreted or suggest a guarantee of performance regarding final products or purpose of using the system, nor must it serve as a recommendation for use of any product or process mentioned in the specifications. This system must only be operated by a qualified technician trained for this purpose. No changes that may affect the safety of the system can be made without our prior authorization.

GASCAT Ind. e Com. Ltda. reserves the right to make changes without prior notice, improving the drawings or specifications of the products described.

13 – MAIN COMPONENTS