

**Gas Fired Endothermic Generator**  
**Segregated chambers**  
**Atmosphere Engineering control system & SSI probe**

Start-Up Procedure

- 1.0 Familiarize yourself with contents of this manual and the equipment. Pay particular attention to the **EndoInjector Installation and Operation Manual** and the **Furnace Master Operating Operating Instructions** for the temperature controllers and high temperature limit controls.

The generator has been set up and operated at the factory so the preliminary setting adjustments should be reasonably adjusted for the start-up.

There are four stages in the start-up process. It's important that they be completed in the proper sequence. Do not shortcut the process. The stages are:

- 1.1 Dry out of system (No process gas flow).
  - 1.2 Activation or reducing of the catalyst (With process gas flow at 3:1 air/gas ratio).
  - 1.3 Preliminary adjustments to process gas parameters (Under manual control).
  - 1.4 Activation of Automatic carbon control (Turning the system over to automatic).
- 2.0 Initial Start-up valve settings.
- 2.1 Close the Generator process gas output to furnace(s) valve. Vent the generator output to the vent for combustible gases.
  - 2.2 Open the gas supply valve to Baso Switch on the burn-off vent and light pilot by pressing and holding the red tab on the Baso Switch while holding an open flame in front of the pilot. The tab must be held until the pilot stays lit upon tab release. The supply valve to the burn-off pilot is the 1<sup>st</sup> valve on the low pressure gas train. This pilot must be on in order to start any flow of process gas.
  - 2.3 Open drain/sample at bottom of heat exchanger(s) to drain any condensate from heat exchanger(s). Be careful here because a burnable gas may be present and also because any moisture present may be irritating to the skin. This valve should be opened periodically to check for moisture. A suitable container will be needed.
  - 2.4 Close drain/sample valve.
  - 2.5 Set the "Power" switch on the blue carbon probe control box to "OFF". Until the system is hot and ready to run do not allow the process output gas to flow through the carbon probe.
- 3.0 Turn electrical power disconnect to generator to the "ON" position.
- 4.0 Turn control power selector switch to "ON" position. The Alarm will sound. Press "Alarm Silence" on the furnace master control screen (Black button on lower RH side of panel).

- 5.0 Set temperature controller to 0°F on the furnace master control screen (See Touch Screen). They are factory set to 0°F.
- 6.0 The high temperature limit controls are factory set at 2000°F. (These are the 3 Watlow instruments at the bottom of the panel. To check the limit setpoint, press the Green key on the limit and the lower display will read "Lh.s1". The upper display should read 2000).
- 7.0 Reset fire check valve by lifting and turning the reset stud (See Operation Bulletin FC-1A).
- 8.0 Even through the generator has been operated at the factory some moisture may remain in the catalyst and insulation. Depending upon humidity levels this moisture may be significant. It's important to dry out the catalyst and insulating blanket before making production demands on the generator. If the generator is brought up from a cold start to operating temperature too fast it's possible to damage the catalyst and/or insulation. This will be true any time the generator is allowed to cool to ambient temperature for an extended period of time. It is especially true when starting the system up with new catalyst in place.
- 9.0 Press the "BURNER GAS START" button on the furnace master control panel. This will turn on the burner gas train. The Start button should stay lit to indicate that the burner gas train is on.
- 10.0 Turn the "ZONE ALLOW" switches for 1, 2 & 3 on. The pilot and burners will now light automatically (This may take 10-15 seconds). Open all ball valves between the heat exchangers and the output manifold.
- 11.0 Set the temperature controller to 400°F. The high fire will now operate to bring the zone up to the set point.  
  
Allow the unit to soak for an hour at 400°F and then increase the set temperature 200°F every half hour until a set temperature of 1000°F is reached. After a half hour at 1,000°F the temperature may be brought up to 1900°F; the standard operating temperature.
- 12.0 Set temperature control set point to 1900°F and allow to soak for a half hour.
- 13.0 The system is now ready for the introduction of process gas and the "activation" of the catalyst.
  - 13.1 The active material in the catalyst is nickel. In new catalyst the nickel is in the form of a nickel oxide. The oxide will be "reduced" in the initial operation as the hot process gas comes into contact with the catalyst. This catalyst activation process usually takes somewhere between 2 to 4 hours and will produce some moisture in the form of steam as the hydrogen in the process gas combines with the oxygen in the oxide. This will be observed as water in the drains at the bottoms of the heat exchangers. These drains should be periodically opened during this activation procedure to check for the presence of water.

- 13.2 During this activation process Great care must be exercised to avoid sooting of the catalyst. As the nickel-oxide is being reduced the dew point of the output gas will be quite high; much higher than desirable for production gas. This is normal. The process cannot be hurried. It's going to take 2 – 4 hours to complete. Do not succumb to the temptation to adjust the mixture below the 3:1 setting. The system is factory set to run at 3:1 (3 parts air to 1 part natural gas). There is a tendency to adjust the air/gas ratio to compensate for the temporarily high dew point. This is a terrible idea. It can result in an insufficient amount of oxygen being available for conversion which will result in severe sooting of the catalyst and retort.
- 13.3 Once the catalyst has been “activated” care should be exercised to prevent its exposure to air when the generator is not in operation (This “operation” does not include the burnout procedure). Otherwise, the catalyst can become re-oxidized and will need reactivation by the same procedure before further use.
- 14.0 The “OK TO START INJECTOR MTR” light will turn on when it is ok to start the injector motor. (The Pump will not start until generator temperature exceeds 1700°F.)
- 14.1 Start atmosphere pump by pushing the “INJECTOR MOTOR START” button.
- 14.2 Press the “INJECTOR MOTOR STOP” button and look at the motor to make sure it is roating in the proper direction as indicated on the motor. Re-Start the motor when you have confirmed proper rotaiton.
- 15.0 The “OK to START INJECTOR GAS” light will turn on when it is ok to start the injector gas. (The injector motor must be on and producing presure. A Minimum gas pressure must be supplied to the injector gas train and the Fire Check must be set.)
- 15.1 Start the “Injector Gas” by pushing the “INJECTOR GAS START” button.
- 15.2 The injector was factory set initially to be a 3:1 mixture of air to gas. This was set at the factory but should be checked at this time. This air to gas ratio should be checked frequently during the initial catalyst activation process to ensure that the mix doesn't get too rich. Keep the air/gas ratio at at least 3:1.
- 16.0 Endothermic gas is now being produced. As explained above, the dew point is going to be high for at least a couple of hours until the catalyst is activated. **Resist the urge to adjust the mixture for dew point for at least 4 hours.** After about 3 – 4 hours the dew point should start decreasing and should settle at some nominal level. When it does settle the air/gas ratio (and dew point) can be adjusted down to that desirable for production gas.
- Understand that the richer the mixture is the greater the tendency will be for the system to soot up. Careful attention should be paid to the air/gas ratio to ensure the system is operated at the leanest point that provides acceptable process gas.
- 17.0 The generator is equipped with Automatic Carbon Control. The control of the dew point can now be turned over to the controller.

- 18.0 The carbon probe can now be gradually inserted into the furnace. **IT IS IMPORTANT THAT THE PROBES NOT BE INSERTED ALL THE WAY INTO THE CHAMBERS AT THE TIME OF STARTUP. THE PROBES ARE DESIGNED TO OPERATE AT ABOUT 1550°F +/-150°F. THE CHAMBER OPERATING TEMPERATURE IS GOING TO BE BETWEEN 1700°F AND 1900°F; SUBSTANTIALLY HIGHER THAN THE OPTIMUM PROBE TEMPERATURE. IT IS NECESSARY FIRST GET THE UNIT UP TO OPERATING TEMPERATURE AND THEN TO GRADUALLY INSERT EACH PROBE TO THE POINT AT WHICH IT SEES THE 1550°F OPERATING TEMPERATURE. WHEN INSERTING OR REMOVING THE PROBE, A RATE OF 2 INCHES PER 5 MINUTES SHOULD NOT BE EXCEEDED.** The probe temperature is read on the touch screen. THIS IS A TRIAL AND ERROR PROCESS. The probe reading will not be accurate until the insulation reaches saturation temperature and the probe temperature stabilizes.
- 18.1 Set the “Power” switch on the blue carbon probe control box to “ON”.
- 18.2 When the dew point once again stabilizes the gas is ready for introduction to your process. Open the Generator process gas output to furnace(s) valves.
- 18.3 Adjust the burn-off regulator so that a slight flame is visible at the end of the burn-off pipe during normal operation.
- 19.0 The generator is equipped with an audible as well as visual indicator of alarm conditions.
- 19.1 When an alarm condition occurs the audible alarm will activate and the corresponding message will appear on the bottom of the screen and on the alarm menu. Pressing the “ALARM SILENCE” button will turn off the audible alarm but the alarm light and circuit will remain energized as long as the alarm condition exists. Alarm conditions will also disable or shut down various generator functions.
- 20.0 If the generator is operated above its capacity the retort temperature will be lower resulting in carbon formation and high residuals in the process gas output. The best operating range is about 75% - 80% of rated capacity.